IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF MICHIGAN SOUTHERN DIVISION

In Re Neo Wireless, LLC Patent Litigation	2:22-MD-03034-TGB Hon. Terrence G. Berg
Neo Wireless, LLC v. Ford Motor Company	2:22-CV-11402-TGB
Neo Wireless, LLC v. American Honda Motor Co., Inc., et al.	2:22-CV-11403-TGB
Neo Wireless, LLC v. Volkswagen Group of America, Inc., et al.	2:22-CV-11404-TGB
Neo Wireless, LLC v. Nissan North America Inc., et al.	2:22-CV-11405-TGB
Neo Wireless, LLC v. Toyota Motor Corporation, et al.	2:22-CV-11406-TGB
Neo Wireless, LLC v. General Motors Company, et al.	2:22-CV-11407-TGB
Neo Wireless, LLC v. Tesla Inc.	2:22-CV-11408-TGB
Neo Wireless, LLC v. Mercedes-Benz USA, LLC	2:22-CV-11769-TGB
Neo Wireless, LLC v. FCA US LLC	2:22-CV-11770-TGB

DEFENDANTS' PRELIMINARY INVALIDITY AND UNENFORCEABILITY CONTENTIONS

Defendants[1] hereby provide the following Preliminary Invalidity and Unenforceability Contentions ("Contentions") to Plaintiff Neo Wireless, LLC ("Neo Wireless" or "Plaintiff") for U.S. Patent Nos. 8,467,366 ("the '366 patent"), 10,833,908 ("the '908 patent"), 10,075,941 ("the '941 patent"), 10,447,450 ("the '450 patent"), 10,965,512 ("the '512 patent"), and 10,771,302 ("the '302 patent") (collectively, the "Asserted Patents").

I. PRELIMINARY STATEMENT AND RESERVATION OF RIGHTS

In its September 28, 2022 Infringement Contentions, Neo Wireless asserted the following claims (the "Asserted Claims"):

- Claims 1-5, 17, 20, and 21 of the '366 Patent;
- Claims 1-30 of the '908 Patent;
- Claims 8, 10, 12, 13, and 14 of the '941 Patent;
- Claims 7, 8, 10, and 11 of the '450 Patent;
- Claims 15, 20, 21, 23, 28, and 29 of the '512 Patent; and
- Claims 1, 2, 4-7, 23, 24, and 26-29 of the '302 Patent.

The Defendants do not provide any Contentions directed to claims that Neo Wireless has not asserted for purposes of infringement. To the extent Neo Wireless may be permitted to assert additional claims in the future, the Defendants reserve all rights to disclose new or supplemental

[1] "Defendants" in this document and its attachment refer to: General Motors Co.; General Motors LLC; Ford Motor Co.; Am. Honda Motor Co., Inc., Honda Development & Mfg. of Am., LLC; Volkswagen Grp. of Am., Inc.; Volkswagen Grp. of Am. Chattanooga Operations, LLC; Nissan N. Am. Inc.; Nissan Motor Acceptance Corp. a/k/a Nissan Motor Acceptance Co. LLC; Tesla Inc.; FCA US, LLC; Mercedes-Benz USA, LLC; Toyota Motor Corp.; Toyota Motor N. Am. Inc.; Toyota Motor Sales, USA Inc.; Toyota Motor Eng. & Mfg. N. Am. Inc.; Toyota Motor Credit Corp.

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contentions regarding such claims.

Because the same claim scope must apply for both infringement and invalidity, these Contentions are based on Neo Wireless's assertions in its Infringement Contentions. Defendants do not thereby implicitly or explicitly agree with Neo Wireless's construction of the claims. The Defendants reserve all rights to disclose new or supplemental invalidity contentions, including to address any construction of the claims rendered by the Court, changed theories of infringement, and any newly discovered evidence obtained through continued discovery, both formal and informal.

Subject to the rights reserved in these Contentions, all of the Asserted Claims are invalid under at least one or more of 35 U.S.C. §§ 101, 102, 103, and/or 112. The Asserted Claims are invalid because they are anticipated and/or rendered obvious under 35 U.S.C. §§ 102 and 103. If Neo Wireless contends or a fact-finder finds that one or more limitations of the Asserted Claims are not disclosed in the prior art identified as anticipatory, Defendants reserve the right to assert obviousness based on the identified references and/or to identify other references that would have rendered obvious the allegedly missing limitation. Furthermore, the obviousness combinations of references provided below and in the accompanying claim charts under 35 U.S.C. § 103 are exemplary only and are not intended to be exhaustive. If or when Neo Wireless challenges the disclosure of any of these references with respect to particular limitations of the Asserted Claims, Defendants reserve the right to supplement these Contentions to assert additional or different bases for obviousness. Defendants reserve the right to use any combination of the references set forth in these contentions to demonstrate the obviousness of the Asserted Claims. Additionally, certain claims of the Asserted Patents are invalid for failure to comply with the written description, enablement, and definiteness requirements of 35 U.S.C. § 112. The Asserted Claims are also

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invalid based on obviousness double-patenting.

The Asserted Claims are unenforceable as discussed herein, including in Section VIII below.

Defendants expressly reserve the right to amend, correct, and/or supplement these Contentions in accordance with the Procedural Schedule governing these cases.

* * *

These Contentions reflect Defendants' knowledge, investigation, and discovery as of the date of service. Defendants reserve the right to supplement these Contentions as appropriate and for any permissible reason. For example, pursuant to the Procedural Schedule, Defendants reserve the right to supplement these Contentions after subsequent case events, including any disclosure by Neo Wireless of amended or supplemental infringement contentions, any ruling by the Court on claim construction, or in response to arguments made and positions taken by Neo Wireless during fact and expert discovery. Defendants also reserve the right to supplement these Contentions if they become aware of additional prior art, become aware of additional features of the prior art references cited below, or become aware of any other relevant information through discovery, including non-party discovery, or otherwise. Defendants also reserve the right to modify or supplement their contentions based on the Court's construction of the claims.

In addition to the charts attached hereto, Defendants expressly incorporate by reference, as if expressly set forth in these contentions, all invalidity positions, prior art, and claim charts asserted against Neo Wireless in any Neo Wireless lawsuit or IPR proceeding by defendants, prior defendants, petitioners, and potential or actual licensees to the Asserted Patents. Defendants specifically incorporate by reference all invalidity positions presented in IPR2022-01537,

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IPR2022-01538, IPR2022-01539, IPR2022-01567, IPR2023-00086, IPR2023-00079, and any other *inter partes* petition(s) that may be filed against any of the Asserted Patents.

Defendants' citations to disclosures in any particular prior art reference are not (and are not intended to be) exhaustive but rather illustrative. Defendants reserve the right to rely on uncited portions of the prior art references and on other publications and expert testimony as aids in understanding and interpreting the cited portions, as providing context thereto, as additional evidence that the prior art discloses a claim limitation or the alleged invention as a whole, as evidence of the state of the art at a particular time, as evidence of the obviousness factor of contemporaneous development by others, and as evidence of motivation to combine. Defendants also reserve the right to rely on uncited portions of the prior art references, other publications, and testimony, including expert testimony, to establish bases for combination of prior art references that render the charted claims obvious. Defendants also reserve the right to rely upon any documentary or testimonial evidence of the existence of any systems that embodied or practiced the disclosures found in the accompanying invalidity charts, for example as discussed in the prior art references cited herein, as such systems may qualify as prior art under 35 U.S.C. § 102(g).[2]

Defendants intend to rely on admissions concerning the scope of the prior art relevant to the Asserted Patents found in, *inter alia*: the patent prosecution histories for the Asserted Patents and related patents and/or patent applications (including all prior art cited therein); any deposition testimony of the named inventors on the Asserted Patents and related patents and/or patent applications in this matter or any other matter; evidence and testimony relating to the level of skill in the art; and the papers filed and any evidence submitted by Neo Wireless in connection with this matter.

[2] Citations herein refer to the pre-AIA version of Title 35 of the U.S. Code.

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Defendants reserve the right to assert that the Asserted Claims are invalid under 35 U.S.C. § 102(f) in the event Defendants obtain additional evidence that the inventors named in any of the Asserted Patents did not invent the subject matter claimed therein. Should Defendants obtain such evidence, it will provide the name of the person(s) from whom and the circumstances under which the alleged invention or any part of it was derived.

These Contentions are not intended to include or otherwise reflect Defendants' claim interpretations. Because the Court has not yet construed any of the claims in this litigation, Defendants base these Contentions at least on their present understanding of Neo Wireless's view and application of the claim scope, to the extent that view can be inferred from Neo Wireless's actual and/or apparent application of those claims. But Defendants do not adopt any constructions or interpretations impliedly or expressly in these Contentions. Moreover, Defendants' Contentions may reflect alternative positions as to claim construction and scope.

For the purposes of these Contentions, Defendants have made assumptions regarding possible meanings of indefinite claim terms. By making these assumptions, Defendants do not admit that any claim language satisfies 35 U.S.C. § 112. Similarly, the use of asserted claim terms herein should not be understood to mean that such terms, as used in the Asserted Patents or claims thereof, are definite or otherwise comply with the conditions of patentability under 35 U.S.C. § 112. Likewise, the use of asserted claim terms herein should not be understood to suggest or imply a common, usual, ordinary, customary, plain, or accepted meaning in the art for any such terms.

By providing these Contentions, Defendants are not waiving nor limiting their rights to make arguments in the future about the proper scope of the claims or to advance alternative constructions to those Neo Wireless advocates. Defendants expressly reserve the right to argue

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for narrower claim constructions during this litigation and to supplement these Contentions after the Court has issued a claim construction ruling.

The Defendants' factual investigations, including their investigation of prior art and grounds for invalidity, is ongoing. Further, the Defendants' invalidity positions will be the subject of expert testimony. The Defendants reserve the right to supplement these Contentions, including, without limitation, adding additional prior art and grounds of invalidity in accordance with the Federal Rules of Civil Procedure and Procedural Schedule in these cases, or otherwise.

II. PERSON HAVING ORDINARY SKILL IN THE ART

A person of ordinary skill in the art ("POSITA" or "POSA") would have a bachelor's degree in electrical engineering, computer engineering, computer science, or an equivalent field, or an advanced degree in those fields, as well as at least 3-5 years of academic or industry experience in mobile wireless communications, or comparable industry experience.

III. IDENTIFICATION OF RELEVANT PRIOR ART

A. Priority Dates

In its Infringement Contentions, Neo Wireless asserted the following priority dates for the Asserted Patents:

- According to Neo Wireless, the asserted claims of the '366 Patent are supposedly entitled to a priority date of no later than March 9, 2004.
- According to Neo Wireless, the asserted claims of the '908 Patent are supposedly entitled to a priority date of no later than January 29, 2004.
- According to Neo Wireless, the asserted claims of the '941 Patent are supposedly entitled to a priority date of no later than February 13, 2004.

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- According to Neo Wireless, the asserted claims of the ’450 Patent are supposedly entitled to a priority date of no later than September 28, 2005.
- According to Neo Wireless, the asserted claims of the ’512 Patent are supposedly entitled to a priority date of no later than January 29, 2004.
- According to Neo Wireless, the asserted claims of the ’302 Patent are supposedly entitled to a priority date of no later than January 29, 2004.

Defendants do not agree, and therefore dispute, that the Asserted Claims are entitled to the priority date asserted by Neo Wireless. For example, Neo Wireless asserted that the ’450 Patent has an alleged priority date of September 28, 2005. The alleged priority is date is based on the filing of Provisional application No. 60/721,451, to which the ’450 Patent claims priority. But Provisional application No. 60/721,451 does not include written description of the alleged invention sufficient to enable any person skilled in the art to make and use a method comprising “receive a signal containing information from the base station over *a segment of time-frequency resource*, the segment having a starting time-frequency coordinate and *the segment comprising N time-frequency resource units within a time interval*, each unit containing a set of frequency subcarriers in a group of OFDM symbols, where N=2, 4, or 8” as set forth at claim 7 of the ’450 Patent. Provisional application No. 60/721,451 discloses:

> In one embodiment, a mapper, as implied by the “Subchannel and Symbol Construction” box in Figure 2, is designed to map the logical frequency/subcarrier and OFDM symbol indices seen by upper layer facilities, such as the MAC resource scheduler or the coding and modulation modules, to the actual physical subcarrier and OFDM symbol indices. A contiguous time-frequency area before the mapping may be actually discontinuous after the mapping, and vice versa. On the other hand, in a special case, the mapping may be a “null process”, which maintains the same time and frequency indices before and after the mapping. The mapping process may change from time slot to time slot, from frame to frame, or from cell to cell. Without loss of generality, in the invention, the terms “resource”, “airlink resource”, “physical resource”, “radio resource”, and “time-frequency resource” may refer to either the time-frequency resource before such mapping or that after such mapping.

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Provisional application No. 60/721,451 at 5 (emphasis added). As the PTAB explained, "With the goal of improving spectral efficiency, the '450 patent describes a system and method for minimizing the control overhead in a multi-carrier wireless communication network by using a 'time-frequency resource.'" IPR2021-01486, Decision Denying Institution of Inter Partes Review, at 4. The PTAB further explained that the contentions that this limitation are disclosed are not correct where, "such contentions are premised on . . . conflation of separate frequency subchannels and time slots as the recited singular 'time-frequency resource'." *Id* at 27. As shown above, Provisional application No. 60/721,451 discloses a mapping involving separate time and frequency coordinates ("indices"). Provisional application No. 60/721,451 defines its "time-frequency resource" as either said resource before such a mapping, comprising separate "logical frequency/subcarrier and OFDM symbol indices", or that after such mapping, comprising separate "physical subcarrier and OFDM symbol indices". The time-frequency area disclosed may be discontinuous, so a singular time frequency resource is not disclosed. While Provisional application No. 60/721,451 describes one-dimensional coordinates, it nowhere else defines "time-frequency resource". It therefore does not disclose any singular "time-frequency resource". The '450 patent is therefore not entitled to the claimed priority date of September 28, 2005. The correct and legally-applicable priority date of the '450 patent is instead the filing date of application No. PCT/US2006/038149, September 28, 2006.

As another example, Neo Wireless asserted that the '302 Patent has an alleged priority date of January 29, 2004. The alleged priority is date is based on the filing of Provisional applications No. 60/540,032 and 60/540,586, to which the '302 Patent claims priority. But the disclosure of these two provisional applications does not disclose that the supposed probing signal (the DSSS signal) is modulated in the frequency domain. Instead, the January 30, 2004 provisional only

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describes the DSSS signals as being modulated in the time domain, while the MC signals are disclosed as being modulated in the frequency domain. *See* Jan 30, 2004 Provisional Application No. 60/540,586 at 2 ("[T]he MC signal is modulated on subcarriers in the frequency domain while the SS signal is modulated in the time domain."), 5 ('[T]he MC signal is modulated on subcarriers in the frequency domain while the SS signal is modulated in the time domain."). It is only in the PCT application filed in 2005 that there is disclosure of DSSS signals, which are used as probing signals in the patent specification, being modulated in the time and frequency domain. *See, e.g.,* '302 pat. at 5:22-26 ("The information from the DSSS receiver 920 will then be used . . . to derive the channel information in the case of channel probing"), 9:7-8 ("DSSS signal is used for channel probing or to carry short messages."); 4:45-48 ("In another embodiment, the MC signal is modulated on subcarriers in the frequency domain while the DSSS signal is modulated in either the time domain or the frequency domain."). The '302 patent is therefore not entitled to the claimed priority date of the provisional applications' filing dates in January 2004. The correct and legally-applicable priority date of the '450 patent is instead no earlier than the filing date of application No. PCT/US2005/003518, on January 27, 2005.

The examples for the '450 Patent and '302 Patent above are illustrative, but not exhaustive, of the priority problems that afflict the Asserted Patents. Nonetheless, for the sole purposes of these Contentions, Defendants have applied Neo Wireless's alleged priority dates for each patent to show that, even under Neo Wireless's incorrect priority dates, the Asserted Patents are nonetheless invalid. To the extent Neo Wireless seeks to establish an earlier priority date for any of the Asserted Claims, Defendants reserve the right to amend their invalidity contentions accordingly.

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B. Prior Art Patent Publications

Based on their investigation to date, Defendants have provided in the list below the prior art patent publications presently known to Defendants that they contend anticipate and/or render obvious the Asserted Claims. The prior art identified in these Contentions discloses (i.e., anticipates and/or renders obvious) the elements of the Asserted Claims either explicitly or inherently.

Prior-art patents or publications included in these contentions may be related (such as a divisional, continuation, continuation-in-part, parent, or child) to earlier or later-filed patents or publications, may have counterparts filed in other jurisdictions, or may incorporate (or be incorporated by) other patents or publications by reference. The listed patents or publications are intended to be representative of these other patents or publications to the extent they exist. Defendants accordingly reserve the right to modify, amend, or supplement these contentions with these related patents or publications, as well as other prior art references, upon further investigation. Additionally, any reference in these Contentions, including the appendices and exhibits thereto, to a specific subsection or subsections of 35 U.S.C. § 102, is merely exemplary, and Defendants expressly reserve the right to rely on additional or other sections of 35 U.S.C. § 102, as appropriate. If Neo Wireless asserts that one or more of these references or systems fails to disclose one or more elements of a claim, Defendants reserve the right to also use those references to invalidate the claim under 35 U.S.C. § 103.

Discovery is ongoing, and Defendants' prior art investigation and third-party discovery is therefore not yet complete. Defendants reserve the right to present additional items of prior art under 35 U.S.C. §§ 102 and/or 103 that are located during the course of discovery or further investigation. For example, Defendants expect to receive documents from additional third parties either through informal requests or under subpoenas that are believed to have knowledge,

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documentation, and/or corroborating evidence concerning some of the prior art listed and discussed below. These third parties include without limitation the authors, inventors, or assignees of the references listed in these disclosures.

1. The '366 Patent

Patent No.	Country of Origin	Date of Issue
1 021 012 A1	EP	July 19, 2000
1 276 288 A1	EP	January 15, 2003
1 635 494 B1	EP	April 21, 2010
20030058589A	KR	July 7, 2003
2001/0024956 A1	US	September 27, 2001
2003/0076812 A1	US	April 24, 2003
2003/0198179 A1	US	October 23, 2003
2004/0001429 A1	US	January 1, 2004
2004/0066740 A1	US	April 8, 2004
2004/0114504 A1	US	June 17, 2004
2004/0114566 A1	US	June 17, 2004
2004/0136464 A1	US	July 15, 2004
2004/0174845 A1	US	September 9, 2004
2005/0002323 A1	US	January 6, 2005
2005/0058058 A1	US	March 17, 2005
2005/0101326 A1	US	May 12, 2005
2005/0153723 A1	US	July 14, 2005
2005/0163244 A1	US	July 28, 2005
2005/0232183 A1	US	October 20, 2005
5,732,113 A	US	March 24, 1998
5,903,614 A	US	May 11, 1999
5,909,436 A	US	June 1, 1999
6,091,702 A	US	July 18, 2000
6,442,220 B1	US	August 27, 2002
6,486,831 B1	US	November 26, 2002
6,519,291 B1	US	February 11, 2003
6,567,482 B1	US	May 20, 2003
6,628,697 B1	US	September 30, 2003
6,738,443 B1	US	May 18, 2004
6,801,782 B2	US	October 5, 2004
6,850,481 B2	US	February 1, 2005
6,947,748 B2	US	September 20, 2005
7,069,577 B2	US	June 27, 2006
7,088,782 B2	US	August 8, 2006
7,099,269 B2	US	August 29, 2006
7,145,955 B1	US	December 5, 2006

Patent No.	Country of Origin	Date of Issue
7,177,266 B2	US	February 13, 2007
7,254,196 B2	US	August 7, 2007
7,263,058 B2	US	August 28, 2007
7,295,518 B1	US	November 13, 2007
7,310,303 B2	US	December 18, 2007
7,336,953 B2	US	February 26, 2008
7,363,038 B2	US	April 22, 2008
7,369,853 B2	US	May 6, 2008
7,415,080 B2	US	August 19, 2008
7,426,232 B2	US	September 16, 2008
7,450,489 B2	US	November 11, 2008
7,483,367 B2	US	January 27, 2009
7,551,546 B2	US	June 23, 2009
7,602,696 B2	US	October 13, 2009
7,639,600 B1	US	December 29, 2009
7,675,841 B2	US	March 9, 2010
7,738,437 B2	US	June 15, 2010
7,787,431 B2	US	August 31, 2010
7,787,514 B2	US	August 31, 2010
7,986,742 B2	US	July 26, 2011
8,320,301 B2	US	November 27, 2012
8,406,114 B2	US	March 26, 2013
8,792,325 B1	US	July 29, 2014
9,166,741 B2	US	October 20, 2015
2005/050887 A2	WO	June 2, 2005

2. The ’908 Patent

Patent No.	Country of Origin	Date of Issue
2002350321 B2	AU	July 9, 2003
0 966 797 A2	EP	December 29, 1999
1 061 687 A1	EP	December 20, 2000
1 276 288 A1	EP	January 15, 2003
1 635 494 B1	EP	April 21, 2010
20030058589A	KR	July 7, 2003
10,742,358 B2	US	August 11, 2020
2002/0159414 A1	US	October 31, 2002
2002/0159422 A1	US	October 31, 2002
2002/0181509 A1	US	December 5, 2002
2003/0076812 A1	US	April 24, 2003
2004/0001429 A1	US	January 1, 2004
2004/0081131 A1	US	April 29, 2004
2004/0125869 A1	US	July 1, 2004
2004/0128605 A1	US	July 1, 2004

Patent No.	Country of Origin	Date of Issue
2004/0136464 A1	US	July 15, 2004
2004/0141481 A1	US	July 22, 2004
2004/0156328 A1	US	August 12, 2004
2004/0228269 A1	US	November 18, 2004
2005/0157678 A1	US	July 21, 2005
2007/0053280 A1	US	March 8, 2007
5,430,760 A	US	July 4, 1995
5,909,436 A	US	June 1, 1999
6,091,702 A	US	July 18, 2000
6,320,897 B1	US	November 20, 2001
6,381,229 B1	US	April 30, 2002
6,574,267 B1	US	June 3, 2003
6,711,120 B1	US	March 23, 2004
6,714,511 B1	US	March 30, 2004
6,850,481 B2	US	February 1, 2005
60/391624	US	June 27, 2002
60/421309	US	October 25, 2002
60/429081	US	November 26, 2002
60/432440	US	December 10, 2002
60/438601	US	January 7, 2003
60/441105	US	January 21, 2003
7,088,782 B2	US	August 8, 2006
7,099,269 B2	US	August 29, 2006
7,254,196 B2	US	August 7, 2007
7,289,834 B2	US	October 30, 2007
7,319,660 B2	US	January 15, 2008
7,426,232 B2	US	September 16, 2008
7,512,086 B2	US	March 31, 2009
7,551,546 B2	US	June 23, 2009
7,602,696 B2	US	October 13, 2009
7,738,437 B2	US	June 15, 2010
7,782,750 B2	US	August 24, 2010
7,787,514 B2	US	August 31, 2010
8,098,751 B2	US	January 17, 2012
8,159,932 B1	US	April 17, 2012
8,169,944 B2	US	May 1, 2012
8,320,301 B2	US	November 27, 2012
8,842,657 B2	US	September 23, 2014
9,473,269 B2	US	October 18, 2016
1999/060729 A1	WO	November 25, 1999
2000/032000 A1	WO	June 2, 2000
2005/022792 A2	WO	March 10, 2005

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3. The ’941 Patent

Patent No.	Country of Origin	Date of Issue
1 276 288 A1	EP	January 15, 2003
1,299,978 B1	EP	October 3, 2018
10,742,358 B2	US	August 11, 2020
2002/0119781 A1	US	August 29, 2002
2002/0147017 A1	US	October 10, 2002
2002/0154705 A1	US	October 24, 2002
2002/0183010 A1	US	December 5, 2002
2003/0125040 A1	US	July 3, 2003
2004/0142698 A1	US	July 22, 2004
2004/0165684 A1	US	August 26, 2004
2005/0018755 A1	US	January 27, 2005
2005/0068909 A1	US	March 31, 2005
2006/0034163 A1	US	February 16, 2006
6,400,699 B1	US	June 4, 2002
6,473,467 B1	US	October 29, 2002
6,802,035 B2	US	October 5, 2004
6,853,629 B2	US	February 8, 2005
6,859,503 B2	US	February 22, 2005
6,937,558 B2	US	August 30, 2005
6,937,592 B1	US	August 30, 2005
6,947,748 B2	US	September 20, 2005
6,952,454 B1	US	October 4, 2005
6,985,432 B1	US	January 10, 2006
6,985,434 B2	US	January 10, 2006
7,020,069 B1	US	March 28, 2006
7,020,110 B2	US	March 28, 2006
7,039,001 B2	US	May 2, 2006
7,095,709 B2	US	August 22, 2006
7,126,996 B2	US	October 24, 2006
7,142,864 B2	US	November 28, 2006
7,146,172 B2	US	December 5, 2006
7,167,690 B2	US	January 23, 2007
7,248,879 B1	US	July 24, 2007
7,317,750 B2	US	January 8, 2008
7,339,897 B2	US	March 4, 2008
7,418,043 B2	US	August 26, 2008
7,421,039 B2	US	September 2, 2008
7,430,257 B1	US	September 30, 2008
7,436,757 B1	US	October 14, 2008
7,471,932 B2	US	December 30, 2008
7,551,546 B2	US	June 23, 2009
7,769,097 B2	US	August 3, 2010

Patent No.	Country of Origin	Date of Issue
7,813,441 B2	US	October 12, 2010
7,961,809 B2	US	June 14, 2011
8,098,751 B2	US	January 17, 2012
8,270,521 B2	US	September 18, 2012
8,320,301 B2	US	November 27, 2012
8,542,765 B2	US	September 24, 2013
8,571,057 B2	US	October 29, 2013
8,670,390 B2	US	March 11, 2014
8,934,445 B2	US	January 13, 2015
9,473,269 B2	US	October 18, 2016
2001/071928 A2	WO	September 27, 2001
2005/062497 A1	WO	July 7, 2005

4. The ’450 Patent

Patent No.	Country of Origin	Date of Issue
2001/0043576 A1	US	November 22, 2001
2004/0264507 A1	US	December 30, 2004
2005/0058089 A1	US	March 17, 2005
2005/0063345 A1	US	March 24, 2005
2005/0075148 A1	US	April 7, 2005
2005/0141475 A1	US	June 30, 2005
2005/0197123 A1	US	September 8, 2005
2005/0201476 A1	US	September 15, 2005
2005/0277429 A1	US	December 15, 2005
2006/0039274 A1	US	February 23, 2006
2006/0046647 A1	US	March 2, 2006
2006/0203935 A1	US	September 14, 2006
2006/0245384 A1	US	November 2, 2006
2006/0285481 A1	US	December 21, 2006
2007/0019753 A1	US	January 25, 2007
2007/0053320 A1	US	March 8, 2007
2007/0201406 A1	US	August 30, 2007
2008/0317152 A1	US	December 25, 2008
2009/0175363 A1	US	July 9, 2009
6,039,624 A	US	March 21, 2000
6,904,283 B2	US	June 7, 2005
7,020,069 B1	US	March 28, 2006
7,020,110 B2	US	March 28, 2006
7,042,858 B1	US	May 9, 2006
7,095,708 B1	US	August 22, 2006
7,333,463 B2	US	February 19, 2008
7,522,637 B2	US	April 21, 2009
7,545,763 B2	US	June 9, 2009

Patent No.	Country of Origin	Date of Issue
7,577,438 B2	US	August 18, 2009
7,643,832 B2	US	January 5, 2010
7,684,807 B2	US	March 23, 2010
7,706,456 B2	US	April 27, 2010
7,813,322 B2	US	October 12, 2010
7,830,907 B1	US	November 9, 2010
7,929,407 B2	US	April 19, 2011
8,054,788 B2	US	November 8, 2011
8,089,911 B2	US	January 3, 2012
8,165,009 B2	US	April 24, 2012
8,315,326 B2	US	November 20, 2012
8,537,760 B2	US	September 17, 2013
8,588,145 B2	US	November 19, 2013
8,670,390 B2	US	March 11, 2014
8,744,465 B2	US	June 3, 2014
8,769,046 B2	US	July 1, 2014
10,355,825 B2	US	July 16, 2019
RE44927 E	US	June 3, 2014
2006/0269005 A1	US	November 30, 2006
2005/081437 A1	WO	September 1, 2005
2006/075205 A1	WO	July 20, 2006

5. The ’512 Patent

Patent No.	Country of Origin	Date of Issue
1 117 188 A2	EP	July 18, 2001
1 148 673 A2	EP	October 24, 2001
1 204 224 A2	EP	May 8, 2002
1 324 510 A1	EP	July 2, 2003
1 367 741 A2	EP	December 3, 2003
8,428,594 B2	US	April 23, 2013
2002/0003774 A1	US	January 10, 2002
2002/0086708 A1	US	July 4, 2002
2002/0136176 A1	US	September 26, 2002
2002/0163879 A1	US	November 7, 2002
2003/0072254 A1	US	April 17, 2003
2003/0072255 A1	US	April 17, 2003
2003/0156570 A1	US	August 21, 2003
2004/0081131 A1	US	April 29, 2004
2004/0095902 A1	US	May 20, 2004
2004/0131007 A1	US	July 8, 2004
2004/0166886 A1	US	August 26, 2004
2004/0179627 A1	US	September 16, 2004
2004/0228267 A1	US	November 18, 2004

Patent No.	Country of Origin	Date of Issue
2005/0030886 A1	US	February 10, 2005
2005/0063298 A1	US	March 24, 2005
2005/0070285 A1	US	March 31, 2005
2005/0085265 A1	US	April 21, 2005
2005/0122928 A1	US	June 9, 2005
2005/0157637 A1	US	July 21, 2005
2005/0163262 A1	US	July 28, 2005
2005/0163265 A1	US	July 28, 2005
2006/0034163 A1	US	February 16, 2006
2006/0114812 A1	US	June 1, 2006
2006/0146867 A1	US	July 6, 2006
2007/0133386 A1	US	June 14, 2007
2007/0263667 A1	US	November 15, 2007
2008/0107192 A1	US	May 8, 2008
5,867,478 A	US	February 2, 1999
6,088,347 A	US	July 11, 2000
6,501,788 B1	US	December 31, 2002
6,560,209 B1	US	May 6, 2003
6,611,507 B1	US	August 26, 2003
6,937,642 B2	US	August 30, 2005
7,042,858 B1	US	May 9, 2006
7,120,395 B2	US	October 10, 2006
7,242,955 B2	US	July 10, 2007
7,280,467 B2	US	October 9, 2007
7,304,939 B2	US	December 4, 2007
7,433,339 B2	US	October 7, 2008
7,512,409 B1	US	March 31, 2009
7,548,527 B2	US	June 16, 2009
7,551,546 B2	US	June 23, 2009
7,664,533 B2	US	February 16, 2010
7,764,593 B2	US	July 27, 2010
7,826,471 B2	US	November 2, 2010
7,873,021 B2	US	January 18, 2011
9,125,202 B2	US	September 1, 2015
9,473,269 B2	US	October 18, 2016
2002/049385 A2	WO	June 20, 2002
2004/049618 A1	WO	June 10, 2004
2005/041448 A1	WO	May 6, 2005
2005/060195 A1	WO	June 30, 2005

6. The ’302 Patent

Patent No.	Country of Origin	Date of Issue
1 137 211 A1	EP	September 26, 2001

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Patent No.	Country of Origin	Date of Issue
2002/0118783 A1	US	August 29, 2002
2002/0136176 A1	US	September 26, 2002
2002/0154705 A1	US	October 24, 2002
2002/0159537 A1	US	October 31, 2002
2002/0172308 A1	US	November 21, 2002
2003/0081538 A1	US	May 1, 2003
2003/0179776 A1	US	September 25, 2003
2003/0193889 A1	US	October 16, 2003
2003/0227888 A1	US	December 11, 2003
2004/0001429 A1	US	January 1, 2004
2004/0066754 A1	US	April 8, 2004
2004/0081123 A1	US	April 29, 2004
2004/0081131 A1	US	April 29, 2004
2004/0131007 A1	US	July 8, 2004
2004/0131011 A1	US	July 8, 2004
2004/0179627 A1	US	September 16, 2004
2004/0190640 A1	US	September 30, 2004
2004/0203468 A1	US	October 14, 2004
2004/0218523 A1	US	November 4, 2004
2005/0030886 A1	US	February 10, 2005
2005/0120097 A1	US	June 2, 2005
2005/0135291 A1	US	June 23, 2005
2005/0157801 A1	US	July 21, 2005
2005/0163082 A1	US	July 28, 2005
2005/0163238 A1	US	July 28, 2005
2005/0163258 A1	US	July 28, 2005
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5,519,730 A	US	May 21, 1996
5,867,478 A	US	February 2, 1999
5,909,436 A	US	June 1, 1999
6,141,393 A	US	October 31, 2000
6,483,814 B1	US	November 19, 2002
6,510,133 B1	US	January 21, 2003
6,928,062 B2	US	August 9, 2005
6,999,467 B2	US	February 14, 2006
60/422362	US	October 29, 2002
60/422368	US	October 29, 2002
60/438601	US	January 7, 2003
60/532791	US	December 23, 2003
60/538210	US	January 21, 2004
7,042,858 B1	US	May 9, 2006

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Patent No.	Country of Origin	Date of Issue
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7,145,940 B2	US	December 5, 2006
7,221,645 B2	US	May 22, 2007
7,236,452 B2	US	June 26, 2007
7,242,722 B2	US	July 10, 2007
7,283,498 B2	US	October 16, 2007
7,317,931 B2	US	January 8, 2008
7,508,798 B2	US	March 24, 2009
7,640,373 B2	US	December 29, 2009
7,920,503 B2	US	April 5, 2011
7,986,742 B2	US	July 26, 2011
8,213,994 B2	US	July 3, 2012
8,218,609 B2	US	July 10, 2012
8,320,301 B2	US	November 27, 2012
8,427,936 B2	US	April 23, 2013
8,553,595 B2	US	October 8, 2013
8,553,822 B2	US	October 8, 2013
9,473,269 B2	US	October 18, 2016
2001/089097 A2	WO	November 22, 2001
2002/031991 A2	WO	April 18, 2002
2003/003634 A1	WO	January 9, 2003
2003/047141 A1	WO	June 5, 2003
2004/073276 A1	WO	August 26, 2004

C. Prior Art Non-Patent Publications[3,4]

1. The ’366 Patent

Title	Date of publication	Author or Publisher
Outer Loop Power Control for TDD Mode, RAN WG2 777/99, 3GPP TSG RAN Working Group 2 #6	August 17-20, 1999	3GPP

[3] Any discussion of a non-patent publication in either Section III.C or in one of the claim charts included herewith that discloses a corresponding product or system shall also apply with equal force to the underlying product or system. In other words, both the non-patent publication and the underlying product or system themselves qualify as prior art in the context that they are used herein.

[4] Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the public availability, as necessary, of any non-patent publication if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge,

Title	Date of publication	Author or Publisher
Report on Ad-hoc 9 Activities between WG1#6 and WG1#7, TSGR1#7(99)a78, TSG-RAN Working Group 1 meeting #3	Aug 30 - Sept 3 1999	3GPP
"Multicarrier Modulation for Data Transmission: An Idea Whose Time Has Come," IEEE Comm. Mag., 1990	1990	Bingham
"Synthesis of Band-Limited Orthogonal Signals for Multichannel Data Transmission," Bell Syst. Tech. Jnl., 1966	1966	Chang
"Analysis and Simulation of a Digital Mobile Channel Using Orthogonal Frequency Division Multiplexing," IEEE Trans. Comm., Vol. 33, No. 7, 1985	1985	Cimini
"Peak-to-Mean Power Control in OFDM, Golay Complementary Sequences, and Reed-Muller Codes," IEEE Trans. Info. Theory, Vol. 45, No. 7, 1999	1999	Davis
"Peak-to-Mean Power Control in OFDM, Golay Complementary Sequences, and Reed-Muller Codes," IEEE Transactions on Information Theory, Vol. 45, No. 7, pp. 2397-2417	November 1999	Davis et al.
Universal Mobile Telecommunications System (UMTS); UMTS Terrestrial Radio Access (UTRA); Concept evaluation (UMTS 30.06 version 3.0.0), TR 101 146 V3.0.0	December 1997	ETSI
"Initial Uplink Synchronization and Power Control (Ranging Process) for OFDMA Systems," Proc. IEEE GLOBECOM 2004, Vol. 6, pp. 3999-4003	2004	Fu et al.
"Adjacent Channel Interference in an OFDM System," Proc. Vehic. Tech. Conf., 1996	1996	Gudmunson et al.
Air Interface for Fixed Broadband Wireless Access Systems Part A: Systems between 2 and 11 GHz, IEEE 802.16ab-01/01r1	July 2001	IEEE
IEEE 802.16b PHY Strawman, IEEE 802.16.4-01/12	May 8, 2001	IEEE
IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access	January 15, 2003	IEEE

documentation, and/or corroborating evidence concerning the public availability of the identified non-patent publications.

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Title	Date of publication	Author or Publisher
Systems—Amendment 1: Detailed System Profiles for 10-66 GHz, IEEE 802.16c-2002		
IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems—Amendment 2: Medium Access Control Modification and Additional Physical Layer Specifications for 2-11 GHz, IEEE 802.16a-2003	April 1, 2003	IEEE
"Peering Into the WiMAX Spec: Part 1," EE Times	January 20, 2004	Johnston et al.
"OFDMA Uplink Ranging for IEEE 802.16e Using Modified Generalized Chirp-Like Polyphase Sequences," 1st IEEE and IFIP International Conference in Central Asia on Internet, 2005	2005	Lee
"Short Initial Ranging Transmission for IEEE 802.16 OFDMA," IEEE C802.16e-03/53r2	September 11, 2003	Lim et al.
"A Comparison of Peak Power Reduction Schemes for OFDM," IEEE Global Telecommunications Conference 1997, Vol. 1, pp. 1-5	1997	Müller et al.
"A Novel Peak Power Reduction Scheme for OFDM," Proc. of PIMRC '97, Vol. 3, pp. 1090-1094	September 1997	Müller et al.
"OFDM with Trailing Zeros Versus OFDM with Cyclic Prefix: Links, Comparisons and Application to the HIPERLAN/2 System," 2000 IEEE International Conference on Communications, Vol 2, pp. 1049-1053	2000	Muquet et al.
"Generalized Chirp-Like Polyphase Sequences with Optimum Correlation Properties," IEEE Transactions on Information Theory, Vol. 38, No. 4, pp. 1406-1409	July 1992	Popovic
Initial OFDMA Proposal for the 802.16.4 PHY Layer, IEEE 802.16.4c-01/01	January 11, 2001	Segal et al.
"Analysis of the Uplink of an Asynchronous Multi-user DMT OFDMA System Impaired by Time Offsets, Frequency Offsets, and Multi-path Fading," Proc. Vehic. Tech. Conf., 2000	2000	Tonello et al.
"OFDM Codes for Peak-to-Average Power Reduction and Error Correction,"	1996	Van Nee

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Title	Date of publication	Author or Publisher
Proceedings of GLOBECOM '96, Vol. 1, pp. 740-744		
"Reducing the Peak-to-Average Power Ratio of OFDM," 48th IEEE Vehicular Technology Conference, 1998, Vol. 3, pp. 2072-2076	1998	Van Nee
"OFDM for Wireless Multimedia Communications," Artech House 2000	2000	Van Nee et al.
"Implementation of a MIMO OFDM-Based Wireless LAN System," IEEE Transactions on Signal Processing, Vol. 52, No. 2	February 2004	Van Zelst et al.
"A Conceptual Study of OFDM-based Multiple Access Schemes: Part 1 – Air Interface Requirements, 1996	1996	Wahlqvist et al.
"Time Synchronization in the Uplink of an OFDM System," Proc. Vehic. Tech. Conf., 1996, pp. 1569–73	1996	Wahlqvist et al.
"COFDM: An Overview," IEEE Trans. Broadc., Vol. 41, No. 1, 1995	1995	Zou et al.

2. The '908 Patent

Title	Date of publication	Author or Publisher
3GPP; Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (FDD) (Release 6), 3GPP TS 25.211 V6.0.0	December 2003	3GPP
"A Comparison Between Synchronous CDMA and Orthogonal Frequency Division Multiplexing (OFDM) for Fixed Broadband Wireless Access," Master's Thesis, Virginia Polytechnic Institute, Blacksburg	April 15, 2002	Chheda
"Peak-to-Mean Power Control in OFDM, Golay Complementary Sequences, and Reed-Muller Codes," IEEE Transactions on Information Theory, Vol. 45, No. 7, pp. 2397-2417	November 1999	Davis et al.
IEEE Standard 802.16: A Technical Overview of the WirelessMAN™ Air Interface for Broadband Wireless Access, IEEE C802.16-02/05	June 4, 2002	Eklund et al.
Digital cellular telecommunications system (Phase 2+); Physical layer on the radio path; (Release 5), ETSI TS 145 001 V5.7.0	November 2003	ETSI

Title	Date of publication	Author or Publisher
ETSI Terrestrial Trunked Radio (TETRA); Packet Data Optimized (PDO); Part 2: Air Interface (AI), ETS 300 393-2	April 1999	ETSI
ETSI TR 101 683 V1.1.1, Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; System Overview	February 2000	ETSI
ETSI TS 101 475 V1.2.2, Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Physical (PHY) Layer	February 2001	ETSI
ETSI TS 101 761-1 V1.3.1, Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Data Link Control (DLC) Layer; Part 1: Basic Data Transport Functions	December 2001	ETSI
ETSI TS 101 761-2 V1.1.1, Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Data Link Control (DLC) Layer; Part 2: Radio Link Control (RLC) Sublayer	April 2000	ETSI
"An Asynchronous Time Division Multiplexing - Multiple Access Protocol for Indoor Wireless Multi-service Networks," Proceedings of ICUPC 97, Vol. 2, pp. 918-922	1997	Farnham
"Initial Uplink Synchronization and Power Control (Ranging Process) for OFDMA Systems," Proc. IEEE GLOBECOM 2004, Vol. 6, pp. 3999-4003	2004	Fu et al.
"The Mobile Communications Handbook," Second Ed., Wiley, 1999	1999	Gibson
IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems—Amendment 2: Medium Access Control Modification and Additional Physical Layer Specifications for 2-11 GHz, IEEE 802.16a-2003 ("WiMAX 2003")	April 1, 2003	IEEE
"Peering Into the WiMAX Spec: Part 1," EE Times	January 20, 2004	Johnston et al.
"A Flexible Spread-Spectrum Multi-Carrier Multiple-Access System for Multi-Media Applications," Proc. of PIMRC '97, Vol. 1, pp. 100-104	1997	Kaiser et al.
"OFDMA Uplink Ranging for IEEE 802.16e Using Modified Generalized Chirp-Like	2005	Lee

Title	Date of publication	Author or Publisher
Polyphase Sequences," 1stIEEE and IFIP International Conference in Central Asia on Internet, 2005		
"OFDM with Trailing Zeros Versus OFDM with Cyclic Prefix: Links, Comparisons and Application to the HIPERLAN/2 System," 2000 IEEE International Conference on Communications, Vol 2, pp. 1049-1053	2000	Muquet et al.
"Generalized Chirp-Like Polyphase Sequences with Optimum Correlation Properties," IEEE Transactions on Information Theory, Vol. 38, No. 4, pp. 1406-1409	July 1992	Popovic
"OFDM Codes for Peak-to-Average Power Reduction and Error Correction," Proceedings of GLOBECOM '96, Vol. 1, pp. 740-744	1996	Van Nee
"Reducing the Peak-to-Average Power Ratio of OFDM," 48th IEEE Vehicular Technology Conference, 1998, Vol. 3, pp. 2072-2076	1998	Van Nee
"Time Synchronization in the Uplink of an OFDM System," Proceedings of Vehicular Technology Conference, 1996, Vol. 3, pp. 1569-1573	April 1996	Wahlqvist et al.

3. The '941 Patent

Title	Date of publication	Author or Publisher
3GPP; Technical Specification Group Radio Access Network; Physical Layer Aspects of UTRA High Speed Downlink Packet Access (Release 2000), 3G TR25.848 V0.6.0	May 2000	3GPP
"Channel Estimation in OFDM Systems," Thesis, King Fahd University, Saudi Arabia	August 2002	Arshad
"Adaptive modulation and MIMO coding for broadband wireless data networks," IEEE Communications Magazine 40(6):108-115 (2002)	June 2002	Catreux et al.
"On Channel Estimation and Detection for Multicarrier Signals in Fast and Selective Rayleigh Fading Channels," IEEE Transactions on Communications, Vol. 49, No. 8	August 2001	Choi et al.

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Title	Date of publication	Author or Publisher
"Link Adaptation and Channel Prediction in Wireless OFDM Systems," 45th Midwest Symposium on Circuits and Systems, 2002	2002	Forenza et al.
IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems, IEEE 802.16-2001	April 8, 2002	IEEE
IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems—Amendment 2: Medium Access Control Modification and Additional Physical Layer Specifications for 2-11 GHz, IEEE 802.16a-2003	April 1, 2003	IEEE
"A Fourth-Generation MIMO-OFDM Broadband Wireless System: Design, Performance, and Field Trial Results," IEEE Communications Magazine 40(9):143-149 (2002)	Sept. 2002	Sampath et al.
"OFDM Technique in Packet Captured Slotted Aloha Mobile Communication Systems," Master's Thesis, University of Madras, India	1999	Varadarajan
"Multiuser OFDM with Adaptive Sub-carrier, Bit, and Power Allocation," IEEE Journal on Selected Areas in Communications, Vol. 17, No. 10, pp. 1747-1758	October 1999	Wong et al.

4. The '450 Patent

Title	Date of publication	Author or Publisher
"Assessment of Advanced Beamforming and MIMO Technologies," Information Society Technologies 2003-507581 WINNER, D2.7, Ver. 1.0	2003	Alexiou et al.
"Performance Modelling and Enhancement of Wireless Communication Protocols," PhD Thesis, Bournemouth University, England	December 2004	Chatzimisios
"Great Expectations: The Value of Spatial Diversity in Wireless Networks," Proceedings of the IEEE, Vol. 92, No. 2, pp. 219-270	February 2004	Diggavi et al.
IEEE Standard 802.16: A Technical Overview of the WirelessMAN™ Air	June 4, 2002	Eklund et al.

Title	Date of publication	Author or Publisher
Interface for Broadband Wireless Access, IEEE C802.16-02/05		
"802.11® Wireless Networks: The Definitive Guide," O'Reilly, 2002	April 2002	Gast
IEEE Standard for Local and Metropolitan Area Networks, Part 16: Air Interface for Fixed Broadband Wireless Access Systems, IEEE Std 802.16-2004	2004	IEEE
OFDM Proposal for the IEEE 802.16a PHY Draft Standard, Version 0.46, IEEE 802.16.3c-01/33r2	March 9, 2001	IEEE
International Telemetering Conference 2001, Volume XXXVII	2001	International Foundation for Telemetering
"Peering Into the WiMAX Spec: Part 1," EE Times	January 20, 2004	Johnston et al.
"Peering Into the WiMAX Spec: Part 2," EE Times	January 21, 2004	Johnston et al.
"A Comparison of Timing Methods in Orthogonal Frequency Division Multiplexing (OFDM) Systems," Master's Thesis, Naval Postgraduate School, Monterey	September 2004	Oz

5. The '512 Patent

Title	Date of publication	Author or Publisher
3GPP; Technical Specification Group Radio Access Network; Beamforming Enhancements (Release 5), 3GPP TR 25.887 V1.0.0	December 2001	3GPP
3GPP; Technical Specification Group Radio Access Network; Feasibility Study for OFDM for UTRAN Enhancement, (Release 6), 3GPP TR 25.892 V0.5.2	December 2003	3GPP
Different pilots shape distribution for OFDM blocks, R1-030679, 3GPP TSG-RAN-1 Meeting #33	August 25 - 29, 2003	3GPP
Proposed WID for Improvement of support of existing Beam-forming techniques, RP-030556, 3GPP TSG RAN Meeting #21	September 16 - 19, 2003	3GPP
Some elements on OFDM UE complexity, R1-031091, 3GPP TSG-RAN-1 Meeting #34	September 6 - 10, 2003	3GPP
Stand-alone DSCH, proposed text for inclusion in TR 25.848 v 0.4.0,	Feb. 27 - March 3, 2001	3GPP

Title	Date of publication	Author or Publisher
TSGR1#19(01)0293, TSG-RAN Working Group1 meeting #19		
Text proposal on different pilots distribution for OFDM blocks, R1-031188, 3GPP TSG-RAN-1 Meeting #35	2003	3GPP
Performance of Smart Antennas and PCF, IEEE 802.11-00/269	September 2000	Alastalo et al.
IEEE 802.16 Broadband Wireless Access Working Group, Channel Estimation and Feedback Report for OFDM AAS, IEEE 802.16d-04/06	January 12, 2004	IEEE
IEEE 802.16 Broadband Wireless Access Working Group, Draft Document for SC-FDE PHY Layer System for Sub 11 GHz BWA, IEEE 802.16c-01/32	March 5, 2001	IEEE
IEEE Standard 802.11-1999, Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications	August 20, 1999	IEEE
IEEE Standard 802.11a-1999 (R2003), Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications	June 12, 2003	IEEE
IEEE Standard 802.11g-2003, Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, Amendment 4: Further Higher Data Rate Extension in the 2.4 GHz Band	September 18, 2000	IEEE
IEEE Standard 802.16-2001, Air Interface for Fixed Broadband Wireless Access Systems	April 8, 2002	IEEE
IEEE Standard 802.16a-2003, Air Interface for Fixed Broadband Wireless Access Systems, Amendment 2: Medium Access Control Modifications and Additional Physical Layer Specifications for 2-11 GHz	January 29, 2003	IEEE
Channel Estimation and feedback report for OFDM AAS, IEEE 802.16d-04/06	January 12, 2004	Kaitz et al.
"A Preamble-Based Cell Searching Technique for OFDM Cellular Systems," 2003 IEEE 58th Vehicular Technology Conference, Vol. 4, pp. 2471-2475	2003	Kim et al.
"Optimizing the Number of Dedicated Pilot Symbols for Forward Link in W-CDMA Systems," IEEE 51st Vehicular Technology Conference Proceedings, 2000, Vol. 3, pp. 2118-2122	2000	Usuda et al.

Title	Date of publication	Author or Publisher
Comments related to using the TG1 MAC for TG3 purposes, IEEE 802.16.1c-00/13	October 30, 2000	Ye

6. The '302 Patent

Title	Date of publication	Author or Publisher
"Narrow-Band Interference Rejection in Orthogonal Multi-carrier Spread-Spectrum Communications," Proc. of 1994 3rd IEEE International Conference on Universal Personal Communications, pp. 46-50	1994	Fazel
IEEE Part 11: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications: High Speed Physical Layer in the 5 GHz band, IEEE Std 802.11a-1999	September 16, 1999	IEEE
IEEE Standard for Local and Metropolitan Area Networks - Part 16: Air Interface for Fixed Broadband Wireless Access Systems, IEEE 802.16a-2001	April 8, 2002	IEEE
IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems—Amendment 2: Medium Access Control Modification and Additional Physical Layer Specifications for 2-11 GHz, IEEE 802.16a-2003	April 1, 2003	IEEE
"Introducing Novel FDD and FDM in MC-CDMA to Enhance Performance," 2000 IEEE Radio and Wireless Conference, pp. 29-32	2000	Natarajan et al.
"OFDM For Wireless Multimedia Communications" (2000), ISBN: 0-89006-530-6	2000	Nee et al.
"Time Synchronization in the Uplink of an OFDM System," Proceedings of Vehicular Technology Conference, 1996, Vol. 3, pp. 1569-1573	April 1996	Wahlqvist et al.
"A Novel Uplink Channel Estimation in OFDM-CDMA Systems," IEEE Transactions on Consumer Electronics, Vol. 50, no. 1, pp. 125-129	February 2004	Zheng et al.

D. Prior Art Products and/or Knowledge

The Asserted Claims are invalid under 35 U.S.C. §§ 102 and/or 103 based on prior art items offered for sale or publicly used or known or prior inventions, such as prior art products, including systems embodying any alleged inventions or structures described in, and/or any knowledge disclosed by or referred to in, any of the prior art patents or prior art publications identified above in Sections III.B and III.C. Because Defendants have not yet completed discovery in this case, Defendants reserve the right to supplement this disclosure with facts, documents, or other information learned at a later point through third-party discovery or further investigation. For example, Defendants expect to receive documents from additional third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning some of the prior art listed above and below and/or additional prior art. These third parties include without limitation the authors, inventors, or assignees of the references listed in these disclosures. In addition, Defendants reserve the right to assert invalidity under other sections of 35 U.S.C. § 102 to the extent that discovery or further investigation yield information forming the basis for such invalidity.

Table 1: Products[5]

Entity that Maded/ Used / Offered / Known	Item Offered for Sale / Publically Used / Known	Date of Use / Sale / Offer / Public Disclosure	Identity of Person Receiving Offer / To Whom Made Known
Motorola Inc.	Canopy	At least 2002	Motorola Actual/Potential Customers

[5] Any discussion of a physical product (such as those listed in Table 1) herein shall also apply with equal force to the corresponding product-related documents produced herewith, as well as those corresponding product-related documents produced at later points during discovery. In other words, both the product-related documents and the underlying products themselves qualify as prior art in the context that they are used herein.

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Entity that Maded/ Used / Offered / Known	Item Offered for Sale / Publically Used / Known	Date of Use / Sale / Offer / Public Disclosure	Identity of Person Receiving Offer / To Whom Made Known
Motorola Inc.	Project Angel	At least March 2002	Motorola Actual/Potential Customers
Clearwire	Clear	At least 2004	Clearwire Actual/Potential Customers
Atheros	AR5005G	At least 2003	Atheros Actual/Potential Customers
Netro	Angel	At least 2003	Netro Actual/Potential Customers
SR Telecom	Angel	At least 2003	SR Telecom Actual/Potential Customers
AT&T Wireless	Digital Broadband (Project Angel)	At least 2000	AT&T Actual/Potential Customers
Radix/BeamReach	BeamPlex/Project Angel	At least 2002	BeamReach Actual/Potential Customers
Broadstrom/Adaptix	Broad@ir/CelerFlex/Project Angel	At least 2000	Adaptix Actual/Potential Customers
NextNet Wireless	Broadband Wireless	At least 2003	NextNet Actual/Potential Customers
L-3 PrimeWave Communications/IoSpan	AirBurst	At Least 2002	IoSpan Actual/Potential Customers
Amphion Semiconductor LTD.	CS3820 and CS3720	At least 2002	Amphion Actual/Potential Customers
Alvarion	BreezeMAX	At least 2002	Alvarion Actual/Potential Customers
Linksys	WAP54G/WMP54G/WRT54G	At least 2003	Linksys Actual/Potential Customers

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Entity that Maded/ Used / Offered / Known	Item Offered for Sale / Publically Used / Known	Date of Use / Sale / Offer / Public Disclosure	Identity of Person Receiving Offer / To Whom Made Known
Netgear	WG511T/WGT624	At least 2003	Netgear Actual/Potential Customers

All of the products listed in Table 1 above qualify as prior art to each of the Asserted Patents under 35 U.S.C. §102(b) because they were each in "public use" or "on sale" prior to the earliest U.S. application filing date corresponding to each of the Asserted Patents.[6]

The Federal Circuit has held that "[t]he proper test for the public use prong of the [pre-AIA] § 102(b) statutory bar is whether the purported use: (1) was accessible to the public; or (2) was commercially exploited." *See Invitrogen Corp. v. Biocrest Mfg. L.P.,* 424 F.3d 1374, 1380 (Fed. Cir. 2005). Additionally, the on-sale bar of § 102(b) is triggered when the invention is both (1) the subject of a commercial offer for sale not primarily for experimental purposes and (2) ready for patenting. *Pfaff v. Wells Elecs., Inc*., 525 U.S. 55, 67 (1998). Each of the products listed in Table 1 above meets these criteria.

The Canopy and Project Angel were sold and/or offered for sale by Motorola, and were in public use by its customers in the 2002 timeframe or earlier. Motorola published sales and marketing documentation targeted towards Motorola's existing or future customers, and disclosed specific implementation details about the Canopy and Project Angel systems. As such, these publications indicate that at least by 2002, the Canopy and Project Angel systems were each being commercially exploited and were each ready for patenting. Discovery is ongoing in this case, and

[6] Based on information currently available to Defendants, the earliest possible claimed priority date of any Asserted Patents is January 29, 2004.

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Defendants will supplement their contentions with respect to the Canopy and Project Angel systems being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the Canopy and Project Angel systems being in "public use" or "on sale."

Clear was sold and/or offered for sale by Clearwire, and was in public use by its customers in the 2004 timeframe or earlier. Clearwire published sales and marketing documentation targeted towards Clearwire's existing or future customers, and disclosed specific implementation details about the Clear system. As such, these publications indicate that at least by 2004, the Clear system was being commercially exploited and was ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the Clear system being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the Clear system being in "public use" or "on sale."

The AR5005G was sold and/or offered for sale by Atheros, and was in public use by its customers in the 2003 timeframe or earlier. Atheros published sales and marketing documentation targeted towards Atheros' existing or future customers, and disclosed specific implementation details about the AR5005G. As such, these publications indicate that at least by 2003, the AR5005G was being commercially exploited and was ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the AR5005G being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas

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that are believed to have knowledge, documentation, and/or corroborating evidence concerning the AR5005G being in "public use" or "on sale."

Angel was sold and/or offered for sale by Netro, and was in public use by its customers in the 2003 timeframe or earlier. Netro published sales and marketing documentation targeted towards Netro's existing or future customers, and disclosed specific implementation details about the Angel system. As such, these publications indicate that at least by 2003, the Angel system was being commercially exploited and was ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the Angel system being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the Angel system being in "public use" or "on sale."

Angel was sold and/or offered for sale by SR Telecom, and was in public use by its customers in the 2003 timeframe or earlier. SR Telecom published sales and marketing documentation targeted towards SR Telecom's existing or future customers, and disclosed specific implementation details about the Angel system. As such, these publications indicate that at least by 2003, the Angel system was being commercially exploited and was ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the Angel system being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the Angel system being in "public use" or "on sale."

Digital Broadband (Project Angel) was sold and/or offered for sale by AT&T Wireless,

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and was in public use by its customers in the 2000 timeframe or earlier. AT&T Wireless published sales and marketing documentation targeted towards AT&T Wireless's existing or future customers, and disclosed specific implementation details about the Digital Broadband system. As such, these publications indicate that at least by 2000, the Digital Broadband system was being commercially exploited and was ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the Digital Broadband system being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the Digital Broadband system being in "public use" or "on sale."

BeamPlex was sold and/or offered for sale by BeamReach, formally known as Radix, and was in public use by its customers in the 2002 timeframe or earlier. BeamReach published sales and marketing documentation targeted towards BeamReach's existing or future customers, and disclosed specific implementation details about the BeamPlex system. As such, these publications indicate that at least by 2002, the BeamPlex system was being commercially exploited and was ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the BeamPlex system being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the BeamPlex system being in "public use" or "on sale."

The Broad@ir and CelerFlex systems were sold and/or offered for sale by Adaptix, formally known as Broadstrom, and were in public use by its customers in the 2000 timeframe or

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earlier. Adaptix published sales and marketing documentation targeted towards Adaptix's existing or future customers, and disclosed specific implementation details about the Broad@ir and CelerFlex systems. As such, these publications indicate that at least by 2002, the Broad@ir and CelerFlex systems were being commercially exploited and were ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the Broad@ir and CelerFlex systems being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the Broad@ir and CelerFlex systems being in "public use" or "on sale."

Broadband Wireless was sold and/or offered for sale by NextNet, and was in public use by its customers in the 2003 timeframe or earlier. NextNet published sales and marketing documentation targeted towards NextNet's existing or future customers, and disclosed specific implementation details about the Broadband Wireless system. As such, these publications indicate that at least by 2003, the Broadband Wireless system was being commercially exploited and was ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the Broadband Wireless system being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the Broadband Wireless system being in "public use" or "on sale."

AirBurst was sold and/or offered for sale by L-3 PrimeWave Communications, formally known as IoSpan, and was in public use by its customers in the 2002 timeframe or earlier. IoSpan

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published sales and marketing documentation targeted towards IoSpan's existing or future customers, and disclosed specific implementation details about the AirBurst system. As such, these publications indicate that at least by 2002, the AirBurst system was being commercially exploited and was ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the AirBurst system being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the AirBurst system being in "public use" or "on sale."

The CS3820 and CS3720 systems were sold and/or offered for sale by Amphion Semiconductor LTD, and were in public use by its customers in the 2002 timeframe or earlier. Amphion published sales and marketing documentation targeted towards Amphion's existing or future customers, and disclosed specific implementation details about the CS3820 and CS3720 systems. As such, these publications indicate that at least by 2002, the CS3820 and CS3720 systems were being commercially exploited and were ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the CS3820 and CS3720 systems being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the CS3820 and CS3720 systems being in "public use" or "on sale."

BreezeMAX was sold and/or offered for sale by Alvarion, and was in public use by its customers in the 2002 timeframe or earlier. Alvarion published sales and marketing

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documentation targeted towards Alvarion's existing or future customers, and disclosed specific implementation details about the BreezeMAX system. As such, these publications indicate that at least by 2002, the BreezeMAX system was being commercially exploited and was ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the BreezeMAX system being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the BreezeMAX system being in "public use" or "on sale."

The WAP54G, WMP54G, and WRT54G were sold and/or offered for sale by Linksys, and were in public use by its customers in the 2003 timeframe or earlier. Linksys published sales and marketing documentation targeted towards Linksys' existing or future customers, and disclosed specific implementation details about the WAP54G, WMP54G, and WRT54G systems. As such, these publications indicate that at least by 2003, the WAP54G, WMP54G, and WRT54G systems were being commercially exploited and were ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the WAP54G, WMP54G, and WRT54G systems being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the WAP54G, WMP54G, and WRT54G systems being in "public use" or "on sale."

The WG511T and WGT624 were sold and/or offered for sale by Negear, and were in public use by its customers in the 2003 timeframe or earlier. Netgear published sales and marketing

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documentation targeted towards Netgear's existing or future customers, and disclosed specific implementation details about the WG511T and WGT624 systems. As such, these publications indicate that at least by 2003, the WG511T and WGT624 systems were being commercially exploited and were ready for patenting. Discovery is ongoing in this case, and Defendants will supplement their contentions with respect to the WG511T and WGT624 systems being in "public use" or "on sale" if and when more information becomes available. Indeed, Defendants expect to receive documents from third parties either through informal requests or under subpoenas that are believed to have knowledge, documentation, and/or corroborating evidence concerning the WG511T and WGT624 systems being in "public use" or "on sale."

The above discussion is not exclusive. Defendants reserve the right to rely on both the listed products as well as other products that may become known and/or relevant during the course of this matter.

Any citation to one or more of these prior art references, or other prior art references regarding any method or system, should be construed to constitute not only a citation to the prior art reference itself but also a reference to the system itself. Discovery is ongoing in this case, and Defendants will supplement these contentions if and when more information becomes available.

E. Prior Art Under 35 U.S.C. §§ 102(f) and 102(g)

Each prior art patent, publication, or product identified above was either effectively filed or issued (for patents), published (for publications) or known, used, offered for sale or sold (for products) before the earliest claimed priority date of the Asserted Patent to which it is applied for invalidity, and none appears to have been abandoned, suppressed, or concealed, so each such reference also constitutes evidence of prior invention pursuant to 35 U.S.C. § 102(g), if it is in the U.S. The persons or entities involved with each such invention include the named inventors on

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the above-identified patents, the authors listed on the above-identified publications, and the entities and individuals identified in connection with the above-identified products.

Because Defendants have not yet completed discovery in this case, including taking depositions of the named inventors of the Asserted Patents, reviewing Neo Wireless's productions, and seeking discovery of prior inventions by third parties, Defendants reserve the right to supplement this disclosure with facts, documents, or other information learned at a later point through discovery or further investigation.

IV. ANTICIPATION AND OBVIOUSNESS (35 U.S.C. §§ 102 AND 103)

The Asserted Claims are anticipated by and/or rendered obvious in view of one or more items of prior art identified in these contentions, alone and/or in combination. Based on their investigation to date, Defendants have provided in the lists above the prior art presently known to Defendants that anticipates and/or renders obvious the Asserted Claims under at least Neo Wireless's actual and/or apparent application of those claims. The prior art identified in these contentions discloses (i.e., anticipates and/or renders obvious) the elements of the Asserted Claims either explicitly or inherently.

Prior art patents or publications included in these contentions may be related (such as a divisional, continuation, continuation-in-part, parent, or child) to earlier or later-filed patents or publications, may have counterparts filed in other jurisdictions, or may incorporate (or be incorporated by) other patents or publications by reference. The listed patents or publications are intended to be representative of these other patents or publications to the extent they exist. Defendants accordingly reserve the right to modify, amend, or supplement these contentions with these related patents or publications, as well as other prior art references, upon further investigation. Additionally, any reference in these Contentions, including the appendices and/or

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exhibits thereto, to a specific subsection or subsections of 35 U.S.C. § 102, is merely exemplary, and Defendants expressly reserve the right to rely on additional or other sections of 35 U.S.C. § 102, as appropriate.

Although Defendants' investigation is ongoing, information available to date indicates that each prior art system disclosed above was at least (1) known or used in this country before the alleged invention of the claimed subject matter of the Asserted Patents; (2) in public use, on sale, or offered for sale in this country more than one year before the effective filing date for the Asserted Patents; or (3) invented and not abandoned, suppressed, or concealed prior to the alleged invention of the Asserted Patents.

Much of the art identified in these contentions reflects common knowledge and the state of the art prior to the filing or asserted priority dates of the Asserted Patents. As such, the obviousness combinations in these contentions are intended to be exemplary. There are many possible combinations of the disclosed prior art, and the inclusion of certain exemplary combinations does not exclude other combinations. For example, where a particular contention calls for combining references, any of a number of references can be combined.

Depending on the construction of the claims of the Asserted Patents, and/or positions that Neo Wireless or its expert witnesses may take concerning claim interpretation, infringement, and/or invalidity issues, different ones of the charted prior art references in the Exhibits may be of greater or lesser relevance and different combinations of these references may be implicated. Given the uncertainty, the charts may reflect alternative applications of the prior art against the Asserted Claims.

Citations to particular excerpts from the prior art are likewise exemplary and not exhaustive of the evidentiary support for the invalidity of the Asserted Patents contained in and/or concerning

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a particular piece of prior art. Defendants may rely on uncited portions of the prior art references, other documents or operational systems, the "Background of the Invention" and other relevant portions of the Asserted Patents, the prosecution histories of the Asserted Patents (including all cited references), and forthcoming fact and expert testimony to provide context to aid in understanding the prior art reference and/or the cited portions of the references. Where Defendants cite to a particular figure in a reference, the citation encompasses the caption and description of the figure and any text relating to or discussing the figure. Likewise, where Defendants cite text referring to a figure, the citation includes the figure as well (and vice versa).

A. Prior Art Under 35 U.S.C. § 102

The references and systems in the tables above independently anticipate the Asserted Claims under 35 U.S.C. §§ 102(a), (b), (e), (f) and/or (g), as set forth in the charts attached as:

- Exhibits A-01 through Exhibits A-09 for the asserted claims of the '366 Patent;
- Exhibits B-01 through Exhibits B-16 for the asserted claims of the '908 Patent;
- Exhibits C-01 through Exhibits C-08 for the asserted claims of the '941 Patent;
- Exhibits D-01 through Exhibits D-09 for the asserted claims of the '450 Patent;
- Exhibits E-01 through Exhibits E-10 for the asserted claims of the '512 Patent; and
- Exhibits F-01 through Exhibits F-11 for the asserted claims of the '302 Patent.

Where an asserted prior art reference in any attached claim charts relies on a claim of priority to assert a critical reference date under pre-AIA 35 U.S.C. § 102 *et seq*. (including pre-AIA § 102(e)), compliance with pre-AIA 35 U.S.C. § 112, first paragraph, or 35 U.S.C. § 112(a), is shown in Exhibits G-01 through Exhibits G-13, and/or an appendix to a given claim chart (e.g., Exhibits B-06, D-03, D-05, D-09, E-07, F-02, F-10).

These charts, however, are exemplary. The claimed features are similarly described and suggested in other places (including in all of the documents cited during prosecution of each piece of prior art), and also were present when prior-art systems practicing the described prior art were used before the application that ultimately led to the Asserted Patents. Thus, where patents or other printed materials are disclosed, Defendants reserve the right to also rely on those materials as descriptions of systems, devices, or methods referenced therein, publicly used, and/or on sale or known in the United States. Further, Defendants reserve the right to rely on other evidence of the prior art beyond merely the exemplary references cited in the charts attached as Exhibits.

Where patents or other printed materials are disclosed, Defendants reserve the right to also rely on those materials as descriptions of systems, devices, or methods referenced therein, publicly used, and/or on sale or known in the United States. Defendants reserve the right to also use those references to invalidate the claim under 35 U.S.C. § 103.

B. Prior Art Under 35 U.S.C. § 103

The references and systems in the exemplary tables above, whether alone or in combination with each other and/or the references identified above, render the Asserted Claims obvious under 35 U.S.C. § 103, as set forth in at least the following charts:

- Exhibits A-01 through Exhibits A-09 for the asserted claims of the ’366 Patent;
- Exhibits B-01 through Exhibits B-16 for the asserted claims of the ’908 Patent;
- Exhibits C-01 through Exhibits C-08 for the asserted claims of the ’941 Patent;
- Exhibits D-01 through Exhibits D-09 for the asserted claims of the ’450 Patent;
- Exhibits E-01 through Exhibits E-10 for the asserted claims of the ’512 Patent; and
- Exhibits F-01 through Exhibits F-11 for the asserted claims of the ’302 Patent.

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Where an asserted prior art reference in any attached claim charts relies on a claim of priority to assert a critical reference date under pre-AIA 35 U.S.C. § 102 *et seq*. (including pre-AIA § 102(e)), compliance with pre-AIA 35 U.S.C. § 112, first paragraph, or 35 U.S.C. § 112(a), is shown in Exhibits G-01 through Exhibits G-13, and/or an appendix to a given claim chart (e.g., Exhibits B-06, D-03, D-05, D-09, E-07, F-02, F-10).

These charts, however, are exemplary. The claimed features are similarly described and suggested in other places (including in all of the documents cited during prosecution of each piece of prior art), and also were present when prior-art systems practicing the described prior art were used before the application that ultimately led to the Asserted Patents. Thus, where patents or other printed materials are disclosed, Defendants reserve the right to also rely on those materials as descriptions of systems, devices, or methods referenced therein, publicly used, and/or on sale or known in the United States. Further, Defendants reserve the right to rely on other evidence of the prior art beyond merely the exemplary references cited in the charts attached as Exhibits.

Defendants' assertion that the combinations above render the asserted claims obvious under 35 U.S.C. § 103 is not, and is not intended to be, an admission or suggestion that each reference does not independently anticipate the Asserted Claims under 35 U.S.C. § 102. *See Connell v. Sears, Roebuck & Co*., 722 F.2d 1542, 1548 (Fed. Cir. 1983) ("'[A]nticipation is the epitome of obviousness.'") (quoting *In re Fracalossi*, 681 F.2d 792, 794 (CCPA 1982)). Nor does the inclusion of the exemplary combinations in the attached Exhibits and Appendices exclude other combinations of prior art disclosed in this or previous sections.

Each prior art reference or system may be combined with (1) information known to persons skilled in the art at the time of the alleged invention; (2) any other anticipatory prior art references

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or systems; and (3) any of the additional prior art identified above or in the prosecution of the Asserted Patents and related applications.

All discussion of obviousness in these Contentions follows well-established precedent. In *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417–18, 420–21 (2007), the Supreme Court rejected the Federal Circuit's rigid "teaching, suggestion, or motivation" requirement in favor of a flexible, functional approach in which an explicit motivation to combine prior art references is not required to establish obviousness. The Court further held that patents based on new combinations of elements or components already known in a technical field may be obvious. Specifically, the Court in *KSR* rejected a rigid application of the "teaching, suggestion, or motivation [to combine]" test. *Id*. at 418-419. "In determining whether the subject matter of a patent claim is obvious, neither the particular motivation nor the avowed purpose of the patentee controls. What matters is the objective reach of the claim." *Id*. at 419. "Under the correct analysis, any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed." *Id*. at 420 . In particular, the Supreme Court emphasized the principle that "[t]he combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." *Id*. at 416. A key inquiry is whether the "improvement is more than the predictable use of prior art elements according to its established function." *Id*. at 417.

Although a teaching, suggestion, or motivation to combine references is not required, a motivation to modify a particular reference or system or to combine any two or more references or systems comes from (1) the nature of the problem being solved; (2) the teachings of the prior art; (3) the knowledge and common sense of persons of ordinary skill in the art; (4) the fact that all of the references teach systems and methods related to the subject matter of the Asserted

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Patents; (5) the fact that many of the authors of the references were part of the same academic or research community and presented at many of the same conferences; (6) the existence of similar improvements in similar applications; (7) the number of identified, predictable solutions to the problem addressed by the Asserted Patents; and (8) considerations of efficiency, effectiveness, convenience, cost-savings, and accessibility.

The rationale to combine or modify prior art references is significantly stronger when the references seek to solve the same problem, come from the same field, and correspond well. *In re Inland Steel Co.*, 265 F.3d 1354, 1362 (Fed. Cir. 2001) (allowing two references to be combined as invalidating art under similar circumstances where the art "focus[ed] on the same problem . . . c[a]me from the same field of art [and] . . . the identified problem found in the two references correspond[ed] well").

In view of the Supreme Court's *KSR* decision, the PTO issued a set of new Examination Guidelines. *See* Examination Guidelines for Determining Obviousness Under 35 U.S.C. § 103 in view of the Supreme Court Decision in *KSR International Co. v. Teleflex, Inc.*, 72 Fed. Reg. 57526 (October 10, 2007). Those Guidelines summarized the *KSR* decision, and identified various rationales for finding a claim obvious, including those based on other precedents. Those rationales include: (1) combining prior art elements according to known methods to yield predictable results; (2) simple substitution of one known element for another to obtain predictable results; (3) use of a known technique to improve similar devices (methods, or products) in the same way; (4) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results; (5) "obvious to try" — choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; (6) known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives

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or other market forces if the variations would have been predictable to one of ordinary skill in the art; (7) some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention. *Id*. at 57529. Defendants contend that one or more of these or other rationales apply in considering the obviousness of the Asserted Claims.

Notably, all of the references come from the same field of endeavor. Persons of skill in this field are taught about, and have skill in, combining references in order to increase the capabilities or lower the costs of cellular communication. Indeed, it would have been obvious to try combining the prior art references identified above because there were only a finite number of predictable solutions and/or because known work in one field or endeavor prompted variations based on predictable design incentives and/or market forces either in the same field or a different one. The combination of prior art references identified in these contentions would have been obvious because the claimed combinations represent the known potential options with a reasonable expectation of success. Additionally, one of ordinary skill in the art would have been motivated to create combinations identified in these contentions using: known methods to yield predictable results; known techniques in the same way; a simple substitution of one known, equivalent element for another to obtain predictable results; and/or teaching, suggestion, or motivation in the prior art generally. Also, market forces in the industry, and the desire to improve features and performance, would motivate the addition of features to systems as they become available, become less expensive, become more commonly used, provide better performance, reduce costs, size or weight, or predictably achieve other clearly desirable results.

1. Exemplary Motivations to Combine

Exemplary combinations of prior art references that render the Asserted Claims invalid as obvious under 35 U.S.C. § 103 are described in:

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- Exhibits A-01 through Exhibits A-09 for the asserted claims of the ’366 Patent;
- Exhibits B-01 through Exhibits B-16 for the asserted claims of the ’908 Patent;
- Exhibits C-01 through Exhibits C-08 for the asserted claims of the ’941 Patent;
- Exhibits D-01 through Exhibits D-09 for the asserted claims of the ’450 Patent;
- Exhibits E-01 through Exhibits E-10 for the asserted claims of the ’512 Patent; and
- Exhibits F-01 through Exhibits F-11 for the asserted claims of the ’302 Patent.

Where an asserted prior art reference in any attached claim charts relies on a claim of priority to assert a critical reference date under pre-AIA 35 U.S.C. § 102 *et seq*. (including pre-AIA § 102(e)), compliance with pre-AIA 35 U.S.C. § 112, first paragraph, or 35 U.S.C. § 112(a), is shown in Exhibits G-01 through Exhibits G-13, and/or an appendix to a given claim chart (e.g., Exhibits B-06, D-03, D-05, D-09, E-07, F-02, F-10).

As illustrative examples, the below combinations and motivations in addition to the general motivations described above, render the Asserted Claims obvious. Discovery is ongoing, and the product and system prior art identified in Section III.D and the WiMax technical standard may be used as evidence of anticipation and/or obviousness alone or in view of the following. Additional motivations to combine are also listed in the chart for each reference and its combinations.

a. The ’366 Patent

A person of ordinary skill in the art would have been motivated to combine or modify each piece of prior art identified in Sections III.B-E in such a way as to render the asserted claims of the ’366 patent invalid. For example, Defendants identify at least the following grounds (and similar permutations based on the listed references) that render the asserted claims of the ’366 patent invalid under 35 U.S.C. § 103.

(i) Ma ’546 in combination with the knowledge of a skilled artisan, Li ’781, Jeong ’589, TR, 802.16a-2003, C802.16e-03/53r2, and /or Suh ’464

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Ma ’546 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Ma ’546 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’366 patent was filed. Specifically:

- Ma ’546, Jeong ’589, Li ’781, TR, C802.16e-03/53r2, 802.16a-2003, and Suh ’464 are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using RACH. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration

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with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Ma '546 and Jeong '589**: Jeong '589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong '589 teaches and describes "[t]he present invention relates to a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. "According to the ranging interval, four new initial ranging sub-channel allocation methods are proposed to perform the initial ranging function. The new initial ranging structures are suitable for the cases of both frequency division duplex ("FDD") and time division duplex ("TDD")." *Id.* One object of the invention of Jeong '589 is to solve "problems is ranging interval and ranging unit for initial ranging in OFDMA wireless communication system to reduce ICI between ranging signals in TDD mode OFDMA wireless communication system." *Id.* at 3. Jeong '589 states "another object of the present invention to provide a ranging interval and ranging subchannel allocation method for initial ranging in an OFDMA wireless communication system which enables a subscriber station to perform a transmission operation in advance of a predetermined transmission time by a

processing delay of the subscriber station." *Id.* Ma '546 discloses "[a] wireless terminal and network terminal are provided for implementing a new uplink OFDM protocol. In the new protocol, the wireless terminal has a first transmit chain for generating and transmitting a low rate mode OFDM transmission in a first frequency band of the OFDM band; and a second transmit chain for generating and transmitting a burst-mode transmission in a second frequency band of the OFDM band, the first frequency band being distinct from the second frequency band." Ma '546 at Abstract. Ma '546 states that the "invention relates generally to wireless communications and, in particular, to an uplink air interface used in a wireless communication network, and more particularly to dual-mode shared OFDM methods/transmitters, receivers and systems." *Id.* at 1:11-15. Ma '546 further teaches that "OFDM is used for uplink transmissions from one user at a time, with multiple-user access being arranged in a TDM fashion. However, this type of uplink access scheme cannot effectively support cellular network deployment and mobility because it does not provide the quality of service and features required in cellular networks. In addition, these schemes do not support circuitry data services such as voice." *Id.* at 2:36-44. To address these problems, Ma '546 discloses various time-frequency resource allocation techniques with two different modes. *See id.* at 10:25-35 ("According to the OFDMA scheme provided by an embodiment of the invention, a common wireless channel 50 is implemented using an OFDM transmission scheme within an overall OFDM band. . . . The two different OFDMA modes are referred to herein generally as Mode-1 and Mode-2 respectively."). Ma '546 explains "Mode-1 is used to provide low rate circuit

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oriented connectivity for multiple users simultaneously preferably using orthogonal code separation, while Mode-2 is used to provide higher rate bursty packet connectivity." *Id.* at 10:41-45. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. Moreover, these references share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine Jeong '589 with Ma '546 at least because Ma '546 provides a method for reducing both intra- and inter-cell interference through PN spreading unique to the base station. It would have been obvious for a POSITA to combine Ma '546 with Jeong '589 at least because Ma '546 provides a method for using resource allocation techniques (such as those disclosed in Jeong '589) in order to optimize system resources and maintain quality of service.

- **Ma '546 and 802.16a-2003:** 802.16a-2003 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. 802.16a-2003 discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the

DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.* at 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* Ma '546 discloses "[a] wireless terminal and network terminal are provided for implementing a new uplink OFDM protocol. In the new protocol, the wireless terminal has a first transmit chain for generating and transmitting a low rate mode OFDM transmission in a first frequency band of the OFDM band; and a second transmit chain for generating and transmitting a burst-mode transmission in a second frequency band of the OFDM band, the first frequency band being distinct from the second frequency band." Ma '546 at Abstract. Ma '546 states that the "invention relates generally to wireless communications and, in particular, to an uplink air interface used in a wireless communication network, and more particularly to dual-mode shared OFDM methods/transmitters, receivers and systems." *Id.* at 1:11-15. Ma '546 further teaches that "OFDM is used for uplink transmissions from one user at a time, with multiple-user access being arranged in a TDM fashion. However, this type of uplink access scheme cannot effectively support cellular network deployment and mobility because it does not provide the quality of service and features required in cellular networks. In addition, these schemes do not support circuitry data services such as voice." *Id.* at 2:36-44. To address these problems, Ma '546 discloses

various time-frequency resource allocation techniques with two different modes. *See id.* at 10:25-35 ("According to the OFDMA scheme provided by an embodiment of the invention, a common wireless channel 50 is implemented using an OFDM transmission scheme within an overall OFDM band. . . . The two different OFDMA modes are referred to herein generally as Mode-1 and Mode-2 respectively."). Ma '546 explains "Mode-1 is used to provide low rate circuit oriented connectivity for multiple users simultaneously preferably using orthogonal code separation, while Mode-2 is used to provide higher rate bursty packet connectivity." *Id.* at 10:41-45. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. Moreover, these references share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine 802.16a-2003 with Ma '546 at least because Ma '546 provides a method for reducing both intra- and inter-cell interference through PN spreading unique to the base station. It would have been obvious for a POSITA to combine Ma '546 with 802.16a-2003 at least because Ma '546 provides a method for using resource allocation techniques (such as those disclosed in 802.16a-2003) in order to optimize system resources and maintain quality of service. A POSITA would have had a reasonable expectation of success in this implementation at least because Ma and 802.16a-2003 are related to similar methods and systems (i.e., data transmission and random access in OFDM-based communication systems).

- **Ma '546 and TR:** TR "describes the basic concept behind the OFDMA proposal and its advantages and featuers [*sic*] which is the most advanced of its kind present today." TR at 175. TR describes "RACH (Random Access Channel) Physical Structure" and "OFDMA Resource Allocation/Physical Channel." *Id.* at 191, 196-200. TR discloses "bandslots" where "The whole system frequency band is divided into small blocks (bandslots) with a fixed number of subcarriers." *Id.* at 199. TR, like the '366 patent, describes a random access process, which includes ranging that "typically involves an exchange of messages between the base station and the mobile station by which the mobile station aligns itself with the start of each time slot." '366 patent at 1:43-47. For example, TR discloses "After the mobile has detected the basestations [*sic*] timing it sends an RACH to the basestation. The BS measures the time offset for the received RACH and sends back the necessary timing advance to the MS (very similar to GSM). In the frame structure of the OFDMA system reserved slots for reception of RACH exist." TR at 206. TR further discloses "bandslots" where "[t]he whole system frequency band is divided into small blocks (bandslots) with a fixed number of subcarriers." *Id.* at 199. TR discloses "Unmodulated Guard Carrier," namely, "the two subcarriers at the edge of the bandslot [that] are left unmodulated" (i.e., unused and thus having zero power due to the absence of modulation symbols) in each bandslot "to reduce adjacent channel emissions and facilitate easy bandslot separation." TR at 199, 202. Under this arrangement, the interference of two adjacent blocks of subcarriers is reduced, which may occur when their orthogonality is compromised due to nonlinear PA [power amplifier] effects." *Id.* Use of unmodulated subcarriers is known as a

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"guard band," which is a narrow frequency band provided between adjacent channels to prevent interference. Ma '546 states that the "invention relates generally to wireless communications and, in particular, to an uplink air interface used in a wireless communication network, and more particularly to dual-mode shared OFDM methods/transmitters, receivers and systems." *Id.* at 1:11-15. Ma '546 further teaches that "OFDM is used for uplink transmissions from one user at a time, with multiple-user access being arranged in a TDM fashion. However, this type of uplink access scheme cannot effectively support cellular network deployment and mobility because it does not provide the quality of service and features required in cellular networks. In addition, these schemes do not support circuitry data services such as voice." *Id.* at 2:36-44. To address these problems, Ma '546 discloses various time-frequency resource allocation techniques with two different modes. *See id.* at 10:25-35 ("According to the OFDMA scheme provided by an embodiment of the invention, a common wireless channel 50 is implemented using an OFDM transmission scheme within an overall OFDM band. . . . The two different OFDMA modes are referred to herein generally as Mode-1 and Mode-2 respectively."). Ma '546 explains "Mode-1 is used to provide low rate circuit oriented connectivity for multiple users simultaneously preferably using orthogonal code separation, while Mode-2 is used to provide higher rate bursty packet connectivity." *Id.* at 10:41-45. To implement Ma '546's OFDMA-based air interface system, a POSITA would have reasons to leverage the basic system characteristics of the OFDMA-based air interface proposal for a UMTS system as disclosed in TR, especially given various advantages of the OFDMA-based air

interface identified in TR, including flexibility in supporting both circuit switched services (e.g., voice) and packet oriented services. TR at 177, 180, 182. Moreover, a POSITA would have been motivated to incorporate TR's guard carrier/guard band feature into Ma's RACH channel to advantageously (1) reduce adjacent channel emissions (2) facilitate easy bandslot separation, (3) relax receiver blocking requirements, and (4) reduce the interference of two adjacent blocks of subcarriers, as taught by TR. In fact, this ordinary implementation of the guard carrier would have been merely the application of a known technique (leaving subcarriers on the edge of a bandslot unmodulated to create a guard band between adjacent subchannels as taught by TR, to a known system (Ma's OFDMA communication system) ready for improvement to yield predictable results. A POSITA would have had a reasonable expectation of success in this implementation at least because Ma and TR are related to similar methods and systems (i.e., data transmission and random access in OFDMA-based communication systems).

- **Ma '546 and Li '781:** Li '781 is directed to "[a] method and apparatus for subcarrier selection for systems." Li '781 at Abstract. Li '781 discloses " the system employs orthogonal frequency division multiple access (OFDMA). . . . In one embodiment, a method for subcarrier selection comprises each of multiple subscribers measuring channel and interference information for subcarriers based on pilot symbols received from a base station, at least one of subscribers selecting a set of candidate subcarriers, providing feedback information on the set of candidate subcarriers to the base station, and the one subscriber receiving an indication of subcarriers of the set of subcarriers selected by the base station for use

by the one subscriber." *Id.* Li '781 teaches and describes "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '781 at [0001]. According to Li '781, "[o]ne approach to subcarrier allocation for OFDMA is a joint optimization operation, not only requiring the activity and channel knowledge of all the subscribers in all the cells, but also requiring frequent rescheduling every time an existing subscribers is dropped off the network or a new subscribers is added onto the network." *Id.* at [0006]. However, this approach "is often impractical in real wireless system, mainly due to the bandwidth cost for updating the subscriber information and the computation cost for the joint optimization." *Id.* Li '781 also describes that with an "aggressive frequency reuse plan, e.g., the same spectrum is used for multiple neighboring cells, the problem of intercell interference arises." *Id.* at [0005]. "At the receiver, the subscriber first distinguishes the two sequences using the signal processing methods which are well known in the art, e.g., the correlation methods, and then estimates the channel and interference level." *Id.* at [0090]. Thus, Li '781 teaches "[a] distributed, reduced-complexity approach for subcarrier allocation." *Id.* at [0023]. Ma '546 teaches that "OFDM is used for uplink transmissions from one user at a time, with multiple-user access being arranged in a TDM fashion. However, this type of uplink access scheme cannot effectively support cellular network deployment and mobility because it does not provide the quality of service and features required in cellular networks. In addition, these schemes do not support circuitry data services such as voice." *Id.* at 2:36-44. To address these problems, Ma '546 discloses various time-frequency resource allocation techniques

with two different modes. *See id.* at 10:25-35 ("According to the OFDMA scheme provided by an embodiment of the invention, a common wireless channel 50 is implemented using an OFDM transmission scheme within an overall OFDM band. . . . The two different OFDMA modes are referred to herein generally as Mode-1 and Mode-2 respectively."). Ma '546 explains "Mode-1 is used to provide low rate circuit oriented connectivity for multiple users simultaneously preferably using orthogonal code separation, while Mode-2 is used to provide higher rate bursty packet connectivity." *Id.* at 10:41-45. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Ma '564 with Li '781 at least because Ma '546 provides a method for using resource allocation techniques to optimize system resources and reduce interference. Also, the combination would have been merely the application of a known technique (adaptive subcarrier selection, as taught by Li) to a known system (Ma 589's OFDMA communication system) to yield predictable results, without significantly altering or hindering the functions performed by the communication system.

- **Ma '546 and C802.16e-03/53r2:** C802.16e-03/53r2 teaches and describes a method for an OFDM communication system that includes "the UL-MAP IE" being used to inform all SS's in the cell (i.e. cell specific) and the IE has a "subchannel offset." C802.16e-03/53r2 at 1-6. It would have been obvious for a POSITA to combine Ma '564 with C802.16e-03/53r2 at least because Ma '546

provides a method for using resource allocation techniques to optimize system resources and reduce interference. Also, the combination would have been merely the application of a known technique (as taught by C802.16e-03/53r2) to a known system (Ma 549's OFDMA communication system) to yield predictable results, without significantly altering or hindering the functions performed by the communication system. It would have been obvious for a POSITA to combine Ma '546 with C802.16e-03/53r2at least because doing so provides an improved means of resource allocation in a communication system.

- **Ma '546 and Suh '464:** Suh '464 is directed to an apparatus and "method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system." Suh '464 at Abstract. Specifically, the invention of Suh '464 "relates generally to an orthogonal frequency division multiplexing (OFDM) communication system, and in particular, to an apparatus and method for generating a preamble sequence in an OFDM communication system." *Id.* at [0003]. Suh '464 explains that in an "OFDM communication system, if the IFFT-transformed OFDM symbol is transmitted as it is, interference between a previous OFDM symbol and a current OFDM symbol is unavoidable. In order to remove the inter-symbol interference, a guard interval is inserted." *Id.* at [0010]. However, " if a receiver incorrectly estimates a start point of an OFDM symbol, interference occurs between subcarriers, causing an increase in error probability of a received OFDM symbol." *Id.* To address this "a "cyclic prefix" scheme or a "cyclic postfix" scheme has been proposed for the guard

interval." *Id.* According to Suh ''464, "[t]he OFDM communication system may perform frame timing synchronization, frequency synchronization, and channel estimation using a guard interval and a pilot subcarrier in addition to the preamble" where "[t]he preamble sequence is used to transmit previously known symbols at a beginning part of every frame or data burst, and update estimated time/frequency/channel information at a data transmission part, using information on the guard interval and the pilot subcarrier." *Id.* at [0013]. Ma '546 teaches that "OFDM is used for uplink transmissions from one user at a time, with multiple-user access being arranged in a TDM fashion. However, this type of uplink access scheme cannot effectively support cellular network deployment and mobility because it does not provide the quality of service and features required in cellular networks. In addition, these schemes do not support circuitry data services such as voice." *Id.* at 2:36-44. To address these problems, Ma '546 discloses various time-frequency resource allocation techniques with two different modes. *See id.* at 10:25-35 ("According to the OFDMA scheme provided by an embodiment of the invention, a common wireless channel 50 is implemented using an OFDM transmission scheme within an overall OFDM band. . . . The two different OFDMA modes are referred to herein generally as Mode-1 and Mode-2 respectively."). Ma '546 explains "Mode-1 is used to provide low rate circuit oriented connectivity for multiple users simultaneously preferably using orthogonal code separation, while Mode-2 is used to provide higher rate bursty packet connectivity." *Id.* at 10:41-45. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in

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communications systems using improved resource allocation techniques. Further, Ma '546 and Suh '464 sought to solve similar problems involving interference and quality of service in communication networks. It would have been obvious for a POSITA to combine Ma '564 with Suh '464 at least because Ma '546 provides a method and apparatus for uplink OFDM and for using resource allocation techniques (similar to those disclosed in Suh '464) in order to optimize system resources and maintaining a desired quality of service. Moreover, a POSITA would have been motivated to incorporate Suh '464's guard interval into Ma 564's RACH channel to advantageously (1) reduce adjacent channel emissions and (2) reduce the interference. A POSITA would have had a reasonable expectation of success in this implementation at least because Ma '546 and Suh '464 are related to similar methods and systems (i.e., data transmission and random access in OFDMA-based communication systems).

(ii) Jeong '589 in combination with the knowledge of a skilled artisan, Ma '546, Li '781, TR, 802.16a-2003, C802.16e-03/53r2, and /or Suh '464

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Jeong '589 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Jeong '589 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have

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had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '366 patent was filed. Specifically:

- Jeong '589, Jeong '546, Li '781, TR, 802.16a-2003, C802.16e-03/53r2, and Suh '464 are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using RACH. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Jeong '589 and Ma '546**: Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 discloses "[a] wireless terminal and network terminal are provided for implementing a new uplink OFDM protocol. In the new protocol, the wireless terminal has a first transmit chain for generating and transmitting a low rate mode OFDM transmission in a first frequency band of the OFDM band; and a second transmit chain for generating and transmitting a burst-mode transmission in a second frequency band of the OFDM band, the first frequency band being distinct from the second frequency band." Ma '546 at Abstract. Ma '546 states that the "invention relates generally to wireless communications and, in particular, to an uplink air interface

used in a wireless communication network, and more particularly to dual-mode shared OFDM methods/transmitters, receivers and systems." *Id.* at 1:11-15. Ma '546 further teaches that "OFDM is used for uplink transmissions from one user at a time, with multiple-user access being arranged in a TDM fashion. However, this type of uplink access scheme cannot effectively support cellular network deployment and mobility because it does not provide the quality of service and features required in cellular networks. In addition, these schemes do not support circuitry data services such as voice." *Id.* at 2:36-44. To address these problems, Ma '546 discloses various time-frequency resource allocation techniques with two different modes. *See id.* at 10:25-35 ("According to the OFDMA scheme provided by an embodiment of the invention, a common wireless channel 50 is implemented using an OFDM transmission scheme within an overall OFDM band. . . . The two different OFDMA modes are referred to herein generally as Mode-1 and Mode-2 respectively."). Ma '546 explains "Mode-1 is used to provide low rate circuit oriented connectivity for multiple users simultaneously preferably using orthogonal code separation, while Mode-2 is used to provide higher rate bursty packet connectivity." *Id.* at 10:41-45. Jeong '589 teaches and describes "[t]he present invention relates to a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove

interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. "According to the ranging interval, four new initial ranging sub-channel allocation methods are proposed to perform the initial ranging function. The new initial ranging structures are suitable for the cases of both frequency division duplex ("FDD") and time division duplex ("TDD")." *Id.* One object of the invention of Jeong '589 is to solve "problems is ranging interval and ranging unit for initial ranging in OFDMA wireless communication system to reduce ICI between ranging signals in TDD mode OFDMA wireless communication system." *Id.* at 3. Jeong '589 states "another object of the present invention to provide a ranging interval and ranging subchannel allocation method for initial ranging in an OFDMA wireless communication system which enables a subscriber station to perform a transmission operation in advance of a predetermined transmission time by a processing delay of the subscriber station." *Id*. at 3. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. Moreover, these references share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine Jeong '589 with Ma '546 at least because Ma '546 provides a method for reducing both intra- and inter-cell interference through PN spreading unique to the base station. It would have been obvious for a POSITA to combine Ma '546 with Jeong '589 at least because Ma '546 provides a method for using resource allocation techniques (such as those

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disclosed in Jeong '589) in order to optimize system resources and maintain quality of service.

- **Jeong '589 and 802.16a-2003:** 802.16a-2003 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. 802.16a-2003 discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.* at 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. Moreover, these references share at least the goal of reducing interference between the RACH and other uplink signals. It would

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have been obvious for a POSITA to combine Jeong '589 with 802.16a-2003 at least because 802.16a-2003 provides 802.16a-2003 describes the use of different antenna schemes. It would have been obvious for a POSITA to combine 802.16a-2003 with Jeong '589 at least because Jeong '589 provides a method for using resource allocation techniques (such as those disclosed in 802.16a-2003) in order to optimize system resources and maintain quality of service.

- **Jeong '589 and TR:** TR "describes the basic concept behind the OFDMA proposal and its advantages and featuers [*sic*] which is the most advanced of its kind present today." TR at 175. TR describes "RACH (Random Access Channel) Physical Structure" and "OFDMA Resource Allocation/Physical Channel." *Id.* at 191, 196-200. TR discloses "bandslots" where "The whole system frequency band is divided into small blocks (bandslots) with a fixed number of subcarriers." *Id.* at 199. TR, like the '366 patent, describes a random access process, which includes ranging that "typically involves an exchange of messages between the base station and the mobile station by which the mobile station aligns itself with the start of each time slot." '366 patent at 1:43-47. For example, TR discloses "After the mobile has detected the basestations [*sic*] timing it sends an RACH to the basestation. The BS measures the time offset for the received RACH and sends back the necessary timing advance to the MS (very similar to GSM). In the frame structure of the OFDMA system reserved slots for reception of RACH exist." TR at 206. TR further discloses "bandslots" where "[t]he whole system frequency band is divided into small blocks (bandslots) with a fixed number of subcarriers." *Id.* at 199. TR discloses "Unmodulated Guard Carrier," namely, "the two subcarriers at the edge

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of the bandslot [that] are left unmodulated" (i.e., unused and thus having zero power due to the absence of modulation symbols) in each bandslot "to reduce adjacent channel emissions and facilitate easy bandslot separation." TR at 199, 202. Under this arrangement, the interference of two adjacent blocks of subcarriers is reduced, which may occur when their orthogonality is compromised due to nonlinear PA [power amplifier] effects." *Id.* Use of unmodulated subcarriers is known as a "guard band," which is a narrow frequency band provided between adjacent channels to prevent interference. *Id.* Jeong '589 teaches and describes "[t]he present invention relates to a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. "According to the ranging interval, four new initial ranging sub-channel allocation methods are proposed to perform the initial ranging function. The new initial ranging structures are suitable for the cases of both frequency division duplex ("FDD") and time division duplex ("TDD")." *Id.* One object of the invention of Jeong '589 is to solve "problems is ranging interval and ranging unit for initial ranging in OFDMA wireless communication system to reduce ICI between ranging signals in TDD mode OFDMA wireless communication system." *Id.* at 3. Jeong '589 states

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"another object of the present invention to provide a ranging interval and ranging subchannel allocation method for initial ranging in an OFDMA wireless communication system which enables a subscriber station to perform a transmission operation in advance of a predetermined transmission time by a processing delay of the subscriber station." *Id*. at 3. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. To implement Jeong '589's OFDMA-based system, a POSITA would have reasons to leverage the basic system characteristics of the OFDMA-based air interface proposal for a UMTS system as disclosed in TR, especially given various advantages of the OFDMA-based air interface identified in TR, including flexibility in supporting both circuit switched services (e.g., voice) and packet oriented services. TR at 177, 180, 182. Moreover, a POSITA would have been motivated to incorporate TR's guard carrier/guard band feature into Jeong 589's system to reduce the interference, as taught by TR. In fact, this ordinary implementation of the guard carrier would have been merely the application of a known technique (leaving subcarriers on the edge of a bandslot unmodulated to create a guard band between adjacent subchannels as taught by TR, to a known system (Jeong 589's OFDMA communication system) ready for improvement to yield predictable results. A POSITA would have had a reasonable expectation of success in this implementation at least because Jeong '589 and TR are related to similar methods and systems (i.e., data transmission and random access in OFDMA-based communication systems).

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- **Jeong '589 and Li '781:** Li '781 is directed to "[a] method and apparatus for subcarrier selection for systems." Li '781 at Abstract. Li '781 discloses " the system employs orthogonal frequency division multiple access (OFDMA). . . . In one embodiment, a method for subcarrier selection comprises each of multiple subscribers measuring channel and interference information for subcarriers based on pilot symbols received from a base station, at least one of subscribers selecting a set of candidate subcarriers, providing feedback information on the set of candidate subcarriers to the base station, and the one subscriber receiving an indication of subcarriers of the set of subcarriers selected by the base station for use by the one subscriber." *Id.* Li '781 teaches and describes "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '781 at [0001]. According to Li '781, "[o]ne approach to subcarrier allocation for OFDMA is a joint optimization operation, not only requiring the activity and channel knowledge of all the subscribers in all the cells, but also requiring frequent rescheduling every time an existing subscribers is dropped off the network or a new subscribers is added onto the network." *Id.* at [0006]. However, this approach "is often impractical in real wireless system, mainly due to the bandwidth cost for updating the subscriber information and the computation cost for the joint optimization." *Id.* "At the receiver, the subscriber first distinguishes the two sequences using the signal processing methods which are well known in the art, e.g., the correlation methods, and then estimates the channel and interference level." *Id.* at [0090]. Li '781 also describes that with an "aggressive frequency reuse plan, e.g., the same spectrum is used for multiple neighboring cells,

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the problem of intercell interference arises." *Id.* at [0005]. Thus, Li '781 teaches "[a] distributed, reduced-complexity approach for subcarrier allocation." *Id.* at [0023]. Jeong '589 teaches and describes "[t]he present invention relates to a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. "According to the ranging interval, four new initial ranging sub-channel allocation methods are proposed to perform the initial ranging function. The new initial ranging structures are suitable for the cases of both frequency division duplex ("FDD") and time division duplex ("TDD")." *Id.* One object of the invention of Jeong '589 is to solve "problems is ranging interval and ranging unit for initial ranging in OFDMA wireless communication system to reduce ICI between ranging signals in TDD mode OFDMA wireless communication system." *Id.* at 3. Jeong '589 states "another object of the present invention to provide a ranging interval and ranging subchannel allocation method for initial ranging in an OFDMA wireless communication system which enables a subscriber station to perform a transmission operation in advance of a predetermined transmission time by a processing delay of the subscriber station." *Id*. at 3. Thus, these references were in the same field of endeavor, and shared the

same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Jeong '589 with Li '781 at least because Jeong '589 provides methods by which a user can receive the ranging interval and sub-channel information from the base station in order to transmit a ranging signal for initial system access, which improves usage of system resources. Also, the combination would have been merely the application of a known technique (adaptive subcarrier selection, as taught by Li) to a known system (Jeong 589's OFDMA communication system) to yield predictable results, without significantly altering or hindering the functions performed by the communication system.

- **Jeong '589 and C802.16e-03/53r2**: C802.16e-03/53r2 teaches and describes a method for an OFDM communication system that includes "the UL-MAP IE" being used to inform all SS's in the cell (i.e. cell specific) and the IE has a "subchannel offset." C802.16e-03/53r2 at 1-6. It would have been obvious for a POSITA to combine Jeong '589 with C802.16e-03/53r2 at least because Jeong '589 provides methods by which a user can receive the ranging interval and sub-channel information from the base station in order to transmit a ranging signal for initial system access, which improves usage of system resources. Also, the combination would have been merely the application of a known technique (as taught by C802.16e-03/53r2) to a known system (Jeong 589's OFDMA communication system) to yield predictable results, without significantly altering or hindering the functions performed by the communication system. It would have been obvious

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for a POSITA to combine Ma '546 with C802.16e-03/53r2at least because doing so provides an improved means of resource allocation in a communication system.

- **Jeong '589 and Suh '464:** Suh '464 is directed to an apparatus and "method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system." Suh '464 at Abstract. Specifically, the invention of Suh '464 "relates generally to an orthogonal frequency division multiplexing (OFDM) communication system, and in particular, to an apparatus and method for generating a preamble sequence in an OFDM communication system." *Id.* at [0003]. Suh '464 explains that in an "OFDM communication system, if the IFFT-transformed OFDM symbol is transmitted as it is, interference between a previous OFDM symbol and a current OFDM symbol is unavoidable. In order to remove the inter-symbol interference, a guard interval is inserted." *Id.* at [0010]. However, " if a receiver incorrectly estimates a start point of an OFDM symbol, interference occurs between subcarriers, causing an increase in error probability of a received OFDM symbol." *Id.* To address this "a "cyclic prefix" scheme or a "cyclic postfix" scheme has been proposed for the guard interval." *Id.* According to Suh ''464, "[t]he OFDM communication system may perform frame timing synchronization, frequency synchronization, and channel estimation using a guard interval and a pilot subcarrier in addition to the preamble" where "[t]he preamble sequence is used to transmit previously known symbols at a beginning part of every frame or data burst, and update estimated time/frequency/channel information at a data transmission part, using information on the guard interval and

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the pilot subcarrier." *Id.* at [0013]. Jeong '589 teaches and describes "[t]he present invention relates to a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. "According to the ranging interval, four new initial ranging sub-channel allocation methods are proposed to perform the initial ranging function. The new initial ranging structures are suitable for the cases of both frequency division duplex ("FDD") and time division duplex ("TDD")." *Id.* One object of the invention of Jeong '589 is to solve "problems is ranging interval and ranging unit for initial ranging in OFDMA wireless communication system to reduce ICI between ranging signals in TDD mode OFDMA wireless communication system." *Id.* at 3. Jeong '589 states "another object of the present invention to provide a ranging interval and ranging subchannel allocation method for initial ranging in an OFDMA wireless communication system which enables a subscriber station to perform a transmission operation in advance of a predetermined transmission time by a processing delay of the subscriber station." *Id*. at 3. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in communications systems. It would have been

obvious for a POSITA to combine Jeong '589 with Suh '464 at least because Jeong '589 provides methods by which a user can receive the ranging interval and sub-channel information from the base station in order to transmit a ranging signal for initial system access, which improves usage of system resources. Moreover, a POSITA would have been motivated to incorporate Suh '464's guard interval into Jeong '589's sub-channel to advantageously (1) reduce adjacent channel emissions and (2) reduce the interference of two adjacent blocks of subcarriers. A POSITA would have had a reasonable expectation of success in this implementation at least because Jeong '589 and Suh '464 are related to similar methods and systems (i.e., data transmission and random access in OFDMA-based communication systems).

(iii) 802.16a-2003 in combination with the knowledge of a skilled artisan, Ma '546, Li '781, Jeong '589, TR, 802.16.4, C802.16e-03/53r2, 802.16c-2002, and /or Suh '464

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine 802.16a-2003 with each of these references. A person of ordinary skill in the art would have found it obvious to combine 802.16a-2003 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed

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disclosures were well-known at the time the application leading to the '366 patent was filed. Specifically:

- 802.16a-2003, Ma '546, Jeong '589, Li '781, TR, 802.16.4, 802.16c-2002, C802.16e-03/53r2, and Suh '464 are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using RACH. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **802.16a-2003 and Jeong '589**: Jeong '589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong '589 teaches and describes "[t]he present invention relates to a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. "According to the ranging interval, four new initial ranging sub-channel

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allocation methods are proposed to perform the initial ranging function. The new initial ranging structures are suitable for the cases of both frequency division duplex ("FDD") and time division duplex ("TDD")." *Id.* One object of the invention of Jeong '589 is to solve "problems is ranging interval and ranging unit for initial ranging in OFDMA wireless communication system to reduce ICI between ranging signals in TDD mode OFDMA wireless communication system." *Id.* at 3. Jeong '589 states "another object of the present invention to provide a ranging interval and ranging subchannel allocation method for initial ranging in an OFDMA wireless communication system which enables a subscriber station to perform a transmission operation in advance of a predetermined transmission time by a processing delay of the subscriber station." *Id.* 802.16a-2003 discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on

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subchannels of the OFDMA symbol. *Id.* at 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* 802.16a-2003's communication system is configured to adapt its transmission parameters based on the capabilities of the base station and subscribers as well as the state of the channel. 802.16a-2003, 4 ("adaptive modulation: A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles,"), 83 ("The downlink burst profile is determined by the BS according to the quality of the signal that is received by each SS."). 802.16a-2003 discloses that AAS uses "channel state information in the PHY at both downlink and uplink." 802.16a-2003, 67; *see also id.*, 203, 220-221. This channel state information is used "in adjusting the direction of the adaptive array." *Id.*, 42-44. In this manner, 802.16a-2003's describes the use of different antenna schemes. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. Moreover, these references share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine Jeong '589 with 802.16a-2003 at least because 802.16a-2003 describes the use of different antenna schemes. It would have been obvious for a POSITA to combine 802.16a-2003 with Jeong '589 at least because Jeong '589 provides a method for using resource allocation techniques (such as those disclosed in 802.16a-2003) in order to optimize system resources and maintain quality of service.

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- **802.16a-2003 and Ma '546**: Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 discloses "[a] wireless terminal and network terminal are provided for implementing a new uplink OFDM protocol. In the new protocol, the wireless terminal has a first transmit chain for generating and transmitting a low rate mode OFDM transmission in a first frequency band of the OFDM band; and a second transmit chain for generating and transmitting a burst-mode transmission in a second frequency band of the OFDM band, the first frequency band being distinct from the second frequency band." Ma '546 at Abstract. Ma '546 states that the "invention relates generally to wireless communications and, in particular, to an uplink air interface used in a wireless communication network, and more particularly to dual-mode shared OFDM methods/transmitters, receivers and systems." *Id.* at 1:11-15. Ma '546 further teaches that "OFDM is used for uplink transmissions from one user at a time, with multiple-user access being arranged in a TDM fashion. However, this type of uplink access scheme cannot effectively support cellular network deployment and mobility because it does not provide the quality of service and features required in cellular networks. In addition, these schemes do not support circuitry data services such as voice." *Id.* at 2:36-44. To address these problems, Ma '546 discloses various time-frequency resource allocation techniques with two different modes. *See id.* at 10:25-35 ("According to the OFDMA scheme provided by an embodiment of the invention, a common wireless channel 50 is implemented using an OFDM transmission scheme within an overall OFDM band. . . . The two different OFDMA modes are referred to herein generally as Mode-1 and Mode-2 respectively."). Ma '546

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explains "Mode-1 is used to provide low rate circuit oriented connectivity for multiple users simultaneously preferably using orthogonal code separation, while Mode-2 is used to provide higher rate bursty packet connectivity." *Id.* at 10:41-45. 802.16a-2003's communication system is configured to adapt its transmission parameters based on the capabilities of the base station and subscribers as well as the state of the channel. 802.16a-2003, 4 ("adaptive modulation: A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles,"), 83 ("The downlink burst profile is determined by the BS according to the quality of the signal that is received by each SS."). 802.16a-2003 discloses that AAS uses "channel state information in the PHY at both downlink and uplink." 802.16a-2003, 67; *see also id.*, 203, 220-221. This channel state information is used "in adjusting the direction of the adaptive array." *Id.*, 42-44. In this manner, 802.16a-2003's describes the use of different antenna schemes. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. Moreover, these references share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine 802.16a-2003 with Ma '546 at least because Ma '546 provides a method for reducing both intra- and inter-cell interference through PN spreading unique to the base station. It would have been obvious for a POSITA to combine Ma '546 with 802.16a-2003 at least because 802.16a-2003

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provides a method for using resource allocation techniques (such as those disclosed in Ma ’546) in order to optimize system resources and maintain quality of service.

- **802.16a-2003 and TR:** TR “describes the basic concept behind the OFDMA proposal and its advantages and featuers [*sic*] which is the most advanced of its kind present today.” TR at 175. TR describes “RACH (Random Access Channel) Physical Structure” and “OFDMA Resource Allocation/Physical Channel.” *Id.* at 191, 196-200. TR discloses “bandslots” where “The whole system frequency band is divided into small blocks (bandslots) with a fixed number of subcarriers.” *Id.* at 199. TR, like the ’366 patent, describes a random access process, which includes ranging that “typically involves an exchange of messages between the base station and the mobile station by which the mobile station aligns itself with the start of each time slot.” ’366 patent at 1:43-47. For example, TR discloses “After the mobile has detected the basestations [*sic*] timing it sends an RACH to the basestation. The BS measures the time offset for the received RACH and sends back the necessary timing advance to the MS (very similar to GSM). In the frame structure of the OFDMA system reserved slots for reception of RACH exist.” TR at 206. TR further discloses “bandslots” where “[t]he whole system frequency band is divided into small blocks (bandslots) with a fixed number of subcarriers.” *Id.* at 199. TR discloses “Unmodulated Guard Carrier,” namely, “the two subcarriers at the edge of the bandslot [that] are left unmodulated” (i.e., unused and thus having zero power due to the absence of modulation symbols) in each bandslot “to reduce adjacent channel emissions and facilitate easy bandslot separation.” TR at 199, 202. Under this arrangement, the interference of two adjacent blocks of subcarriers is reduced, which

may occur when their orthogonality is compromised due to nonlinear PA [power amplifier] effects." *Id.* Use of unmodulated subcarriers is known as a "guard band," which is a narrow frequency band provided between adjacent channels to prevent interference. 802.16a-2003 discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.* at 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* 802.16a-2003's communication system is configured to adapt its transmission parameters based on the capabilities of the base station and subscribers as well as the state of the channel. 802.16a-2003, 4 ("adaptive modulation: A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst

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profiles,"), 83 ("The downlink burst profile is determined by the BS according to the quality of the signal that is received by each SS."). 802.16a-2003 discloses that AAS uses "channel state information in the PHY at both downlink and uplink." 802.16a-2003, 67; *see also id.*, 203, 220-221. This channel state information is used "in adjusting the direction of the adaptive array." *Id.*, 42-44. In this manner, 802.16a-2003's describes the use of different antenna schemes. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. Moreover, these references share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine Jeong '589 with 802.16a-2003 at least because 802.16a-2003 describes the use of different antenna schemes. It would have been obvious for a POSITA to combine 802.16a-2003 with TR at least because TR provides a method for using resource allocation techniques (such as those disclosed in 802.16a-2003) in order to optimize system resources and maintain quality of service. Moreover, a POSITA would have been motivated to incorporate TR's guard carrier/guard band feature into 802.16a-2003's RACH channel to advantageously (1) reduce adjacent channel emissions (2) facilitate easy bandslot separation, (3) relax receiver blocking requirements, and (4) reduce the interference of two adjacent blocks of subcarriers, as taught by TR. In fact, this ordinary implementation of the guard carrier would have been merely the application of a known technique (leaving subcarriers on the edge of a bandslot unmodulated to create a guard band between adjacent subchannels as taught by TR, to a known system (802.16a-2003's OFDM

communication system) ready for improvement to yield predictable results. A POSITA would have had a reasonable expectation of success in this implementation at least because 802.16a-2003 and TR are related to similar methods and systems (i.e., data transmission and random access in OFDM-based communication systems).

- **802.16a-2003 and Li '781:** Li '781 is directed to "[a] method and apparatus for subcarrier selection for systems." Li '781 at Abstract. Li '781 discloses " the system employs orthogonal frequency division multiple access (OFDMA). . . . In one embodiment, a method for subcarrier selection comprises each of multiple subscribers measuring channel and interference information for subcarriers based on pilot symbols received from a base station, at least one of subscribers selecting a set of candidate subcarriers, providing feedback information on the set of candidate subcarriers to the base station, and the one subscriber receiving an indication of subcarriers of the set of subcarriers selected by the base station for use by the one subscriber." *Id.* Li '781 teaches and describes "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '781 at [0001]. According to Li '781, "[o]ne approach to subcarrier allocation for OFDMA is a joint optimization operation, not only requiring the activity and channel knowledge of all the subscribers in all the cells, but also requiring frequent rescheduling every time an existing subscribers is dropped off the network or a new subscribers is added onto the network." *Id.* at [0006]. However, this approach "is often impractical in real wireless system, mainly due to the bandwidth cost for updating the subscriber information and the computation cost for the joint optimization." *Id.* Li '781 also describes that with an "aggressive frequency reuse

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plan, e.g., the same spectrum is used for multiple neighboring cells, the problem of intercell interference arises." *Id.* at [0005]. "At the receiver, the subscriber first distinguishes the two sequences using the signal processing methods which are well known in the art, e.g., the correlation methods, and then estimates the channel and interference level." *Id.* at [0090]. Thus, Li '781 teaches "[a] distributed, reduced-complexity approach for subcarrier allocation." *Id.* at [0023]. 802.16a-2003 discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.* at 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* 802.16a-2003's communication system is configured to adapt its transmission parameters based on the capabilities of the base station and subscribers as well as the state of the channel. 802.16a-2003, 4 ("adaptive modulation: A system's ability

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to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles,"), 83 ("The downlink burst profile is determined by the BS according to the quality of the signal that is received by each SS."). 802.16a-2003 discloses that AAS uses "channel state information in the PHY at both downlink and uplink." 802.16a-2003, 67; *see also id.*, 203, 220-221. This channel state information is used "in adjusting the direction of the adaptive array." *Id.*, 42-44. In this manner, 802.16a-2003's describes the use of different antenna schemes. It would have been obvious for a POSITA to combine 802.16a-2003 with Li '781 at least because 802.16a-2003 describes the use of different antenna schemes. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine 802.16a-2003 with Li '781 at least because 802.16a-2003 provides a method for using resource allocation techniques to optimize system resources and reduce interference. Also, the combination would have been merely the application of a known technique (adaptive subcarrier selection, as taught by Li '781) to a known system (802.16a-2003's OFDMA communication system) to yield predictable results, without significantly altering or hindering the functions performed by the communication system.

- **802.16a-2003 and C802.16e-03/53r2:** C802.16e-03/53r2 teaches and describes a method for an OFDM communication system that includes "the UL-MAP IE" being used to inform all SS's in the cell (i.e. cell specific) and the IE has a "subchannel

offset." C802.16e-03/53r2 at 1-6. It would have been obvious for a POSITA to combine 802.16a-2003 with C802.16e-03/53r2 at least because 802.16a-2003 provides a method for using resource allocation techniques to optimize system resources and reduce interference. Also, the combination would have been merely the application of a known technique (as taught by C802.16e-03/53r2) to a known system (802.16a-2003's OFDMA communication system) to yield predictable results, without significantly altering or hindering the functions performed by the communication system. It would have been obvious for a POSITA to combine 802.16a-2003 with C802.16e-03/53r2at least because doing so provides an improved means of resource allocation in a communication system.

- **802.16a-2003 and 802.16.4:** 802.16.4 teaches "The following contribution proposes some modifications to the IEEE 802.11a, HiperLAN2 PHY and 802.16.1 MAC layer in order to adopt it to the TG4 bands. The purposes of the proposed changes are to deal with higher delay spreads, interfering signals, coexistence with other systems, users power balance, Improved Error Correcting Code (ECC), Adaptive Power Control and Peak to Average Power Reduction (PAPR) reduction. The proposed PHY layer uses the OFDMA concept in order to construct a very robust and back-compatible layer. Many advantages are gained by using the OFDMA modulation, which are elaborated throughout the document" 802.16.4 at 3. Furthermore 802.16.4 discusses "The following description refers to the down stream and up stream access methods. There are two basic approaches when using the OFDMA concept: One where several OFDM symbols are used for data transmission (all Sub-Channels in the OFDM symbol are used for data only) and other OFDM symbols are used for

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synchronization (all Sub-Channels in the OFDM symbol are used for ranging only)." *Id* at 12. It would have been obvious for a POSITA to combine 802.16a-2003 with 802.16.4 at least because 802.16a-2003 provides a method for using resource allocation techniques to optimize system resources and reduce interference. Also, the combination would have been merely the application of a known technique (as taught by 802.16.4) to a known system (802.16a-2003's OFDMA communication system) to yield predictable results, without significantly altering or hindering the functions performed by the communication system. It would have been obvious for a POSITA to combine 802.16a-2003 with 802.16.4 at least because doing so provides an improved means of resource allocation in a communication system.

- **802.16a-2003 and 802.16c-2002:** 802.16c discloses This introduction is not part of IEEE Std 802.16c-2002, IEEE Standard for Local and metropolitan area networks—Part 16: Air Interface for Fixed Broadband Wireless Access Systems—Amendment 1: Detailed System Profiles for 10–66 GHz.) This amendment updates and expands Clause 12 of IEEE Std 802.16-2001, which concerns system profiles that list sets of features and functions to be used in typical implementation cases. Errors and inconsistencies in IEEE Std 802.16-2001 are also corrected. The scope is limited to 10–66 GHz. 802.16a-2003 explains that it "amends IEEE Std 802.16-2001 by enhancing the medium access control layer and providing additional physical layer specifications in support of broadband wireless access at frequencies from 2-11 GHz." 802.16a-2003, cover, iii ("This amendment expands the scope of IEEE Std 802.16-2001 by extending the WirelessMAN air interface to address operational frequencies from 2-11 GHz."). 802.16a-2003 also contains specific editing

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instructions that "define how to merge the material contained herein into the existing base standard (IEEE Std 802.l6TM-2001) to form the comprehensive standard." 802.16a-2003, 1. Thus, 802.16a-2003 directly references and builds upon 802.16a-2001. These references were in the same field of endeavor, and were directed to the same standard which improved data transmissions in multi-carrier communications environments. Therefore, it would have been obvious for a POSITA to combine 802.16a-2003 with 802.16c-2002 at least because 802.16a-2003 directly references and incorporates 802.16a-2001, which is directly referenced by 802.16c-2002. It would have been obvious for a POSITA to consider 802.16a-2003 and 802.16c-2002 as part of the same document.

- **802.16a-2003 and Suh '464:** Suh '464 is directed to an apparatus and "method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system." Suh '464 at Abstract. Specifically, the invention of Suh '464 "relates generally to an orthogonal frequency division multiplexing (OFDM) communication system, and in particular, to an apparatus and method for generating a preamble sequence in an OFDM communication system." *Id.* at [0003]. Suh '464 explains that in an "OFDM communication system, if the IFFT-transformed OFDM symbol is transmitted as it is, interference between a previous OFDM symbol and a current OFDM symbol is unavoidable. In order to remove the inter-symbol interference, a guard interval is inserted." *Id.* at [0010]. However, " if a receiver incorrectly estimates a start point of an OFDM symbol, interference occurs between subcarriers, causing an increase in error probability of

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a received OFDM symbol." *Id.* To address this "a "cyclic prefix" scheme or a "cyclic postfix" scheme has been proposed for the guard interval." *Id.* According to Suh '464, "[t]he OFDM communication system may perform frame timing synchronization, frequency synchronization, and channel estimation using a guard interval and a pilot subcarrier in addition to the preamble" where "[t]he preamble sequence is used to transmit previously known symbols at a beginning part of every frame or data burst, and update estimated time/frequency/channel information at a data transmission part, using information on the guard interval and the pilot subcarrier." *Id.* at [0013]. 802.16a-2003 discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.* at 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* 802.16a-

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2003's communication system is configured to adapt its transmission parameters based on the capabilities of the base station and subscribers as well as the state of the channel. 802.16a-2003, 4 ("adaptive modulation: A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles,"), 83 ("The downlink burst profile is determined by the BS according to the quality of the signal that is received by each SS."). 802.16a-2003 discloses that AAS uses "channel state information in the PHY at both downlink and uplink." 802.16a-2003, 67; *see also id.*, 203, 220-221. This channel state information is used "in adjusting the direction of the adaptive array." *Id.*, 42-44. In this manner, 802.16a-2003's describes the use of different antenna schemes. It would have been obvious for a POSITA to combine 802.16a-2003 with Suh '464 at least because 802.16a-2003 describes the use of different antenna schemes. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine 802.16a-2003 with Suh '464 at least because 802.16a-2003 provides a method for using resource allocation techniques to optimize system resources and reduce interference. Also, the combination would have been merely the application of a known technique (adaptive subcarrier selection, as taught by Suh '464) to a known system (802.16a-2003's OFDMA communication system) to yield predictable results, without significantly altering or hindering the functions performed by the communication system. Moreover, a

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POSITA would have been motivated to incorporate Suh '464's guard interval into 802.16a-2003 sub-channel to advantageously (1) reduce adjacent channel emissions and (2) reduce the interference of two adjacent blocks of subcarriers.

(iv) Suh in combination with the knowledge of a skilled artisan, Ma, Suzuki, Van Nee, Wahlqvist, and/or Gudmundson

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Suh with each of these references. A person of ordinary skill in the art would have found it obvious to combine Suh with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '366 patent was filed. Specifically:

- Suh, Ma, Suzuki, Van Nee, Wahlqvist, and Gudmundson all describe the design of a cellular wireless system using OFDM, and they note the extraordinary flexibility of allocation offered by the time-frequency resources in an OFDM system. In addition to that advantage, these references address the OFDM challenges of low peak-to-average power ratio and frequency efficiency. Like any wireless cellular system, these references also address access to that system by a new mobile device, and the necessary synchronization.

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- **Suh and Ma**: Suh is directed to an OFDM wireless communication system. Suh, 1:9-10. As part of using that communication system, Suh discloses the use of ranging sequences to enable random access by a mobile station to a base station to thereby provide coverage to the mobile station within the cell served by the base station. Suh explicitly notes that the provision of a low PAPR is desirable in an OFDM system, and notes that preamble design can lead to a low PAPR. Like Suh, Ma discloses an OFDM wireless communication system and ranging access by a mobile station. Ma provides additional details on ranging sequences for use in a ranging signal to gain that access to the base station. Ma, [0204]–[0243]. Ma also describes a proposed approach to an implementation of an open loop power control for the mobile station, when communicating to the base station. Ma, [0195]–0203]. Therefore, a POSITA would have looked to the prior art, such as Ma, to determine how to provide ranging access solutions that complement Suh's teachings in the design of an OFDM wireless communications system. Similarly, a POSITA would have looked to the prior art, such as Ma, to determine how to provide power control solutions that complement Suh's teachings in the design of an OFDM wireless communications system. Each of Ma's contributions has an expectation of success, since the flexibility of an OFDM wireless communication systems allows a person of ordinary skill in the art to separately design the ranging signals and sequences used from the design of the underlying OFDM hardware, and expect success when used together. Similarly, the approach for a power control solution may be separately designed using Ma's teaching, and then successfully applied to any underlying OFDM hardware system.

- **Suh and Suzuki:** Suh is directed to an OFDM wireless communication system. Suh, 1:9-10. As part of using that communication system, Suh discloses the use of ranging sequences to enable random access by a mobile station to a base station to thereby provide coverage to the mobile station within the cell served by the base station. Suh explicitly notes that the provision of a low PAPR is desirable in an OFDM system, and notes that preamble design can lead to a low PAPR. Suzuki likewise describes an OFDM communications system. Suzuki, 2:64–67. In particular, Suzuki has a plurality of subcarriers (i.e., a block) that are successively arranged within a pre-allocated band. Id. Suzuki notes the guard band practice in, for example, one slot, where the subcarriers (numbered 0 and 23) at both ends have their powers made zero. Suzuki, 3:17–20. Suh already notes that unused subcarriers should receive null data. Thus, a POSITA would have successfully used Suzuki's knowledge to set the power level of Suh's null subcarriers to have zero power.
- **Suh and Van Nee:** Suh is directed to an OFDM wireless communication system. Suh, 1:9-10. As part of using that communication system, Suh discloses the use of ranging sequences to enable random access by a mobile station to a base station to thereby provide coverage to the mobile station within the cell served by the base station. Suh explicitly notes that the provision of a low PAPR is desirable in an OFDM system, and notes that preamble design can lead to a low PAPR. Van Nee is "the first book to give a broad treatment to OFDM for omobile multimedia communications" and captures the state of the art circa 2000. As Van Nee explained, at the time "OFDM [wa]s of great interest by the researchers in the

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Universities and research laboratories all over the world." Van Nee, 013. "OFDM ha[d] already been accepted for the new wireless local area network standards from IEEE 802.11, High Performance Local Area Network type 2 (HIPERLAN/2) and Mobile Multimedia Access Communication (MMAC) Systems." *Id.* It was also "expected to be used for the wireless broadband multimedia communications." *Id.* Given the prevelance of OFDM at the time and the broad scope of teachings in the reference, Van Nee's teachings are readily applicable to other teachings in the OFDM field. Thus, a POSITA would have understood the teachings in the reference and would have been able to readily and successfully combine Van Nee's teachings with the teachings of other OFDM references, like Suh.

- **Suh and Wahlqvist:** Suh is directed to an OFDM wireless communication system. Suh, 1:9-10. As part of using that communication system, Suh discloses the use of ranging sequences to enable random access by a mobile station to a base station to thereby provide coverage to the mobile station within the cell served by the base station. Suh explicitly notes that the provision of a low PAPR is desirable in an OFDM system, and notes that preamble design can lead to a low PAPR. Wahlqvist's 1996 Conference Paper is directed to an OFDM wireless communications system. Wahlqvist recognized the need for uplink synchronization between base station and mobile station. Wahlqvist, Abstract. To that end, Wahlqvist describes a random access protocol between mobile stations and the base station. Wahlqvist, pp. 1569–1570, FIG. 2. In addition, Wahlqvist provides some details on how a sequence in a ranging signal would be detected, and the relevant time delay be estimated, at the base station in an OFDM system.

To a POSITA, Wahlqvist provides additional design details on a random access approach by a mobile station in an OFDM system. Such additional design details would be successfully used in combination with the other OFDM references, like Suh.

- **Suh and Gudmundson:** Suh is directed to an OFDM wireless communication system. Suh, 1:9-10. As part of using that communication system, Suh discloses the use of ranging sequences to enable random access by a mobile station to a base station to thereby provide coverage to the mobile station within the cell served by the base station. Suh explicitly notes that the provision of a low PAPR is desirable in an OFDM system, and notes that preamble design can lead to a low PAPR. Gudmundson describes the nature of interference, and in particular adjacent channel interference, in an OFDM System. Gudmundson describes how attenuation windows may reduce this interference. Thus, a POSITA would have readily known about the interference problem and successfully applied Gudmundson's guidance in combination with the other OFDM references, like Suh.

(v) Chayat '367 in combination with the knowledge of a skilled artisan, 802.16ab, Ma '546, and /or Jung '504

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Chayat '367 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Chayat '367 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both

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obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '366 patent was filed. Specifically:

- Chayat '367, 802.16ab, Ma '546, and Jung '504 are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using preamble and ranging related techniques. For example, they relate to wireless communications, including signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Chayat '367 and 802.16ab**: 802.16ab is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. 802.16ab teaches "The goal of the enhancements is to use the advantages of the OFDM/OFDMA based PHY to facilitate simpler and safer synchronization of the user with the base station." 802.16ab at 45. "OFDMA PHY DFS is the process that is used primarily to assign one of several possible channels to the SS. Additionally, especially in a mesh mode, DFS may be also used to assign a most feasible channel to each link (unicast/multicast/broadcast). The process requires monitoring by the

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SS and assignment of channels by the upper processing layers of the BS.(Comment: in both Mesh and Directional Antenna Systems the DFS will assign the most feasible channels)" *Id.* at 37. "This single mode of operation is sufficient for the upstream, since the upstream transmissions are point-to-point burst transmissions between each transmitting subscriber station (SS) and each receiving base station (BS). " *Id.* at 75. Chayat '367 discloses "A method of implementing OFDMA systems with enhanced preamble properties is presented. The transmit power is boosted during a preamble transmission, by utilizing preambles with a low Peak-to-Average Power Ratio (PAPR) property, as opposed to higher PAPR during the data portion of the transmission. Further, sets of preambles satisfying good PAPR properties in OFDMA systems are presented. The preambles satisfy a low Peak-to-Average Power Ratio (PAPR) property for numerous subsets of the usable subcarrier set. A method for generating a hierarchical set of preambles for OFDMA communication systems is described. The method hinges on the good PAPR properties of Golay's complementary sequences, and on hierarchical construction methods of larger complementary sequences out of smaller ones." Chayat '367 at Abstract. 802.16ab also states "The SS, after acquiring downstream synchronization and upstream transmission parameters, shall choose randomly a Ranging Slot (with use of a binary truncated exponent algorithm to avoid of possible re-collisions) as the time to perform the ranging, then it chooses randomly a Ranging Code (from the Initial Ranging domain) and sends it to the BS (as a CDMA code)." 802.16ab at 48. Furthermore 802.16ab discloses "The Long Ranging transmission shall be used by any SS that wants to synchronize to the

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system channel for the first time. A Long Ranging transmission shall be performed during the two first consecutive symbols of the UL frame. The same ranging code is transmitted during each symbol. Sending for a consecutive period of two OFDMA signals a preamble shall perform the long ranging transmission. The preamble structure is defined by modulating one Ranging Code, up on the Ranging Sub-Channel carriers. There shall not be any phase discontinuity on the Ranging Sub-Channel carriers during the period of the Long Ranging transmission. This Long Ranging transmission is allowed only on the Ranging Sub-Channel resources defined by the MAC process in the Base Station." 802.16ab at 171. Also, 802.16ab states "Short Ranging transmission The Short Ranging transmission shall be used only by a SS that has already synchronized to the system. The Short Ranging transmission shall be used for system maintenance ranging or for fast bandwidth allocation requests. To perform a Short Ranging transmission, the SS shall send a preamble for a period of one OFDM/OFDMA symbol in the duration of the ranging interval. The preamble structure is defined by modulating one Ranging Code on one Ranging Sub-Channel. This transmission may occur on any OFDM symbol out of the six available ranging symbols." 802.16ab at 171. Chayat '367 discloses "In burst communication systems each transmission typically starts with a preamble, which is used for synchronization and channel estimation. Usually such preamble is structured as one or two OFDM symbols with predefined values modulating each of the subcarriers. The set of predefined values is chosen to satisfy several criteria. One is that all the values have the same modulus, to ease the channel estimation. Only the values corresponding to the assigned subcarriers are non-zero. Another

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criterion is that the preamble time domain waveform has a low Peak-to-Average Power Ratio (PAPR) property, to avoid excessive distortion in the power amplifier." Chayat '367 at 1:46-46. 802.16ab states "Long Ranging transmission The Long Ranging transmission shall be used by any SS that wants to synchronize to the system channel for the first time. A Long Ranging transmission shall be performed during the two first consecutive symbols of the UL frame. The same ranging code is transmitted during each symbol. Sending for a consecutive period of two OFDMA signals a preamble shall perform the long ranging transmission. The preamble structure is defined by modulating one Ranging Code, up on the Ranging Sub-Channel carriers. There shall not be any phase discontinuity on the Ranging Sub-Channel carriers during the period of the Long Ranging transmission. This Long Ranging transmission is allowed only on the Ranging Sub-Channel resources defined by the MAC process in the Base Station." 802.16ab at 171. Chayat '367 discloses "The preambles in OFDMA systems are designed to excite only the subcarriers that are assigned to the user. The OFDMA adds a new twist to the problem, since not only a single preamble with good PAPR properties needs to be designed, but rather a family of preambles for each subset of subcarriers that can be allocated to a single transmitter." Chayat at 2:1-6. 802.16ab states "Ramp Up As both Figure 204 and Figure 205 also indicate, the Burst Preamble also contains a ramp-up region during which the power of the transmitter is ramped up. This ramping may be achieved by initializing the transmit filter memory with zero-valued (null) symbols, and then pushing the desired transmit data symbols into the filter to naturally ramp the filter output (and system power) to its full scale value.

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The ramp up interval length, R, is TBD. If a ramp-up sequence length shorter than one-half the length of the impulse response of the transmit filter is specified, the transmit filter output samples related to first few symbols may be suppressed from the transmit filter output, and a ramped power buildup achieved by windowing the ramp-up sequence, using a raised-cosine window of the desired length R, for example." 802.16ab at 121. Furthermore 802.16ab teaches "During registration, a new subscriber registers during the random access channel and if successful is entered into a ranging process under control of the base station. The ranging process is cyclic in nature where default time and power parameters are used to initiate the process followed by cycles where (re)calculated parameters are used in succession until parameters meet acceptance criteria for the new subscriber. These parameters are monitored, measured and stored at the base station and transmitted to the subscriber unit for use during normal exchange of data. During normal exchange of data, the stored parameters are updated in a periodic manner based on configurable update intervals to ensure changes in the channel can be accommodated. The update intervals will vary in a controlled manner on a subscriber unit by subscriber unit basis." *Id* at 159. Chayat '367 discloses "A method of implementing OFDMA systems with enhanced preamble properties is presented. The transmit power is boosted during a preamble transmission, by utilizing preambles with a low Peak-to-Average Power Ratio (PAPR) property, as opposed to higher PAPR during the data portion of the transmission. Further, sets of preambles satisfying good PAPR properties in OFDMA systems are presented. The preambles satisfy a low Peak-to-Average Power Ratio (PAPR) property for

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numerous subsets of the usable subcarrier set. A method for generating a hierarchical set of preambles for OFDMA communication systems is described." Chayat 367 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goals such as improving data transmissions in multi-carrier communications environments using improved resource allocation techniques and power control. It would have been obvious for a POSITA to combine Chayat '367 with 802.16ab at least because Chayat '367 provides a method for implementing an OFDMA system with enhanced preamble properties. It would have been obvious for a POSITA to combine 802.16ab with Chayat '367 at least because 802.16ab provides a method for using a preamble for ranging, and Chayat '367 pertains to preamble constructions. Also, the combination would have been merely the application of a known technique (using the preamble to perform ranging) to a known system (Chayat's OFDMA communication system) to yield predictable results, without significantly altering or hindering the functions performed by the communication system.

- **Chayat '367 and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 discloses "A wireless terminal and network terminal are provided for implementing a new uplink OFDM protocol. In the new protocol, the wireless terminal has a first transmit chain for generating and transmitting a low rate mode OFDM transmission in a first frequency band of the OFDM band; and a second transmit chain for generating and transmitting a burst-mode transmission in a second frequency band of the OFDM band, the first frequency band being distinct from the second

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frequency band. An access channel is provided which is overlaid over the low rate mode transmissions of other users." Ma '546 at Abstract. Furthermore Ma '536 discusses "In order to reduce multiple-access interference so that spectral efficiency and high data rate limits in a common wireless channel are increased a method and apparatus for uplink multiple-user access is provided. The method and apparatus disclosed herein are based on Orthogonal Frequency Division Modulation (OFDM) adapted so as to provide an effective uplink multiple-user access scheme that can be used in wireless communication networks. Accordingly, from herein the OFDM-based uplink multiple-user access scheme provided by the invention will be simply referred to as OFDMA (Orthogonal Frequency Division Multiple-Access)." *Id.* at 9:38-49. Chayat '367 discloses "A method of implementing OFDMA systems with enhanced preamble properties is presented. The transmit power is boosted during a preamble transmission, by utilizing preambles with a low Peak-to-Average Power Ratio (PAPR) property, as opposed to higher PAPR during the data portion of the transmission. Further, sets of preambles satisfying good PAPR properties in OFDMA systems are presented. The preambles satisfy a low Peak-to-Average Power Ratio (PAPR) property for numerous subsets of the usable subcarrier set. A method for generating a hierarchical set of preambles for OFDMA communication systems is described. The method hinges on the good PAPR properties of Golay's complementary sequences, and on hierarchical construction methods of larger complementary sequences out of smaller ones." Chayat '367 at Abstract. Ma '546 states "Uplink Power Control The power control of the Mode-1 traffic channel can be open-loop power control. In one embodiment power control is achieved as

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follows: 1. UE sends RACH (described in detail below) with the power inversely proportional to the long-term estimated DL C/I measurement and the RACH signature spreading factor (more generally, RACH power increases as estimate decreases); 2. Base station measures the power of RACH from UE and sends back the power control command to UE for increasing/unchanging/decreasing transmit power--this power control transmission may also be construed as an acknowledgement, in the absence of acknowledgement, another access attempt is with increased power; 3. UE starts the uplink transmission with power based on power of RACH with adjustment based on power control command through the dedicated slow traffic channel; 4. Base station controls the uplink power based on the frame error rate from a particular UE." Ma '546 at 18:50-19.2. Chayat '367 discloses "A method of implementing OFDMA systems with enhanced preamble properties is presented. The transmit power is boosted during a preamble transmission, by utilizing preambles with a low Peak-to-Average Power Ratio (PAPR) property, as opposed to higher PAPR during the data portion of the transmission. Further, sets of preambles satisfying good PAPR properties in OFDMA systems are presented. The preambles satisfy a low Peak-to-Average Power Ratio (PAPR) property for numerous subsets of the usable subcarrier set. A method for generating a hierarchical set of preambles for OFDMA communication systems is described. The method hinges on the good PAPR properties of Golay's complementary sequences, and on hierarchical construction methods of larger complementary sequences out of smaller ones." Chayat 367 at Abstract. Thus, these references were in the same field of endeavor, and shared the same

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fundamental goals such as improving data transmissions in multi-carrier communications environments using improved resource allocation techniques and power control. It would have been obvious for a POSITA to combine Chayat '367 with Ma '546 at least because Chayat '367 provides a method for implementing an OFDMA system with enhanced preamble properties. Moreover, a POSITA would have been motivated to incorporate Ma's open or closed loop power control feature into Chayat's power control feature to control the power transmitted for the ranging signal. A POSITA would have had a reasonable expectation of success in this implementation at least because Chayat and Ma are related to similar methods and systems (i.e., data transmission and random access in OFDMA-based communication systems).

- **Chayat '367 and Jung '504:** Jung '504 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jung '504 is directed to "A method and apparatus for generating a preamble sequence in an orthogonal frequency division multiplexing (OFDM) communication system having m subcarriers in a frequency domain." Jung '504 at Abstract. Chayat '367 discloses "A method of implementing OFDMA systems with enhanced preamble properties is presented. The transmit power is boosted during a preamble transmission, by utilizing preambles with a low Peak-to-Average Power Ratio (PAPR) property, as opposed to higher PAPR during the data portion of the transmission. Further, sets of preambles satisfying good PAPR properties in OFDMA systems are presented. The preambles satisfy a low Peak-to-Average Power Ratio (PAPR) property for numerous subsets of the usable subcarrier set. A

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method for generating a hierarchical set of preambles for OFDMA communication systems is described." Chayat '367 at Abstract. Jung '504 discloses "(2) The long preamble sequence is used for initial ranging. (3) The long preamble sequence is used for bandwidth request ranging. Further, the short preamble sequence has the following uses in the OFDM communication system. (1) The short preamble sequence is used as an uplink data preamble sequence. (2) The short preamble sequence is used for periodic ranging. In the OFDM communication system, because accurate synchronization can be acquired by performing initial ranging and periodic ranging, the uplink data preamble sequence is mainly used for channel estimation. For channel estimation, PAPR, performance and complexity should be taken into consideration. In the case of the existing short preamble sequence, a PAPR is 3.5805[dB], and various channel estimation algorithms such as a minimum mean square error (MMSE) algorithm and a least square (LS) algorithm are used." Jung '504 at 0029-0034. Chayat '367 discloses "In burst communication systems each transmission typically starts with a preamble, which is used for synchronization and channel estimation. Usually such preamble is structured as one or two OFDM symbols with predefined values modulating each of the subcarriers. The set of predefined values is chosen to satisfy several criteria. One is that all the values have the same modulus, to ease the channel estimation. Only the values corresponding to the assigned subcarriers are non-zero. Another criterion is that the preamble time domain waveform has a low Peak-to-Average Power Ratio (PAPR) property, to avoid excessive distortion in the power amplifier." Chayat '367 at 1:46-46. Thus, these references were in the same field of endeavor, and shared the

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same fundamental goals inlcuding improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Jung '504 with Chayat '367 at least because Jung '504 provides a method for using a preamble for ranging, and Chayat '367 pertains to preamble constructions. Also, the combination would have been merely the application of a known technique (using the preamble to perform ranging) to a known system (Chayat's OFDMA communication system) to yield predictable results, without significantly altering or hindering the functions performed by the communication system.

(vi) Jung '504 in combination with the knowledge of a skilled artisan, 802.16ab, and /or Ma '546

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Jung '504 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Jung '504 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '366 patent was filed. Specifically:

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- Jung ‘504, 802.16ab, and Ma ‘546 are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using preamble and ranging. For example, they relate to wireless communications, including signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Jung ’504 and 802.16ab**: 802.16ab is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. 802.16ab teaches “The goal of the enhancements is to use the advantages of the OFDM/OFDMA based PHY to facilitate simpler and safer synchronization of the user with the base station.” 802.16ab at 45. “OFDMA PHY DFS is the process that is used primarily to assign one of several possible channels to the SS. Additionally, especially in a mesh mode, DFS may be also used to assign a most feasible channel to each link (unicast/multicast/broadcast). The process requires monitoring by the SS and assignment of channels by the upper processing layers of the BS.(Comment: in both Mesh and Directional Antenna Systems the DFS will assign the most feasible channels)” *Id.* at 37. “This single mode of operation is sufficient for the upstream, since the upstream transmissions are point-to-point burst transmissions between each transmitting subscriber station (SS) and each receiving base station (BS). ” *Id.* at 75. Jung ‘504 discloses “A method and apparatus for generating a preamble

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sequence in an orthogonal frequency division multiplexing (OFDM) communication system having m subcarriers in a frequency domain." Jung '504 at Abstract. Also, Jung '504 teaches "[t]he OFDM communication system uses a subchannelization method in order to increase frequency efficiency. The "subchannelization" scheme divides all of the subcarriers into several subchannels for efficient utilization of a frequency, and each subchannel includes a specified number of subcarriers, the specified number being smaller than the number of all of the subcarriers. For example, if the number of all of the subcarriers for the OFDM communication system is 256 (−128, . . . ,127), the number of subcarriers actually used is 200 (−100, . . . ,100), and they are separated into 4 subchannels. In this case, the following subchannel assignment methods are possible." Jung '504 at 0035. Furthermore Jung '504 teaches "The preamble sequence is used to transmit known symbols at a beginning part of every frame or data burst, and update estimated time/ frequency/channel information at a data transmission part, using information on the guard interval and the pilot subearner." Jung '504 at 0011. 802.16ab discusses "Ramp Up As both Figure 204 and Figure 205 also indicate, the Burst Preamble also contains a ramp-up region during which the power of the transmitter is ramped up. This ramping may be achieved by initializing the transmit filter memory with zero-valued (null) symbols, and then pushing the desired transmit data symbols into the filter to naturally ramp the filter output (and system power) to its full scale value. The ramp up interval length, R, is TBD. If a ramp-up sequence length shorter than one-half the length of the impulse response of the transmit filter is specified, the transmit filter output samples related to first few symbols may be suppressed

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from the transmit filter output, and a ramped power buildup achieved by windowing the ramp-up sequence, using a raised-cosine window of the desired length R, for example." 802.16ab at 121. Furthermore 802.16ab discusses power in relation to path loss "For the mesh mode the procedure is similar with the exception that the used output power is chosen according to the furthest neighbor (from path loss perspective) to be reached." *Id.* At 192. Jung '504 discusses "In order to maximize transmission efficiency of a power amplifier (PA) in a transmitter of an OFDM communication system, a PAPR of an OFDM symbol should be low. That is, because an IFFT-transformed signal is applied to a power amplifier as described above, a low PAPR is required due to a non-linear characteristic of the power amplifier. A PAPR of an OFDM symbol should be low in a ratio of maximum power to average power of a time-domain OFDM symbol corresponding to an IFFT output terminal of the transmitter, and for a low ratio of the maximum power to the average power, uniform distribution must be provided. In other words, a PAPR of an output becomes low if symbols having a low cross correlation are combined in an IFFT input terminal of the transmitter, i.e., in a frequency domain." Jung '504 at 0019. Thus, these references were in the same field of endeavor, and shared the same fundamental goals including improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. Moreover, these references share at least the goal of efficient transmission power control. It would have been obvious for a POSITA to combine 802.16ab with Jung '504 at least because 802.16ab provides a method for using a preamble for ranging, and Jung '504 pertains to generating a preamble. It would have been obvious for a

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POSITA to combine Jung '504 with 802.16ab at least because 802.16ab provides a method for controlling RF output power. It would have been obvious for a POSITA to combine 802.16ab with Jung '504 at least because 802.16ab provides a method for using resource allocation techniques (such as those disclosed in Jung '504) in order to optimize system resources and maintain quality of service.

- **Jung '504 and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 discloses "A wireless terminal and network terminal are provided for implementing a new uplink OFDM protocol. In the new protocol, the wireless terminal has a first transmit chain for generating and transmitting a low rate mode OFDM transmission in a first frequency band of the OFDM band; and a second transmit chain for generating and transmitting a burst-mode transmission in a second frequency band of the OFDM band, the first frequency band being distinct from the second frequency band. An access channel is provided which is overlaid over the low rate mode transmissions of other users." Ma '546 at Abstract. Furthermore Ma '536 discusses "In order to reduce multiple-access interference so that spectral efficiency and high data rate limits in a common wireless channel are increased a method and apparatus for uplink multiple-user access is provided. The method and apparatus disclosed herein are based on Orthogonal Frequency Division Modulation (OFDM) adapted so as to provide an effective uplink multiple-user access scheme that can be used in wireless communication networks. Accordingly, from herein the OFDM-based uplink multiple-user access scheme provided by the invention will be simply referred to as OFDMA (Orthogonal Frequency Division Multiple-Access)." *Id.* at

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9:38-49. Jung '504 discloses "A method and apparatus for generating a preamble sequence in an orthogonal frequency division multiplexing (OFDM) communication system having m subcarriers in a frequency domain." Jung '504 at Abstract. Also, Jung '504 teaches "[t]he OFDM communication system uses a subchannelization method in order to increase frequency efficiency. The "subchannelization" scheme divides all of the subcarriers into several subchannels for efficient utilization of a frequency, and each subchannel includes a specified number of subcarriers, the specified number being smaller than the number of all of the subcarriers. For example, if the number of all of the subcarriers for the OFDM communication system is 256 (−128, . . . ,127), the number of subcarriers actually used is 200 (−100, . . . ,100), and they are separated into 4 subchannels. In this case, the following subchannel assignment methods are possible." Jung '504 at 0035. Furthermore Jung '504 teaches "The preamble sequence is used to transmit known symbols at a beginning part of every frame or data burst, and update estimated time/ frequency/channel information at a data transmission part, using information on the guard interval and the pilot subearner." Jung '504 at 0011. Ma '546 discusses "Uplink Power Control The power control of the Mode-1 traffic channel can be open-loop power control. In one embodiment power control is achieved as follows: 1. UE sends RACH (described in detail below) with the power inversely proportional to the long-term estimated DL C/I measurement and the RACH signature spreading factor (more generally, RACH power increases as estimate decreases); 2. Base station measures the power of RACH from UE and sends back the power control command to UE for increasing/unchanging/decreasing transmit

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power--this power control transmission may also be construed as an acknowledgement, in the absence of acknowledgement, another access attempt is with increased power; 3. UE starts the uplink transmission with power based on power of RACH with adjustment based on power control command through the dedicated slow traffic channel; 4. Base station controls the uplink power based on the frame error rate from a particular UE." Ma '546 at 18:50-19.2. Jung '504 discusses "In order to maximize transmission efficiency of a power amplifier (PA) in a transmitter of an OFDM communication system, a PAPR of an OFDM symbol should be low. That is, because an IFFT-transformed signal is applied to a power amplifier as described above, a low PAPR is required due to a non-linear characteristic of the power amplifier. A PAPR of an OFDM symbol should be low in a ratio of maximum power to average power of a time-domain OFDM symbol corresponding to an IFFT output terminal of the transmitter, and for a low ratio of the maximum power to the average power, uniform distribution must be provided. In other words, a PAPR of an output becomes low if symbols having a low cross correlation are combined in an IFFT input terminal of the transmitter, i.e., in a frequency domain." Jung '504 at 0019. Thus, these references were in the same field of endeavor, and shared the same fundamental goals including improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. Moreover, these references share at least the goal of efficient transmission power control. It would have been obvious for a POSITA to combine Jung '504 with Ma '546 at least because Ma '546 provides a method for controlling RF output power. It would have been obvious for a POSITA to

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combine Ma ‘546 with Jung ’504 at least because Ma ‘546 provides a method for using resource allocation techniques (such as those disclosed in Jung ’504) in order to optimize system resources and maintain quality of service.

(vii) Mody ’782 in combination with the knowledge of a skilled artisan, Jung ‘504, 802.16ab, and /or Ma ’546

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Mody ‘782 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Mody ‘782 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’366 patent was filed. Specifically:

- Mody ’782, Jung ‘504, 802.16ab and Ma ‘546 are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using preamble and ranging. For example, they relate to wireless communications, including signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and

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easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Mody '782 and Jung '504:** Jung '504 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jung '504 is directed to "A method and apparatus for generating a preamble sequence in an orthogonal frequency division multiplexing (OFDM) communication system having m subcarriers in a frequency domain." Jung '504 at Abstract. Chayat '367 discloses "A method of implementing OFDMA systems with enhanced preamble properties is presented. The transmit power is boosted during a preamble transmission, by utilizing preambles with a low Peak-to-Average Power Ratio (PAPR) property, as opposed to higher PAPR during the data portion of the transmission. Further, sets of preambles satisfying good PAPR properties in OFDMA systems are presented. The preambles satisfy a low Peak-to-Average Power Ratio (PAPR) property for numerous subsets of the usable subcarrier set. A method for generating a hierarchical set of preambles for OFDMA communication systems is described." Chayat '367 at Abstract. Jung '504 discloses "(2) The long preamble sequence is used for initial ranging. (3) The long preamble sequence is used for bandwidth request ranging. Further, the short preamble sequence has the following uses in the OFDM communication system. (1) The short preamble sequence is used as an uplink data preamble sequence. (2) The short preamble sequence is used for periodic ranging. In the OFDM communication system, because accurate synchronization can be acquired by performing initial ranging and

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periodic ranging, the uplink data preamble sequence is mainly used for channel estimation. For channel estimation, PAPR, performance and complexity should be taken into consideration. In the case of the existing short preamble sequence, a PAPR is 3.5805[dB], and various channel estimation algorithms such as a minimum mean square error (MMSE) algorithm and a least square (LS) algorithm are used." Jung '504 at 0029-0034. Mody discusses "[a] wireless Orthogonal Frequency Division Multiplexing (OFDM) communication system, the present invention provides systems for synchronizing data transmitted across a channel. The present invention may be used in a Multi-Input, Multi-Output (MIMO) system in which the data is transmitted from any number of transmitting antennas and received by any number of receiving antennas. The number of transmitting and receiving antennas does not necessarily have to be the same. Circuitry is provided for synchronizing the data in both the time domain and frequency domain. Time synchronization involves coarse time synchronization and fine time synchronization. Frequency synchronization involves coarse frequency offset estimation, fine frequency offset estimation, and frequency offset correction." Mody '782 at Abstract. Jung '504 discloses "(2) The long preamble sequence is used for initial ranging. (3) The long preamble sequence is used for bandwidth request ranging. Further, the short preamble sequence has the following uses in the OFDM communication system. (1) The short preamble sequence is used as an uplink data preamble sequence. (2) The short preamble sequence is used for periodic ranging. In the OFDM communication system, because accurate synchronization can be acquired by performing initial ranging and periodic ranging,

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the uplink data preamble sequence is mainly used for channel estimation. For channel estimation, PAPR, performance and complexity should be taken into consideration. In the case of the existing short preamble sequence, a PAPR is 3.5805[dB], and various channel estimation algorithms such as a minimum mean square error (MMSE) algorithm and a least square (LS) algorithm are used." Jung '504 at 0029-0034. Mody '782 discusses "In typical communication systems, training symbols, or preamble, at the beginning of data frames, are usually added as a prefix to the data symbols. The data symbols, of course, include the useful data or information (e.g., voice, data, video, etc.), which is meant to be transmitted to a remote location. The training symbols in SISO systems are used to provide synchronization of the received signals with respect to the transmitted signals, as well as to provide channel parameter estimation." Mody '782 at 1:55-63. Thus, these references were in the same field of endeavor, and shared the same fundamental goals including improving data transmissions in multi-carrier communications environments using improved resource allocation techniques and power control. It would have been obvious for a POSITA to combine Mody '782 with Jung '504 at least because Mody '782 provides a method for implementing an OFDM system with enhanced preamble properties. It would have been obvious for a POSITA to combine Jung '504 with Mody '782 at least because Jung '504 provides a method for using a preamble for ranging, and Mody '782 pertains to utilizing preambles. Also, the combination would have been merely the application of a known technique (using the preamble to perform ranging) to a known system (Mody's OFDM communication system) to yield predictable results, without

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significantly altering or hindering the functions performed by the communication system.

- **Mody '782 and 802.16ab:** 802.16ab is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. 802.16ab teaches "The goal of the enhancements is to use the advantages of the OFDM/OFDMA based PHY to facilitate simpler and safer synchronization of the user with the base station." 802.16ab at 45. "OFDMA PHY DFS is the process that is used primarily to assign one of several possible channels to the SS. Additionally, especially in a mesh mode, DFS may be also used to assign a most feasible channel to each link (unicast/multicast/broadcast). The process requires monitoring by the SS and assignment of channels by the upper processing layers of the BS.(Comment: in both Mesh and Directional Antenna Systems the DFS will assign the most feasible channels)" *Id.* at 37. "This single mode of operation is sufficient for the upstream, since the upstream transmissions are point-to-point burst transmissions between each transmitting subscriber station (SS) and each receiving base station (BS). " *Id.* at 75. Mody discusses "[a] wireless Orthogonal Frequency Division Multiplexing (OFDM) communication system, the present invention provides systems for synchronizing data transmitted across a channel. The present invention may be used in a Multi-Input, Multi-Output (MIMO) system in which the data is transmitted from any number of transmitting antennas and received by any number of receiving antennas. The number of transmitting and receiving antennas does not necessarily have to be the same. Circuitry is provided for synchronizing the data in both the time domain and frequency domain. Time synchronization involves coarse time

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synchronization and fine time synchronization. Frequency synchronization involves coarse frequency offset estimation, fine frequency offset estimation, and frequency offset correction." Mody '782 at Abstract. 802.16ab states "The SS, after acquiring downstream synchronization and upstream transmission parameters, shall choose randomly a Ranging Slot (with use of a binary truncated exponent algorithm to avoid of possible re-collisions) as the time to perform the ranging, then it chooses randomly a Ranging Code (from the Initial Ranging domain) and sends it to the BS (as a CDMA code)." 802.16ab at 48. Furthermore 802.16ab discloses "The Long Ranging transmission shall be used by any SS that wants to synchronize to the system channel for the first time. A Long Ranging transmission shall be performed during the two first consecutive symbols of the UL frame. The same ranging code is transmitted during each symbol. Sending for a consecutive period of two OFDMA signals a preamble shall perform the long ranging transmission. The preamble structure is defined by modulating one Ranging Code, up on the Ranging Sub-Channel carriers. There shall not be any phase discontinuity on the Ranging Sub-Channel carriers during the period of the Long Ranging transmission. This Long Ranging transmission is allowed only on the Ranging Sub-Channel resources defined by the MAC process in the Base Station." 802.16ab at 171. Also, 802.16ab states "Short Ranging transmission The Short Ranging transmission shall be used only by a SS that has already synchronized to the system. The Short Ranging transmission shall be used for system maintenance ranging or for fast bandwidth allocation requests. To perform a Short Ranging transmission, the SS shall send a preamble for a period of one OFDM/OFDMA symbol in the duration

of the ranging interval. The preamble structure is defined by modulating one Ranging Code on one Ranging Sub-Channel. This transmission may occur on any OFDM symbol out of the six available ranging symbols." 802.16ab at 171. Mody '782 discusses "In typical communication systems, training symbols, or preamble, at the beginning of data frames, are usually added as a prefix to the data symbols. The data symbols, of course, include the useful data or information (e.g., voice, data, video, etc.), which is meant to be transmitted to a remote location. The training symbols in SISO systems are used to provide synchronization of the received signals with respect to the transmitted signals, as well as to provide channel parameter estimation." Mody '782 at 1:55-63. Furthermore, 802.16ab teaches "Long Ranging transmission The Long Ranging transmission shall be used by any SS that wants to synchronize to the system channel for the first time. A Long Ranging transmission shall be performed during the two first consecutive symbols of the UL frame. The same ranging code is transmitted during each symbol. Sending for a consecutive period of two OFDMA signals a preamble shall perform the long ranging transmission. The preamble structure is defined by modulating one Ranging Code, up on the Ranging Sub-Channel carriers. There shall not be any phase discontinuity on the Ranging Sub-Channel carriers during the period of the Long Ranging transmission. This Long Ranging transmission is allowed only on the Ranging Sub-Channel resources defined by the MAC process in the Base Station." 802.16ab at 171. Also, 802.16ab discusses "Burst parameters, including modulation type, error correction technique and code rate, number and spacing of pilot and/or training symbols, do not change within an uplink burst, but they can

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change on a burst to burst basis. The Base Station (BS) and its downstream control messages mandate the burst parameters to be used by each Subscriber Station (SS) using the uplink. These parameters may vary from SS to SS, and message type to message type." *Id* at 112. Mody '782 discloses "The pilot/training symbol inserter 32 may be configured so that it is capable of storing multiple sets of training symbols or pilot symbols. In this case, a particular set may be selected, for example, based on desirable communication criteria established by a user. The training symbols for each respective sub-channel may preferably be unique to the particular sub-channel. In order to accommodate amplitude differences between the sub-channels, the training symbols may be designed and adjusted to maintain a constant amplitude at the output of each sub-channel." Mody '782 at 6:16-25. 802.16ab also discusses "The usable carrier space is divided into Ngroups basic groups. Ngroups is equal to the number of data carriers per subchannel (48 in DL and 53 in UL). Each basic group is made up of adjacent carriers. The number of the carriers in a basic group is equal to the number of possible subchannels. As a result of the carrier allocation procedure, each subchannel is built taking one carrier from each basic group." 802.16ab at 165. Mody '782 discusses block size of the training sequence in the preamble "Transmission of the training sequence of length NI corresponds to exciting every Ith sub-channel of an OFDM signal having a block size N. This means that no information is transmitted on the remaining (1−1/I)N sub-channels and the estimates of the channel for the sub-channels are derived from the ones that actually include information. This may result in a poor performance and hence it is left to the system designer to determine the length of the preamble." Mody 782 at

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10:38-56. Also 802,16ab states "Ramp Up As both Figure 204 and Figure 205 also indicate, the Burst Preamble also contains a ramp-up region during which the power of the transmitter is ramped up. This ramping may be achieved by initializing the transmit filter memory with zero-valued (null) symbols, and then pushing the desired transmit data symbols into the filter to naturally ramp the filter output (and system power) to its full scale value. The ramp up interval length, R, is TBD. If a ramp-up sequence length shorter than one-half the length of the impulse response of the transmit filter is specified, the transmit filter output samples related to first few symbols may be suppressed from the transmit filter output, and a ramped power buildup achieved by windowing the ramp-up sequence, using a raised-cosine window of the desired length R, for example." 802.16ab at 121. Furthermore 802.16ab teaches "During registration, a new subscriber registers during the random access channel and if successful is entered into a ranging process under control of the base station. The ranging process is cyclic in nature where default time and power parameters are used to initiate the process followed by cycles where (re)calculated parameters are used in succession until parameters meet acceptance criteria for the new subscriber. These parameters are monitored, measured and stored at the base station and transmitted to the subscriber unit for use during normal exchange of data. During normal exchange of data, the stored parameters are updated in a periodic manner based on configurable update intervals to ensure changes in the channel can be accommodated. The update intervals will vary in a controlled manner on a subscriber unit by subscriber unit basis." *Id* at 159. Mody '782 discusses the power used in training sequences "In the case when the IDFT

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stage 38 is not bypassed, a training sequence may be generated by modulating each of the symbols on the TDBs with a known sequence of symbols in the frequency domain and passing the symbols through the IDFT stage 38. Generally, such a known sequence of symbols is obtained from an alphabet which has its constituents on the unit circle in the complex domain and Such that the resultant sequence in the time domain has a suitable Peak to Average Power Ratio (PAPR)." Mody '782 at 7:7-15. Thus, these references were in the same field of endeavor, and shared the same fundamental goals including improving data transmissions in multi-carrier communications environments using improved resource allocation techniques and power control. It would have been obvious for a POSITA to combine Mody '782 with 802.16ab at least because Mody '782 provides a method for implementing an OFDMA system with enhanced preamble properties. It would have been obvious for a POSITA to combine Mody '782 with 802.16ab at least because Mody '782 provides a method of a pilot containing training sequences in a preamble as 802.16ab discuses a preamble containing ranging sequences. It would have been obvious for a POSITA to combine Mody '782 with 802.16ab at least because Mody '782 discusses blocks of data with sub-channels and 802.16ab discusses sub-channels and sub-frequencies made up of adjacent carriers. It would have been obvious for a POSITA to combine 802.16ab with Mody '782 at least because 802.16ab provides a method for using a preamble for ranging, and Mody '782 pertains to utilizing preambles. It would have been obvious for a POSITA to combine Mody '782 with 802.16ab at least because Mody '782 provides a method

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for using resource allocation techniques (such as those disclosed in 802.16ab) in order to optimize system resources and maintain quality of service.

- **Mody '782 and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 discloses "A wireless terminal and network terminal are provided for implementing a new uplink OFDM protocol. In the new protocol, the wireless terminal has a first transmit chain for generating and transmitting a low rate mode OFDM transmission in a first frequency band of the OFDM band; and a second transmit chain for generating and transmitting a burst-mode transmission in a second frequency band of the OFDM band, the first frequency band being distinct from the second frequency band. An access channel is provided which is overlaid over the low rate mode transmissions of other users." Ma '546 at Abstract. Furthermore Ma '536 discusses "In order to reduce multiple-access interference so that spectral efficiency and high data rate limits in a common wireless channel are increased a method and apparatus for uplink multiple-user access is provided. The method and apparatus disclosed herein are based on Orthogonal Frequency Division Modulation (OFDM) adapted so as to provide an effective uplink multiple-user access scheme that can be used in wireless communication networks. Accordingly, from herein the OFDM-based uplink multiple-user access scheme provided by the invention will be simply referred to as OFDMA (Orthogonal Frequency Division Multiple-Access)." *Id.* at 9:38-49. Mody discusses "[a] wireless Orthogonal Frequency Division Multiplexing (OFDM) communication system, the present invention provides systems for synchronizing data transmitted across a channel. The present invention

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may be used in a Multi-Input, Multi-Output (MIMO) system in which the data is transmitted from any number of transmitting antennas and received by any number of receiving antennas. The number of transmitting and receiving antennas does not necessarily have to be the same. Circuitry is provided for synchronizing the data in both the time domain and frequency domain. Time synchronization involves coarse time synchronization and fine time synchronization. Frequency synchronization involves coarse frequency offset estimation, fine frequency offset estimation, and frequency offset correction." Mody '782 at Abstract. Ma '546 discusses "Uplink Power Control The power control of the Mode-1 traffic channel can be open-loop power control. In one embodiment power control is achieved as follows: 1. UE sends RACH (described in detail below) with the power inversely proportional to the long-term estimated DL C/I measurement and the RACH signature spreading factor (more generally, RACH power increases as estimate decreases); 2. Base station measures the power of RACH from UE and sends back the power control command to UE for increasing/unchanging/decreasing transmit power--this power control transmission may also be construed as an acknowledgement, in the absence of acknowledgement, another access attempt is with increased power; 3. UE starts the uplink transmission with power based on power of RACH with adjustment based on power control command through the dedicated slow traffic channel; 4. Base station controls the uplink power based on the frame error rate from a particular UE." Ma '546 at 18:50-19.2. Mody '782 discusses the power used in training sequences "In the case when the IDFT stage 38 is not bypassed, a training sequence may be generated by modulating each of the symbols on the TDBs with

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a known sequence of symbols in the frequency domain and passing the symbols through the IDFT stage 38. Generally, such a known sequence of symbols is obtained from an alphabet which has its constituents on the unit circle in the complex domain and Such that the resultant sequence in the time domain has a suitable Peak to Average Power Ratio (PAPR)." Mody '782 at 7:7-15. Thus, these references were in the same field of endeavor, and shared the same fundamental goals including improving data transmissions in multi-carrier communications environments using improved resource allocation techniques and power control. It would have been obvious for a POSITA to combine Mody '782 with Ma '546 at least because Mody '782 provides a method for implementing an OFDM system with enhanced preamble properties. It would have been obvious for a POSITA to combine Mody '782 with Ma '546 at least because Mody '782 provides a method for using resource allocation techniques (such as those disclosed in Ma '546) in order to optimize system resources and maintain quality of service.

(viii) 802.16ab in combination with the knowledge of a skilled artisan, and /or Ma '546

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine 802.16ab with each of these references. A person of ordinary skill in the art would have found it obvious to combine 802.16ab with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another

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to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '366 patent was filed. Specifically:

- 802.16ab and Ma '546 are both directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using preamble and ranging. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **802.16ab and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 discloses "A wireless terminal and network terminal are provided for implementing a new uplink OFDM protocol. In the new protocol, the wireless terminal has a first transmit chain for generating and transmitting a low rate mode OFDM transmission in a first frequency band of the OFDM band; and a second transmit chain for generating and transmitting a burst-mode transmission in a second frequency band of the OFDM band, the first frequency band being distinct from the second frequency band. An access channel is provided which is overlaid over the low rate mode transmissions of other users." Ma '546 at Abstract. Furthermore Ma '536

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discusses "In order to reduce multiple-access interference so that spectral efficiency and high data rate limits in a common wireless channel are increased a method and apparatus for uplink multiple-user access is provided. The method and apparatus disclosed herein are based on Orthogonal Frequency Division Modulation (OFDM) adapted so as to provide an effective uplink multiple-user access scheme that can be used in wireless communication networks. Accordingly, from herein the OFDM-based uplink multiple-user access scheme provided by the invention will be simply referred to as OFDMA (Orthogonal Frequency Division Multiple-Access)." *Id.* at 9:38-49. 802.16ab teaches "The goal of the enhancements is to use the advantages of the OFDM/OFDMA based PHY to facilitate simpler and safer synchronization of the user with the base station." 802.16ab at 45. "OFDMA PHY DFS is the process that is used primarily to assign one of several possible channels to the SS. Additionally, especially in a mesh mode, DFS may be also used to assign a most feasible channel to each link (unicast/multicast/broadcast). The process requires monitoring by the SS and assignment of channels by the upper processing layers of the BS.(Comment: in both Mesh and Directional Antenna Systems the DFS will assign the most feasible channels)" *Id.* at 37. "This single mode of operation is sufficient for the upstream, since the upstream transmissions are point-to-point burst transmissions between each transmitting subscriber station (SS) and each receiving base station (BS). " *Id.* at 75. Ma '546 discusses "Uplink Power Control The power control of the Mode-1 traffic channel can be open-loop power control. In one embodiment power control is achieved as follows: 1. UE sends RACH (described in detail below) with the power inversely proportional to the long-term

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estimated DL C/I measurement and the RACH signature spreading factor (more generally, RACH power increases as estimate decreases); 2. Base station measures the power of RACH from UE and sends back the power control command to UE for increasing/unchanging/decreasing transmit power--this power control transmission may also be construed as an acknowledgement, in the absence of acknowledgement, another access attempt is with increased power; 3. UE starts the uplink transmission with power based on power of RACH with adjustment based on power control command through the dedicated slow traffic channel; 4. Base station controls the uplink power based on the frame error rate from a particular UE." Ma '546 at 18:50-19.2. 802.16ab states "Ramp Up As both Figure 204 and Figure 205 also indicate, the Burst Preamble also contains a ramp-up region during which the power of the transmitter is ramped up. This ramping may be achieved by initializing the transmit filter memory with zero-valued (null) symbols, and then pushing the desired transmit data symbols into the filter to naturally ramp the filter output (and system power) to its full scale value. The ramp up interval length, R, is TBD. If a ramp-up sequence length shorter than one-half the length of the impulse response of the transmit filter is specified, the transmit filter output samples related to first few symbols may be suppressed from the transmit filter output, and a ramped power buildup achieved by windowing the ramp-up sequence, using a raised-cosine window of the desired length R, for example." 802.16ab at 121. Furthermore 802.16ab teaches "During registration, a new subscriber registers during the random access channel and if successful is entered into a ranging process under control of the base station. The ranging process is cyclic in nature where default

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time and power parameters are used to initiate the process followed by cycles where (re)calculated parameters are used in succession until parameters meet acceptance criteria for the new subscriber. These parameters are monitored, measured and stored at the base station and transmitted to the subscriber unit for use during normal exchange of data. During normal exchange of data, the stored parameters are updated in a periodic manner based on configurable update intervals to ensure changes in the channel can be accommodated. The update intervals will vary in a controlled manner on a subscriber unit by subscriber unit basis." *Id* at 159. Thus, these references were in the same field of endeavor, and shared the same fundamental goals including improving data transmissions in multi-carrier communications environments using improved resource allocation techniques and power control. It would have been obvious for a POSITA to combine 802.16ab with Ma '546 at least because 802.16ab provides a method for implementing an OFDMA system with enhanced preamble properties. It would have been obvious for a POSITA to combine 802.16ab with Ma '546 at least because 802.16ab provides a method for using resource allocation techniques (such as those disclosed in Ma '546) in order to optimize system resources and maintain quality of service.

(ix) 802.16.4 in combination with the knowledge of a skilled artisan, 802.16ab, and /or Ma '546

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine 802.16.4 with each of these references. A person of ordinary skill in the art would have found it obvious to combine 802.16.4 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve

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similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '366 patent was filed. Specifically:

- 802.16.4, 802.16ab and Ma '546 are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using preamble and ranging. For example, they relate to wireless communications, including signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **802.16.4 and 802.16ab:** 802.16ab is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. 802.16ab teaches "The goal of the enhancements is to use the advantages of the OFDM/OFDMA based PHY to facilitate simpler and safer synchronization of the user with the base station." 802.16ab at 45. "OFDMA PHY DFS is the process that is used primarily to assign one of several possible channels to the SS. Additionally, especially in a mesh mode, DFS may be also used to assign a most feasible channel to each link

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(unicast/multicast/broadcast). The process requires monitoring by the SS and assignment of channels by the upper processing layers of the BS. (Comment: in both Mesh and Directional Antenna Systems the DFS will assign the most feasible channels)" *Id.* at 37. "This single mode of operation is sufficient for the upstream, since the upstream transmissions are point-to-point burst transmissions between each transmitting subscriber station (SS) and each receiving base station (BS)." *Id.* at 75. 802.16.4 teaches "The following contribution proposes some modifications to the IEEE 802.11a, HiperLAN2 PHY and 802.16.1 MAC layer in order to adapt it to the TG4 bands. The purposes of the proposed changes are to deal with higher delay spreads, interfering signals, coexistence with other systems, users power balance, Improved Error Correcting Code (ECC), Adaptive Power Control and Peak to Average Power Reduction (PAPR) reduction. The proposed PHY layer uses the OFDMA concept in order to construct a very robust and back-compatible layer. Many advantages are gained by using the OFDMA modulation, which are elaborated throughout the document" 802.16.4 at 3. Furthermore 802.16.4 discusses "The following description refers to the down stream and up stream access methods. There are two basic approaches when using the OFDMA concept: One where several OFDM symbols are used for data transmission (all Sub-Channels in the OFDM symbol are used for data only) and other OFDM symbols are used for synchronization (all Sub-Channels in the OFDM symbol are used for ranging only)." *Id* at 12. 802.16ab states "Ramp Up As both Figure 204 and Figure 205 also indicate, the Burst Preamble also contains a ramp-up region during which the power of the transmitter is ramped up. This ramping may be achieved by

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initializing the transmit filter memory with zero-valued (null) symbols, and then pushing the desired transmit data symbols into the filter to naturally ramp the filter output (and system power) to its full scale value. The ramp up interval length, R, is TBD. If a ramp-up sequence length shorter than one-half the length of the impulse response of the transmit filter is specified, the transmit filter output samples related to first few symbols may be suppressed from the transmit filter output, and a ramped power buildup achieved by windowing the ramp-up sequence, using a raised-cosine window of the desired length R, for example." 802.16ab at 121. Furthermore 802.16ab teaches "During registration, a new subscriber registers during the random access channel and if successful is entered into a ranging process under control of the base station. The ranging process is cyclic in nature where default time and power parameters are used to initiate the process followed by cycles where (re)calculated parameters are used in succession until parameters meet acceptance criteria for the new subscriber. These parameters are monitored, measured and stored at the base station and transmitted to the subscriber unit for use during normal exchange of data. During normal exchange of data, the stored parameters are updated in a periodic manner based on configurable update intervals to ensure changes in the channel can be accommodated. The update intervals will vary in a controlled manner on a subscriber unit by subscriber unit basis." *Id* at 159. "The following contribution proposes some modifications to the IEEE 802.11a, HiperLAN2 PHY and 802.16.1 MAC layer in order to adapt it to the TG4 bands. The purposes of the proposed changes are to deal with higher delay spreads, interfering signals, coexistence with other systems, users power balance, Improved

Error Correcting Code (ECC), Adaptive Power Control and Peak to Average Power Reduction (PAPR) reduction. The proposed PHY layer uses the OFDMA concept in order to construct a very robust and back-compatible layer. Many advantages are gained by using the OFDMA modulation, which are elaborated throughout the document" 802.16.4 at 3. Thus, these references were in the same field of endeavor, and shared the same fundamental goals including improving data transmissions in multi-carrier communications environments using improved resource allocation techniques and power control. It would have been obvious for a POSITA to combine 802.16.4 with 802.16ab at least because 802.16.4 provides a method for implementing an OFDMA system with enhanced preamble properties. It would have been obvious for a POSITA to combine 802.16.4 with 802.16ab at least because 802.16.4 provides a method for using resource allocation techniques (such as those disclosed in 802.16ab) in order to optimize system resources and maintain quality of service.

- **802.16.4 and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 discloses "A wireless terminal and network terminal are provided for implementing a new uplink OFDM protocol. In the new protocol, the wireless terminal has a first transmit chain for generating and transmitting a low rate mode OFDM transmission in a first frequency band of the OFDM band; and a second transmit chain for generating and transmitting a burst-mode transmission in a second frequency band of the OFDM band, the first frequency band being distinct from the second frequency band. An access channel is provided which is overlaid over the low rate mode transmissions

of other users." Ma '546 at Abstract. Furthermore Ma '536 discusses "In order to reduce multiple-access interference so that spectral efficiency and high data rate limits in a common wireless channel are increased a method and apparatus for uplink multiple-user access is provided. The method and apparatus disclosed herein are based on Orthogonal Frequency Division Modulation (OFDM) adapted so as to provide an effective uplink multiple-user access scheme that can be used in wireless communication networks. Accordingly, from herein the OFDM-based uplink multiple-user access scheme provided by the invention will be simply referred to as OFDMA (Orthogonal Frequency Division Multiple-Access)." *Id.* at 9:38-49.

802.16.4 teaches "The following contribution proposes some modifications to the IEEE 802.11a, HiperLAN2 PHY and 802.16.1 MAC layer in order to adapt it to the TG4 bands. The purposes of the proposed changes are to deal with higher delay spreads, interfering signals, coexistence with other systems, users power balance, Improved Error Correcting Code (ECC), Adaptive Power Control and Peak to Average Power Reduction (PAPR) reduction. The proposed PHY layer uses the OFDMA concept in order to construct a very robust and back-compatible layer. Many advantages are gained by using the OFDMA modulation, which are elaborated throughout the document" 802.16.4 at 3. Furthermore 802.16.4 discusses "The following description refers to the down stream and up stream access methods. There are two basic approaches when using the OFDMA concept: One where several OFDM symbols are used for data transmission (all Sub-Channels in the OFDM symbol are used for data only) and other OFDM symbols are used for synchronization (all Sub-Channels in the OFDM symbol are used for

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ranging only)." *Id* at 12. Ma '546 discusses "Uplink Power Control The power control of the Mode-1 traffic channel can be open-loop power control. In one embodiment power control is achieved as follows: 1. UE sends RACH (described in detail below) with the power inversely proportional to the long-term estimated DL C/I measurement and the RACH signature spreading factor (more generally, RACH power increases as estimate decreases); 2. Base station measures the power of RACH from UE and sends back the power control command to UE for increasing/unchanging/decreasing transmit power--this power control transmission may also be construed as an acknowledgement, in the absence of acknowledgement, another access attempt is with increased power; 3. UE starts the uplink transmission with power based on power of RACH with adjustment based on power control command through the dedicated slow traffic channel; 4. Base station controls the uplink power based on the frame error rate from a particular UE." Ma '546 at 18:50-19.2. 802.16.4 discloses "The following contribution proposes some modifications to the IEEE 802.11a, HiperLAN2 PHY and 802.16.1 MAC layer in order to adapt it to the TG4 bands. The purposes of the proposed changes are to deal with higher delay spreads, interfering signals, coexistence with other systems, users power balance, Improved Error Correcting Code (ECC), Adaptive Power Control and Peak to Average Power Reduction (PAPR) reduction. The proposed PHY layer uses the OFDMA concept in order to construct a very robust and back-compatible layer. Many advantages are gained by using the OFDMA modulation, which are elaborated throughout the document" 802.16.4 at 3. Thus, these references were in the same field of endeavor, and shared the same

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fundamental goals including improving data transmissions in multi-carrier communications environments using improved resource allocation techniques and power control. It would have been obvious for a POSITA to combine 802.16.4 with Ma '546 at least because 802.16.4 provides a method for implementing an OFDMA system with enhanced preamble properties. It would have been obvious for a POSITA to combine 802.16.4 with Ma '546 at least because 802.16.4 provides a method for using resource allocation techniques (such as those disclosed in Ma '546) in order to optimize system resources and maintain quality of service.

b. The '908 Patent

A person of ordinary skill in the art would have been motivated to combine or modify each piece of prior art identified in Sections III.B-E in such a way as to render the asserted claims of the '908 patent invalid. For example, Defendants identify at least the following grounds (and similar permutations based on the listed references) that render the asserted claims of the '908 patent invalid under 35 U.S.C. § 103:

(i) Walton '301 in combination with the knowledge of a skilled artisan, Ma '546, Jeong '589, Benedittis '812, Suh '464, Walton '705, C802.16e-03/53r2, Engstrom '436, Wahlqvist, Kanemoto '414, Li '422, Lee '481, Kaiser, Gibson, and/or Frank

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Walton '301 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Walton '301 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both

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obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

- Walton '301, Ma '546, Jeong '589, Benedittis '812, Suh '464, Walton '705, C802.16e-03/53r2, Engstrom '436, Wahlqvist, Kanemoto '414, Li '422, Lee '481, Kaiser, Gibson, and Frank are all directed to systems and methods for initial random access and synchronization by mobile devices in a communication system. For example, they relate to wireless communications, and in particular to uplink communication and resource allocation for initial mobile device access and synchronization. They involve communication protocols and standards, transmission methods (e.g., OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Walton '301 and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 teaches and describes "[a] wireless terminal and network terminal . . . for implementing a new uplink OFDM protocol" with two distinct frequency bands for, respectively, "transmitting a low rate mode OFDM transmission" and "a burst-mode transmission[.]" Ma '546 at Abstract. Ma '546 further teaches that a random access channel, RACH, can be "overlaid atop the entire common wireless channel" where

it "is transmitted simultaneously both in time and frequency with the other . . . signals by other users." *Id.* at 19:56-61. One goal of the Ma '546 RACH scheme is to reduce interference with other users in the system by using, for example, pseudo-noise ("PN") spreading such that the RACH can be transmitted at a very low power level. *See id.* at 19:62-20:16. Interference between cells is reduced by providing a unique PN code for neighboring base stations. *Id.* at 21:1-5. Similarly, Walton '301 teaches techniques for reducing RACH interference at the receiving antenna by, for example, employing a beam-steering mode. *See* Walton '301 at 28:54-67, Table 24. These references were therefore in the same field of endeavor and share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine Walton '301 with Ma '546 at least because Walton '301 provides methods and techniques for reducing inter-channel interference (such as those disclosed in Ma '546) in order to optimize system resources and maintain quality of service.

- **Walton '301 and Jeong '589:** Jeong '589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel

during the initial ranging process." Jeong '589 at Abstract. One goal of Jeong '589 is to "provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Walton '301 teaches "[r]andom access techniques to allow user terminals to access the system [that] support system access by multiple user terminals, fast acknowledgment of system access attempts, and quick assignment of downlink/uplink resources." Walton '301 at 2:63-67. Thus, these references were in the same field of endeavor and shared at least the goal of providing a means for users to access the system before resources have been allocated. It would have been obvious for a POSITA to combine Walton '301 with Jeong '589 at least because Walton '301 provides methods and techniques for reducing system access time and resource usage (such as those disclosed in Jeong '589) in order to optimize system resources for initial random access.

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- **Walton ’301 and Benedittis ’812:** Benedittis ’812 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Benedittis ’812 teaches and describes “a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization.” Benedittis ’812 at Abstract. Benedittis ’812 achieves this optimization object by “minimizing the overall time and effort spent before entering the dedicated channel.” Benedittis ’812 at [0021]. Benedittis ’812 has as a further object to optimize assignment of “uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination” throughout the system. *Id.* at [0022]. For example, Benedittis ’812 teaches “a randon access procedure in a TD-CDMA network,” Benedittis ’812 at [0023], by “creating complete associative links” between “signature bursts assigned to the serving cell” and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize “access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request).” *Id.* at [0030]-[0031]. Further, it will “limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel.” *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton ’301 with Benedittis ’812 at least because Walton ’301 provides methods and techniques

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for reducing system access time and resource usage (such as those disclosed in Benedittis '812) in order to optimize system resources for initial random access.

- **Walton '301 and Suh '464:** Suh '464 teaches and describes "[a] method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system" by "generating a first preamble sequence in which odd data of the preamble sequence becomes null data and even data of the preamble sequence becomes data" and "generating a second preamble sequence in which even data of the preamble sequence becomes null data and odd data of the preamble sequence becomes data[.]" Suh '464 at Abstract. Suh '454 further teaches that "[p]referably, a preamble sequence having a low peak-to-average power ratio (PAPR) is used . . . in the OFDM communication system . . . because . . . a high PAPR leads to increased power consumption of a radio frequency (FR) amplifier." *Id.* at [0006]. According to Suh '454, such preambles allow user devices to synchronize with the system: "The UE should be synchronized to a start point of data in order to receive the data, and to this end, the UE must acquire a preamble sequence that is commonly used by all systems for synchronization before receiving signals." *Id.* at [0008]. Walton '301 similarly discusses the need to reduce PAPR in OFDM signals. *See* Walton '301 at 49:33-39 ("[S]crambling randomizes the data so that a long sequence of all ones or all zeros is not transmitted [which] can reduce the variation in peak to average power of the OFDM waveform."). Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would

have been obvious for a POSITA to combine Walton '301 with Suh '454 at least because Walton '301 provides methods and techniques for initial system access by user equipment (such as those disclosed in Suh '454) in order to optimize system resources for initial random access.

- **Walton '301 and Walton '705:** Walton '705 teaches and describes "[t]ransmitter and receiver units for use in a communications system and configurable to provide antenna, frequency, or temporal diversity, or a combination thereof, for transmitted signals." Walton '705 at Abstract. In particular, Walton '705 describes "a . . . communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility." *Id.* at [0002]. The system described by Walton '705 was intended to increase efficiency by improving support for both voice and data services. *Id.* at [0011]. According to Walton '705, "it is a challenge to design a communications system capable of efficiently supporting both voice and data services" because of differences in the two data streams. *Id.* at [0006]-[0010]. To address this difficulty, Walton '705 provides a configurable transmitter "that includes a system data processor, one or more modulators, and one or more antennas." *Id.* at [0013]. The system data processor can include one or more encoders that generate a channel data stream, which is modulated using multi-carrier modulation (e.g., orthogonal frequency division multiplexing (ODFM) modulation)." *Id.* at [0015]-[0016]. Walton '301 similarly employs a combination of "MIMO, OFDM, and TDD." Walton '301 at Abstract. Thus, these references were in the same field of endeavor and shared at least the goal of providing efficient data service in wireless communications systems. It

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would have been obvious for a POSITA to combine Walton '301 with Walton '705 at least because Walton '301 provides methods and techniques for modulating data (such as those disclosed in Walton '705) in order to improve system service, throughput, and reliability.

- **Walton '301 and C802.16e-03/53r2:** C802.16e-03/53r2 teaches and describes "a modification to the initial ranging transmission . . . to improve the initial ranging performance." C802.16e-03/53r2 at 1. C802.16e-03/53r2 has as its object reducing interference between multiple subscriber stations ("SS") transmitting a simultaneous or near-simultaneous initial ranging signal, while also reducing required system resources for initial ranging. *Id.* at 2. Walton '301 describes multiple random access options "to facilitate rapid access to the system whenever possible and to minimize the amount of system resources needed to implement random access." Walton '301 at 21:57-67. Thus, these references were in the same field of endeavor and shared at least the goal of minimizing system resource usage for initial random access. It would have been obvious for a POSITA to combine Walton '301 with C802.16e-03/53r2 at least because Walton '301 provides methods and techniques for initial random access (such as those disclosed in C802.16e-03/53r2) in order to minimize system resource usage.
- **Walton '301 and Engstrom '436:** Engstrom '436 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Engstrom '436 teaches and describes "[a] random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital radio communication system, including the steps of cyclically

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repeating a random access sequence and transmitting each cyclically repeated random access sequence in an orthogonal frequency division multiplex format from the mobile station as an uplink transmission." Engstrom '436 at Abstract. One goal of Engstrom '436 is "to facilitate connection of a mobile station to a base station upon call initiation or upon call handover." *Id.* at 2:45-47. Thus, these references were in the same field of endeavor and shared at least the goal of facilitating system access by mobile devices. It would have been obvious for a POSITA to combine Walton '301 with Engstrom '436 at least because Walton '301 provides methods and techniques for random access (such as those disclosed in Engstrom '436) in order to facilitate efficient, seamless system access and resource allocation.

- **Walton '301 and Wahlqvist:** Wahlqvist is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wahlqvist teaches and describes "a new scheme for initial [uplink] time synchronisation [sic]" with "a random access protocol [that] will have good performance in a mobile radio environment." Wahlqvist at 1569 (Abstract). As described by Wahlqvist, the base station and mobile station must by synchronized in both time and frequency to maintain the orthogonality that is characteristic of OFDM systems. *Id.* at 1569. Any loss or lack of synchronization can lead to interference between subcarriers, reducing system performance. *Id.* It is therefore a goal of Wahlqvist to reduce inter symbol interference by providing a random access protocol that is cyclically repeated. *Id.* at 1570. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been

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obvious for a POSITA to combine Walton '301 with Wahlqvist at least because Walton '301 provides methods and techniques for reducing interference between symbols (such as those disclosed in Wahlqvist) in order to improve system performance.

- **Walton '301 and Kanemoto '414:** Kanemoto '414 teaches and describes systems and methods directed to improving spectral efficiency "by assigning only a small number of subcarriers to an access channel as compared with a traffic channel to which a large number of subcarriers are assigned [and] by grouping users and assigning the access channel of each group to an individual subcarrier" to improve power consumption and processing by user devices. Kanemoto '414 at Abstract. Thus, these references were in the same field of endeavor and shared at least the goal of "achieving higher spectral efficiency." *See, e.g.*, Walton '301 at 6:10-11. It would have been obvious for a POSITA to combine Walton '301 with Kanemoto '414 at least because Walton '301 provides methods and techniques for improving spectral efficiency in multi-carrier wireless communication systems (such as those disclosed in Kanemoto '414).
- **Walton '301 and Li '422:** Li '422 teaches and describes "[a] method and apparatus for wireless communication . . . [by] transmitting orthogonal frequency domain multiplexing (OFDM) signals to the subscriber, and receiving direct-sequence spread spectrum (DSSS) signals from the subscriber." Li '422 at Abstract. Li '422 describes the inherent advantages and disadvantages of both OFDM and CDMA schemes for multiple access wireless communications systems. *Id.* at [0004]-[0008]. To optimize these advantages and disadvantages, Li '422 teaches the use

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of OFDM on the downlink and DSSS (CDMA) on the uplink. *Id.* at [0009]. According to Li '422, the techniques disclosed "increase, and potentially maximize, the downlink throughput while increasing, and potentially optimizing, the power efficiency of uplink, and at the same time, maintain the multiple-access flexibility of the overall system." *Id.* at [0031]. Thus, these references were in the same field of endeavor and shared at least the object of providing wireless multiple access communications systems capable of efficient throughput and resource usage. It would have been obvious for a POSITA to combine Walton '301 with Li '422 at least because Walton '301 provides methods and techniques for controlling uplink transmit power at the mobile station (such as those disclosed in Li '422) in order to conserve uplink resources in a multiple access wireless communication system.

- **Walton '301 and Lee '481:** Lee '481 teaches and describes "[a] transmitter device [that] comprises an OFDM transmission unit, a MC-CDMA transmission unit, and a control unit for selecting either the OFDM transmission unit or the MC-CDMA transmission unit at slot time assigned to a receiver device in response to propagation conditions for the receiver device." Lee '481 at Abstract. Lee '481 describes certain advantages and disadvantages of using OFDM and CDMA schemes for multiple access in wireless communication systems. Lee '481 at [0004]-[0009]. To leverage the advantages and disadvantages of these schemes, Lee '481 discloses "a transmitter device and transmitting method for a mobile communication system . . . using OFDM and MC-CDMA schemes in order to solve the problems in each scheme . . . ." *Id.* at [0011]. Thus, these references were in the same field of endeavor and shared at least the goal of providing wireless

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multiple access communications systems capable of efficient throughput and resource usage. It would have been obvious for a POSITA to combine Walton '301 with Lee '481 at least because Walton '301 provides methods and techniques for multiple access resource allocation (such as those disclosed in Lee '481) in order to operate a wireless communication system with high data throughput and reliability.

- **Walton '301 and Kaiser:** Kaiser is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). *Id.* at 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." *Id.* To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. *Id.* at 0001-04, FIGS. 1, 2, 4. Walton '301 also discloses techniques to reduce interference. Walton '301 teaches techniques for reducing RACH interference at the receiving antenna by, for example, employing a beam-steering mode. *See* Walton '301 at 28:54-67, Table 24. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system

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access. It would have been obvious for a POSITA to combine Kaiser with Walton '301 at least because Walton '301 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Walton '301 and Gibson:** Gibson also discloses techniques to reduce interference. Gibson is a treatise on mobile communications that "covers the entire field—from principles of analog and digital communications to cordless telephones, wireless local area networks (LANs), and international technology standards." Gibson, 0003. Gibson, for example, discloses initial channel (or sub-carrier) assignment. *Id.* at 0319. As Gibson explains, "[i]n both FDMA and TDMA systems, channels should not be assigned to a mobile on a permanent basis" because such "[a] fixed assignment strategy would either be extremely wasteful of precious bandwidth or highly susceptible to cochannel interference." *Id*. "Instead, channels must be assigned on demand." *Id*. Gibson therefore discloses using "a separate uplink channel on which mobiles can notify the base station of their need for a traffic channel. This uplink channel is referred to as the random-access channel because of the type of strategy used to regulate access to it." *Id*. Because the random-access channel is shared for all users in range of the base station, Gibson explains that "[a] random access protocol is employed to arbitrate access to this channel." *Id.* at 0324. Thus, these references were in the same field of endeavor and shared at least the goal of providing a means to reduce interference in a mobile telecommunications system. It would have also been obvious to a POSITA to (1) include a random-access channel as a separate uplink channel and (2) perform the channel-assignment

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procedure, as disclosed in Gibson. Doing so would have predictably resulted in a system in which (1) the uplink includes Kaiser's dedicated sub-channels and Gibson's separate, shared random-access channel and (2) the system uses Gibson's procedure to assign channels. Gibson's express teachings would have motivated a POSITA to make this combination because it teaches that "[i]n both FDMA and TDMA systems . . . channels must be assigned on demad" because "[a] fixed assignment strategy would be either extremely wasteful or precious bandwidth or highly susceptible to cochannel interference." Gibson, 0319. Gibson thus teaches employing a "random-access channel" as "a separate uplink channel." *Id*. Gibson also teaches that a "successful procedure" showing the exchange between a mobile station seeking channel assignment and a base station performing channel assignment that uses the random-access channel. *Id*. at 0319-20, FIG. 17.3. A POSITA would have also had a reasonable expectation of success in making this combination and because Gibson's teachniques were well-known and commonly implemented in existing cellular systems by 2004. Accordingly, the Kaiser-Gibson combination is nothing more than the combination of well-known, prior-art elements (e.g., Kaiser's FDMA and TDMA access methods and Gibson's random-access channel and channel-assignment procedure) according to their established functions, yielding predictable results (e.g., channel/carrier assignment in a system employing FDMA and/or TDMA).

- **Walton '301 and Frank:** Frank teaches and describes "[a]n uplink common physical channel (random access channel) frame structure is disclosed with a separate preamble and data portion." Frank at Abstract. Frank recognized that at

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the time "the number of calls being made is expected to increase significantly, which will result in much higher traffic density on random access channels (RACHs)" and "in increased collisions and access failures." Frank, 1:18-23. Frank further recognized that these "systems will have to use much faster and flexible random access procedures, in order to increase their access success rates and reduce their access request processing times." Frank, 1:23-26. To meet this demand, Frank describes a random-access technique that improved upon then-existing approaches. Frank, 2:9-5:31. For example, it uses a guard interval: "[a] guard interval is preferably inserted between the preamble and data portion of the frame, which enables detection of the preamble before the data arrives (requiring less buffering)." Frank, 8:19-22. "[D]uring the guard time interval, T_G, the signature detection processing can be performed at the base station receiver . . . and the base station can determine more quickly whether a random access request has been made." Frank, 9:24-27. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '301 with Frank at least because Walton '301 provides methods and techniques for initial system access by user equipment (such as those disclosed in Frank) to optimize system resources for initial random access.

(ii) Ma '546 in combination with the knowledge of a skilled artisan, Walton '301, Jeong '589, Benedittis '812, Suh '464, Walton '705, C802.16e-03/53r2, Engstrom '436, Wahlqvist, Kanemoto '414, Li '422, Lee '481, Kaiser, Gibson, and/or Frank

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Ma '546 with each of these

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references. A person of ordinary skill in the art would have found it obvious to combine Ma '546 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

- Walton '301, Ma '546, Jeong '589, Benedittis '812, Suh '464, Walton '705, C802.16e-03/53r2, Engstrom '436, Wahlqvist, Kanemoto '414, Li '422, Lee '481, Kaiser, Gibson, and Frank are all directed to systems and methods for initial random access and synchronization by mobile devices in a communication system. For example, they relate to wireless communications, and in particular to uplink communication and resource allocation for initial mobile device access and synchronization. They involve communication protocols and standards, transmission methods (e.g., OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Ma '546 and Walton '301:** Walton '301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '301

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teaches and describes techniques for reducing RACH interference at the receiving antenna by, for example, employing a beam-steering mode. *See* Walton '301 at 28:54-67, Table 24. These references were therefore in the same field of endeavor and share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine Ma '546 with Walton '301 at least because Ma '546 provides methods and techniques for reducing inter-channel interference (such as those disclosed in Walton '301) in order to optimize system resources and maintain quality of service.

- **Ma '546 and Jeong '589:** Jeong '589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. One goal of Jeong '589 is to "provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the

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processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these references were in the same field of endeavor and shared at least the goal of providing a means for users to access the system before resources have been allocated. It would have been obvious for a POSITA to combine Ma '546 with Jeong '589 at least because Ma '546 provides methods and techniques for reducing system access time and resource usage (such as those disclosed in Jeong '589) in order to optimize system resources for initial random access.

- **Ma '546 and Benedittis '812:** Benedittis '812 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." *Id.* at [0021]. Benedittis '812 has as a further object to optimize assignment of "uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination" throughout the system.

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Id. at [0022]. For example, Benedittis '812 teaches "a radon access procedure in a TD-CDMA network," *id.* at [0023], by "creating complete associative links" between "signature bursts assigned to the serving cell" and various channels for data transmission. *See Id.* at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '546 with Benedittis '812 at least because Ma '546 provides methods and techniques for reducing system access time and resource usage (such as those disclosed in Benedittis '812) in order to optimize system resources for initial random access.

- **Ma '546 and Suh '464:** Suh '464 teaches and describes "[a] method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system" by "generating a first preamble sequence in which odd data of the preamble sequence becomes null data and even data of the preamble sequence becomes data" and "generating a second preamble sequence in which even data of the preamble sequence becomes null data and odd data of the preamble sequence becomes data[.]" Suh '464 at Abstract. Suh '454 further teaches that

"[p]referably, a preamble sequence having a low peak-to-average power ratio (PAPR) is used . . . in the OFDM communication system . . . because . . . a high PAPR leads to increased power consumption of a radio frequency (FR) amplifier." *Id.* at [0006]. According to Suh '454, such preambles allow user devices to synchronize with the system: "The UE should be synchronized to a start point of data in order to receive the data, and to this end, the UE must acquire a preamble sequence that is commonly used by all systems for synchronization before receiving signals." *Id.* at [0008]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '546 with Suh '454 at least because Ma '546 provides methods and techniques for initial system access by user equipment (such as those disclosed in Suh '454) in order to optimize system resources for initial random access.

- **Ma '546 and Walton '705:** Walton '705 teaches and describes "[t]ransmitter and receiver units for use in a communications system and configurable to provide antenna, frequency, or temporal diversity, or a combination thereof, for transmitted signals." Walton '705 at Abstract. In particular, Walton '705 describes "a . . . communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility." *Id.* at [0002]. The system described by Walton '705 was intended to increase efficiency by improving support for both voice and data services. *Id.* at [0011]. According to Walton '705, "it is a challenge to design a communications system capable of efficiently supporting both voice and data services" because of differences in the two data

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streams. *Id.* at [0006]-[0010]. To address this difficulty, Walton '705 provides a configurable transmitter "that includes a system data processor, one or more modulators, and one or more antennas." *Id.* at [0013]. The system data processor can include one or more encoders that generate a channel data stream, which is modulated using multi-carrier modulation (e.g., orthogonal frequency division multiplexing (ODFM) modulation)." *Id.* at [0015]-[0016]. Ma '546 It would have been obvious for a POSITA to combine Ma '546 with Walton '705 at least because Ma '546 provides methods and techniques for modulating data (such as those disclosed in Walton '705) in order to improve system service, throughput, and reliability.

- **Ma '546 and C802.16e-03/53r2:** C802.16e-03/53r2 teaches and describes "a modification to the initial ranging transmission . . . to improve the initial ranging performance." C802.16e-03/53r2 at 1. C802.16e-03/53r2 has as its object reducing interference between multiple subscriber stations ("SS") transmitting a simultaneous or near-simultaneous initial ranging signal, while also reducing required system resources for initial ranging. *Id.* at 2. Thus, these references were in the same field of endeavor and shared at least a set of techniques for establishing a random access (initial rangin) protocol for wireless communication systems. It would have been obvious for a POSITA to combine Ma '546 with C802.16e-03/53r2 at least because Ma '546 provides methods and techniques for initial random access (such as those disclosed in C802.16e-03/53r2) in order to minimize system resource usage and facilitate efficient system access.

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- **Ma ’546 and Engstrom ’436:** Engstrom ’436 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Engstrom ’436 teaches and describes “[a] random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital radio communication system, including the steps of cyclically repeating a random access sequence and transmitting each cyclically repeated random access sequence in an orthogonal frequency division multiplex format from the mobile station as an uplink transmission.” Engstrom ’436 at Abstract. One goal of Engstrom ’436 is “to facilitate connection of a mobile station to a base station upon call initiation or upon call handover.” *Id.* at 2:45-47. Thus, these references were in the same field of endeavor and shared at least the goal of facilitating system access by mobile devices. It would have been obvious for a POSITA to combine Ma ’546 with Engstrom ’436 at least because Ma ’546 provides methods and techniques for random access (such as those disclosed in Engstrom ’436) in order to facilitate efficient, seamless system access and resource allocation.
- **Ma ’546 and Wahlqvist:** Wahlqvist is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wahlqvist teaches and describes “a new scheme for initial [uplink] time synchronisation [sic]” with “a random access protocol [that] will have good performance in a mobile radio environment.” Wahlqvist at 1569 (Abstract). As described by Wahlqvist, the base station and mobile station must by synchronized in both time and frequency to maintain the orthogonality that is characteristic of OFDM systems. *Id.* at 1569.

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Any loss or lack of synchronization can lead to interference between subcarriers, reducing system performance. *Id.* It is therefore a goal of Wahlqvist to reduce inter symbol interference by providing a random access protocol that is cyclically repeated. *Id.* at 1570. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '546 with Wahlqvist at least because Ma '546 provides methods and techniques for reducing interference between symbols (such as those disclosed in Wahlqvist) in order to improve system performance.

- **Ma '546 and Kanemoto '414:** Kanemoto '414 teaches and describes systems and methods directed to improving spectral efficiency "by assigning only a small number of subcarriers to an access channel as compared with a traffic channel to which a large number of subcarriers are assigned [and] by grouping users and assigning the access channel of each group to an individual subcarrier" to improve power consumption and processing by user devices. Kanemoto '414 at Abstract. Thus, these references were in the same field of endeavor and shared at least the goal of increasing spectral efficiency. It would have been obvious for a POSITA to combine Ma '546 with Kanemoto '414 at least because Ma '546 provides methods and techniques for improving spectral efficiency in multi-carrier wireless communication systems (such as those disclosed in Kanemoto '414).
- **Ma '546 and Li '422:** Li '422 teaches and describes "[a] method and apparatus for wireless communication . . . [by] transmitting orthogonal frequency domain multiplexing (OFDM) signals to the subscriber, and receiving direct-sequence spread spectrum (DSSS) signals from the subscriber." Li '422 at Abstract. Li '422

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describes the inherent advantages and disadvantages of both OFDM and CDMA schemes for multiple access wireless communications systems. *Id.* at [0004]-[0008]. To optimize these advantages and disadvantages, Li '422 teaches the use of OFDM on the downlink and DSSS (CDMA) on the uplink. *Id.* at [0009]. According to Li '422, the techniques disclosed "increase, and potentially maximize, the downlink throughput while increasing, and potentially optimizing, the power efficiency of uplink, and at the same time, maintain the multiple-access flexibility of the overall system." *Id.* at [0031]. Thus, these references were in the same field of endeavor and shared at least the object of providing wireless multiple access communications systems capable of efficient throughput and resource usage. It would have been obvious for a POSITA to combine Ma '546 with Li '422 at least because Ma '546 provides methods and techniques for controlling uplink transmit power at the mobile station (such as those disclosed in Li '422) in order to conserve uplink resources in a multiple access wireless communication system.

- **Ma '546 and Lee '481:** Lee '481 teaches and describes "[a] transmitter device [that] comprises an OFDM transmission unit, a MC-CDMA transmission unit, and a control unit for selecting either the OFDM transmission unit or the MC-CDMA transmission unit at slot time assigned to a receiver device in response to propagation conditions for the receiver device." Lee '481 at Abstract. Lee '481 describes certain advantages and disadvantages of using OFDM and CDMA schemes for multiple access in wireless communication systems. Lee '481 at [0004]-[0009]. To leverage the advantages and disadvantages of these schemes, Lee '481 discloses "a transmitter device and transmitting method for a mobile

communication system . . . using OFDM and MC-CDMA schemes in order to solve the problems in each scheme . . . ." *Id.* at [0011]. Thus, these references were in the same field of endeavor and shared at least the goal of providing wireless multiple access communications systems capable of efficient throughput and resource usage. It would have been obvious for a POSITA to combine Ma '546 with Lee '481 at least because Ma '546 provides methods and techniques for multiple access resource allocation (such as those disclosed in Lee '481) in order to operate a wireless communication system with high data throughput and reliability.

- **Ma '546 and Kaiser:** Kaiser is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Ma '546 also discloses techniques to reduce interference. Ma '546 teaches and describes "[a] wireless

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terminal and network terminal . . . for implementing a new uplink OFDM protocol" with two distinct frequency bands for, respectively, "transmitting a low rate mode OFDM transmission" and "a burst-mode transmission[.]" Ma '546 at Abstract. Ma '546 further teaches that a random access channel, RACH, can be "overlaid atop the entire common wireless channel" where it "is transmitted simultaneously both in time and frequency with the other . . . signals by other users." *Id.* at 19:56-61. One goal of the Ma '546 RACH scheme is to reduce interference with other users in the system by using, for example, pseudo-noise ("PN") spreading such that the RACH can be transmitted at a very low power level. *See id.* at 19:62-20:16. Interference between cells is reduced by providing a unique PN code for neighboring base stations. *Id.* at 21:1-5. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Ma '546 at least because Ma '546 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Ma '546 and Gibson:** Gibson also discloses techniques to reduce interference. Gibson is a treatise on mobile communications that "covers the entire field—from principles of analog and digital communications to cordless telephones, wireless local area networks (LANs), and international technology standards." Gibson, 0003. Gibson, for example, discloses initial channel (or sub-carrier) assignment. Gibson, 0319. As Gibson explains, "[i]n both FDMA and TDMA systems, channels should not be assigned to a mobile on a permanent basis" because such "[a] fixed

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assignment strategy would either be extremely wasteful of precious bandwidth or highly susceptible to cochannel interference." *Id*. "Instead, channels must be assigned on demand." *Id*. Gibson therefore discloses using "a separate uplink channel on which mobiles can notify the base station of their need for a traffic channel. This uplink channel is referred to as the random-access channel because of the type of strategy used to regulate access to it." *Id*. Because the random-access channel is shared for all users in range of the base station, Gibson explains that "[a] random access protocol is employed to arbitrate access to this channel." Gibson, 0324. Thus, these references were in the same field of endeavor and shared at least the goal of providing a means to reduce interference in a mobile telecommunications system. It would have also been obvious to a POSITA to (1) include a random-access channel as a separate uplink channel and (2) perform the channel-assignment procedure, as disclosed in Gibson. Doing so would have predictably resulted in a system in which (1) the uplink includes Kaiser's dedicated sub-channels and Gibson's separate, shared random-access channel and (2) the system uses Gibson's procedure to assign channels. Gibson's express teachings would have motivated a POSITA to make this combination because it teaches that "[i]n both FDMA and TDMA systems . . . channels must be assigned on demad" because "[a] fixed assignment strategy would be either extremely wasteful or precious bandwidth or highly susceptible to cochannel interference." Gibson, 0319. Gibson thus teaches employing a "random-access channel" as "a separate uplink channel." *Id*. Gibson also teaches that a "successful procedure" showing the exchange between a mobile station seeking channel assignment and a base station

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performing channel assignment that uses the random-access channel. *Id*. at 0319-20, FIG. 17.3. A POSITA would have also had a reasonable expectation of success in making this combination and because Gibson's teachniques were well-known and commonly implemented in existing cellular systems by 2004. Accordingly, the Kaiser-Gibson combination is nothing more than the combination of well-known, prior-art elements (e.g., Kaiser's FDMA and TDMA access methods and Gibson's random-access channel and channel-assignment procedure) according to their established functions, yielding predictable results (e.g., channel/carrier assignment in a system employing FDMA and/or TDMA.

- **Ma '546 and Frank:** Frank teaches and describes "[a]n uplink common physical channel (random access channel) frame structure is disclosed with a separate preamble and data portion." Frank at Abstract. Frank recognized that at the time "the number of calls being made is expected to increase significantly, which will result in much higher traffic density on random access channels (RACHs)" and "in increased collisions and access failures." Frank, 1:18-23. Frank further recognized that these "systems will have to use much faster and flexible random access procedures, in order to increase their access success rates and reduce their access request processing times." Frank, 1:23-26. To meet this demand, Frank describes a random-access technique that improved upon then-existing approaches. Frank, 2:9-5:31. For example, it uses a guard interval: "[a] guard interval is preferably inserted between the preamble and data portion of the frame, which enables detection of the preamble before the data arrives (requiring less buffering)." Frank, 8:19-22. "[D]uring the guard time interval, T_G, the signature detection processing can be

performed at the base station receiver . . . and the base station can determine more quickly whether a random access request has been made." Frank, 9:24-27. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '546 with Frank at least because Ma '546 provides methods and techniques for initial system access by user equipment (such as those disclosed in Frank) to optimize system resources for initial random access.

(iii) Jeong '589 in combination with the knowledge of a skilled artisan, Ma '546, Walton '301, Benedittis '812, Suh '464, Walton '705, C802.16e-03/53r2, Engstrom '436, Wahlqvist, Kanemoto '414, Li '422, Lee '481, Kanterakis, Kaiser, Gibson, Frank, HiperLAN Standard, Walton '269, Ma '437, Walton '944, and/or Tonello

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Jeong '589 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Jeong '589 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

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- Walton ’301, Ma ’546, Jeong ’589, Benedittis ’812, Suh ’464, Walton ’705, C802.16e-03/53r2, Engstrom ’436, Wahlqvist, Kanemoto ’414, Li ’422, Lee ’481, Kanterakis, Kaiser, Gibson, Frank, HiperLAN Standard, Walton ’269, Ma ’437, Walton ’944, and Tonello are all directed to systems and methods for initial random access and synchronization by mobile devices in a communication system. For example, they relate to wireless communications, and in particular to uplink communication and resource allocation for initial mobile device access and synchronization. They involve communication protocols and standards, transmission methods (e.g., OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Jeong ’589 and Ma ’546:** Ma ’546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma ’546 teaches and describes “[a] wireless terminal and network terminal . . . for implementing a new uplink OFDM protocol” with two distinct frequency bands for, respectively, “transmitting a low rate mode OFDM transmission” and “a burst-mode transmission[.]” Ma ’546 at Abstract. Ma ’546 further teaches that a random access channel, RACH, can be “overlaid atop the entire common wireless channel” where it “is transmitted simultaneously both in time and frequency with the other . . . signals by other users.” *Id.* at 19:56-61. One goal of the Ma ’546 RACH scheme is to reduce interference with other users in the system by using, for example, pseudo-noise (“PN”) spreading such that the RACH can be transmitted at a very

low power level. *See id.* at 19:62-20:16. Interference between cells is reduced by providing a unique PN code for neighboring base stations. *Id.* at 21:1-5. These references were therefore in the same field of endeavor and share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine Jeong '589 with Ma '546 at least because Jeong '589 provides methods and techniques for reducing inter-channel interference (such as those disclosed in Ma '546) in order to optimize system resources and maintain quality of service.

- **Jeong '589 and Walton '301:** Walton '301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '301 teaches and describes "[r]andom access techniques to allow user terminals to access the system [that] support system access by multiple user terminals, fast acknowledgment of system access attempts, and quick assignment of downlink/uplink resources." Walton '301 at 2:63-67. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. One goal of Jeong '589 is to "provide [a] ranging interval and ranging sub-channel allocation method for

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initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these references were in the same field of endeavor and shared at least the goal of providing a means for users to access the system before resources have been allocated. It would have been obvious for a POSITA to combine Jeong '589 with Walton '301 at least because Jeong '589 provides methods and techniques for reducing system access time and resource usage (such as those disclosed in Walton '301) in order to optimize system resources for initial random access.

- **Jeong '589 and Benedittis '812:** Benedittis '812 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this

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optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." Benedittis '812 at [0021]. Benedittis '812 has as a further object to optimize assignment of "uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination" throughout the system. *Id.* at [0022]. For example, Benedittis '812 teaches "a radon access procedure in a TD-CDMA network," Benedittis '812 at [0023], by "creating complete associative links" between "signature bursts assigned to the serving cell" and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Jeong '589 with Benedittis '812 at least because Jeong '589 provides methods and techniques for reducing system access time and resource usage (such as those disclosed in Benedittis '812) in order to optimize system resources for initial random access.

- **Jeong '589 and Suh '464:** Suh '464 teaches and describes "[a] method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system" by "generating a first preamble

sequence in which odd data of the preamble sequence becomes null data and even data of the preamble sequence becomes data" and "generating a second preamble sequence in which even data of the preamble sequence becomes null data and odd data of the preamble sequence becomes data[.]" Suh '464 at Abstract. Suh '454 further teaches that "[p]referably, a preamble sequence having a low peak-to-average power ratio (PAPR) is used . . . in the OFDM communication system . . . because . . . a high PAPR leads to increased power consumption of a radio frequency (FR) amplifier." *Id.* at [0006]. According to Suh '454, such preambles allow user devices to synchronize with the system: "The UE should be synchronized to a start point of data in order to receive the data, and to this end, the UE must acquire a preamble sequence that is commonly used by all systems for synchronization before receiving signals." *Id.* at [0008]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Jeong '589 with Suh '454 at least because Jeong '589 provides methods and techniques for initial system access by user equipment (such as those disclosed in Suh '454) in order to optimize system resources for initial random access.

- **Jeong '589 and Walton '705:** Walton '705 teaches and describes "[t]ransmitter and receiver units for use in a communications system and configurable to provide antenna, frequency, or temporal diversity, or a combination thereof, for transmitted signals." Walton '705 at Abstract. In particular, Walton '705 describes "a . . . communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility." *Id.* at [0002]. The

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system described by Walton '705 was intended to increase efficiency by improving support for both voice and data services. *Id.* at [0011]. According to Walton '705, "it is a challenge to design a communications system capable of efficiently supporting both voice and data services" because of differences in the two data streams. *Id.* at [0006]-[0010]. To address this difficulty, Walton '705 provides a configurable transmitter "that includes a system data processor, one or more modulators, and one or more antennas." *Id.* at [0013]. The system data processor can include one or more encoders that generate a channel data stream, which is modulated using multi-carrier modulation (e.g., orthogonal frequency division multiplexing (ODFM) modulation)." *Id.* at [0015]-[0016]. Thus, these references were in the same field of endeavor and shared at least the goal of providing efficient data service in wireless communications systems. It would have been obvious for a POSITA to combine Jeong '589 with Walton '705 at least because Jeong '589 provides methods and techniques for modulating data (such as those disclosed in Walton '705) in order to improve system service, throughput, and reliability.

- **Jeong '589 and C802.16e-03/53r2:** C802.16e-03/53r2 teaches and describes "a modification to the initial ranging transmission . . . to improve the initial ranging performance." C802.16e-03/53r2 at 1. C802.16e-03/53r2 has as its object reducing interference between multiple subscriber stations ("SS") transmitting a simultaneous or near-simultaneous initial ranging signal, while also reducing required system resources for initial ranging. *Id.* at 2. Thus, these references were in the same field of endeavor and shared at least the goal of minimizing system resource usage for initial random access. It would have been obvious for a POSITA

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to combine Jeong ’589 with C802.16e-03/53r2 at least because Jeong ’589 provides methods and techniques for initial random access (such as those disclosed in C802.16e-03/53r2) in order to minimize system resource usage.

- **Jeong ’589 and Engstrom ’436:** Engstrom ’436 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Engstrom ’436 teaches and describes “[a] random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital radio communication system, including the steps of cyclically repeating a random access sequence and transmitting each cyclically repeated random access sequence in an orthogonal frequency division multiplex format from the mobile station as an uplink transmission.” Engstrom ’436 at Abstract. One goal of Engstrom ’436 is “to facilitate connection of a mobile station to a base station upon call initiation or upon call handover.” *Id.* at 2:45-47. Thus, these references were in the same field of endeavor and shared at least the goal of facilitating system access by mobile devices. It would have been obvious for a POSITA to combine Jeong ’589 with Engstrom ’436 at least because Jeong ’589 provides methods and techniques for random access (such as those disclosed in Engstrom ’436) in order to facilitate efficient, seamless system access and resource allocation.
- **Jeong ’589 and Wahlqvist:** Wahlqvist is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wahlqvist teaches and describes “a new scheme for initial [uplink] time synchronisation [sic]” with “a random access protocol [that] will have good performance in a mobile radio

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environment." Wahlqvist at 1569 (Abstract). As described by Wahlqvist, the base station and mobile station must by synchronized in both time and frequency to maintain the orthogonality that is characteristic of OFDM systems. *Id.* at 1569. Any loss or lack of synchronization can lead to interference between subcarriers, reducing system performance. *Id.* It is therefore a goal of Wahlqvist to reduce inter symbol interference by providing a random access protocol that is cyclically repeated. *Id.* at 1570. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Jeong '589 with Wahlqvist at least because Jeong '589 provides methods and techniques for reducing interference between symbols (such as those disclosed in Wahlqvist) in order to improve system performance.

- **Jeong '589 and Kanemoto '414:** Kanemoto '414 teaches and describes systems and methods directed to improving spectral efficiency "by assigning only a small number of subcarriers to an access channel as compared with a traffic channel to which a large number of subcarriers are assigned [and] by grouping users and assigning the access channel of each group to an individual subcarrier" to improve power consumption and processing by user devices. Kanemoto '414 at Abstract. Thus, these references were in the same field of endeavor and shared at least the goal of improving spectral efficiency in random access protocols. It would have been obvious for a POSITA to combine Jeong '589 with Kanemoto '414 at least because Jeong '589 provides methods and techniques for improving spectral

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efficiency in multi-carrier wireless communication systems (such as those disclosed in Kanemoto '414).

- **Jeong '589 and Li '422:** Li '422 teaches and describes "[a] method and apparatus for wireless communication . . . [by] transmitting orthogonal frequency domain multiplexing (OFDM) signals to the subscriber, and receiving direct-sequence spread spectrum (DSSS) signals from the subscriber." Li '422 at Abstract. Li '422 describes the inherent advantages and disadvantages of both OFDM and CDMA schemes for multiple access wireless communications systems. *Id.* at [0004]-[0008]. To optimize these advantages and disadvantages, Li '422 teaches the use of OFDM on the downlink and DSSS (CDMA) on the uplink. *Id.* at [0009]. According to Li '422, the techniques disclosed "increase, and potentially maximize, the downlink throughput while increasing, and potentially optimizing, the power efficiency of uplink, and at the same time, maintain the multiple-access flexibility of the overall system." *Id.* at [0031]. Thus, these references were in the same field of endeavor and shared at least the object of providing wireless multiple access communications systems capable of efficient throughput and resource usage. It would have been obvious for a POSITA to combine Jeong '589 with Li '422 at least because Jeong '589 provides methods and techniques for controlling uplink transmit power at the mobile station (such as those disclosed in Li '422) in order to conserve uplink resources in a multiple access wireless communication system.
- **Jeong '589 and Lee '481:** Lee '481 teaches and describes "[a] transmitter device [that] comprises an OFDM transmission unit, a MC-CDMA transmission unit, and a control unit for selecting either the OFDM transmission unit or the MC-CDMA

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transmission unit at slot time assigned to a receiver device in response to propagation conditions for the receiver device." Lee '481 at Abstract. Lee '481 describes certain advantages and disadvantages of using OFDM and CDMA schemes for multiple access in wireless communication systems. Lee '481 at [0004]-[0009]. To leverage the advantages and disadvantages of these schemes, Lee '481 discloses "a transmitter device and transmitting method for a mobile communication system . . . using OFDM and MC-CDMA schemes in order to solve the problems in each scheme . . . ." *Id.* at [0011]. Thus, these references were in the same field of endeavor and shared at least the goal of providing wireless multiple access communications systems capable of efficient throughput and resource usage. It would have been obvious for a POSITA to combine Jeong '589 with Lee '481 at least because Jeong '589 provides methods and techniques for multiple access resource allocation (such as those disclosed in Lee '481) in order to operate a wireless communication system with high data throughput and reliability.

- **Jeong '589 and Kanterakis:** Kanterakis discloses a random-access preamble followed by a guard period that is used in a channel allocation procedure. Kanterakis, 1:12-21, 2:47-54, 7:24-26, 7:56-57, 8:53-65, FIG. 10. As Figure 10 of Kanterakis shows, Kanterakis's random-access frame format includes a preamble, followed by a time interval T_D, followed by a message data portion. Kanterakis also explains how the base station responds with an acknowledgement signal. Kanterakis, 8:54-62. It explains: "[t]here is one acknowledgement message corresponding to each possible preamble signal." *Id.* at 10:63-64. Thus, these

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references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Jeong '589 with Kanterakis at least because Kanterakis provides methods and techniques for initial system access by user equipment (such as those disclosed in Jeong '589) to optimize system resources for initial random access. For example, a POSITA would have been motivated to include, in the base station's response message, the additional data suggested by Kanterakis because they provide the mobile station with useful information that facilitates progression into subqequent steps of an access procedure. As a POSITA would have appreciated, including the full data sequence corresponding to the original preamble would allow a mobile station to recognize the response as a message that (1) originated from the same base station to which the random-access preamble was sent (as opposed to a base station of another cell), and (2) was specifically intended for the mobile station (as opposed to a different mobile station from the same cell0. The power control information, in turn, would allow the mobile station "to increase or decrease the transmitted power accordingly," (8:63-9:3), further movitating the combination. The combined system would have predictably resulted in a base station's response message to the mobile station's random access preamble signal that includes: (1) assignment information for a dedicated control channel; and (2) the full data sequence contained in the original preamble as well as power control information, as disclosed by Kanterakis. *See id.* at 8:54-9:3, 10:63-66, 18:1-4, 18:31-35, 8:63-9:3. And because the combination would require nothing more than the predictable use of prior art elements (e.g., certain data in Kanterakis's ACK message) according

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to their established funcitons, a POSITA would have reasonably expected the combination to succeed.

- **Jeong ’589 and Kaiser:** Kaiser is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kaiser discloses a system and “multiple access scheme designed for mobile multi-media applications” that “is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation.” Kaiser, 0001. Kaiser explains that the system is “a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its “SS-MC-MA separates the users’ signals according to an FDMA scheme on [the] sub-carrier level,” which advantageously “avoids multiple access interference (MAI) within a cell.” Kaiser, 0001, Abstract. To avoid interference, Kaiser’s “SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme,” which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Jeong ’589 also discloses techniques to reduce interference. Jeong ’589 teaches and describes “a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access (“OFDMA”) type wireless communication system in a point-to-multipoint broadband wireless access (“BWA”) system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process.” Jeong ’589

at Abstract. One goal of Jeong '589 is to "provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Jeong '589 at least because Jeong '589 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Jeong '589 and Gibson:** Gibson also discloses techniques to reduce interference. Gibson is a treatise on mobile communications that "covers the entire field—from principles of analog and digital communications to cordless telephones, wireless local area networks (LANs), and international technology standards." Gibson, 0003. Gibson, for example, discloses initial channel (or sub-carrier) assignment.

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Gibson, 0319. As Gibson explains, "[i]n both FDMA and TDMA systems, channels should not be assigned to a mobile on a permanent basis" because such "[a] fixed assignment strategy would either be extremely wasteful of precious bandwidth or highly susceptible to cochannel interference." *Id*. "Instead, channels must be assigned on demand." *Id*. Gibson therefore discloses using "a separate uplink channel on which mobiles can notify the base station of their need for a traffic channel. This uplink channel is referred to as the random-access channel because of the type of strategy used to regulate access to it." *Id*. Because the random-access channel is shared for all users in range of the base station, Gibson explains that "[a] random access protocol is employed to arbitrate access to this channel." Gibson, 0324. Thus, these references were in the same field of endeavor and shared at least the goal of providing a means to reduce interference in a mobile telecommunications system. It would have also been obvious to a POSITA to (1) include a random-access channel as a separate uplink channel and (2) perform the channel-assignment procedure, as disclosed in Gibson. Doing so would have predictably resulted in a system in which (1) the uplink includes Kaiser's dedicated sub-channels and Gibson's separate, shared random-access channel and (2) the system uses Gibson's procedure to assign channels. Gibson's express teachings would have motivated a POSITA to make this combination because it teaches that "[i]n both FDMA and TDMA systems . . . channels must be assigned on demad" because "[a] fixed assignment strategy would be either extremely wasteful or precious bandwidth or highly susceptible to cochannel interference." Gibson, 0319. Gibson thus teaches employing a "random-access channel" as "a separate uplink

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channel." *Id*. Gibson also teaches that a "successful procedure" showing the exchange between a mobile station seeking channel assignment and a base station performing channel assignment that uses the random-access channel. *Id*. at 0319-20, FIG. 17.3. A POSITA would have also had a reasonable expectation of success in making this combination and because Gibson's teachniques were well-known and commonly implemented in existing cellular systems by 2004. Accordingly, the Kaiser-Gibson combination is nothing more than the combination of well-known, prior-art elements (e.g., Kaiser's FDMA and TDMA access methods and Gibson's random-access channel and channel-assignment procedure) according to their established functions, yielding predictable results (e.g., channel/carrier assignment in a system employing FDMA and/or TDMA.

- **Jeong '589 and Frank:** Frank teaches and describes "[a]n uplink common physical channel (random access channel) frame structure is disclosed with a separate preamble and data portion." Frank at Abstract. Frank recognized that at the time "the number of calls being made is expected to increase significantly, which will result in much higher traffic density on random access channels (RACHs)" and "in increased collisions and access failures." Frank, 1:18-23. Frank further recognized that these "systems will have to use much faster and flexible random access procedures, in order to increase their access success rates and reduce their access request processing times." Frank, 1:23-26. To meet this demand, Frank describes a random-access technique that improved upon then-existing approaches. Frank, 2:9-5:31. For example, it uses a guard interval: "[a] guard interval is preferably inserted between the preamble and data portion of the frame, which enables detection of the

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preamble before the data arrives (requiring less buffering)." Frank, 8:19-22. "[D]uring the guard time interval, T_G, the signature detection processing can be performed at the base station receiver . . . and the base station can determine more quickly whether a random access request has been made." Frank, 9:24-27. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Jeong '589 with Frank at least because Jeong '589 provides methods and techniques for initial system access by user equipment (such as those disclosed in Frank) to optimize system resources for initial random access.

- **Jeong '589 and HiperLAN Standard:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In

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addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Jeong '589 also discloses techniques to reduce interference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. One goal of Jeong '589 is to "provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these

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references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Jeong '589 at least because Jeong '589 provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **Jeong '589 and Walton '269:** Walton '269 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Jeong '589 also discloses techniques to reduce interference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint

broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. One goal of Jeong '589 is to "provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Jeong '589 at least because Jeong '589 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

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- **Jeong ’589 and Ma ’437:** Ma ’437 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma ’437 describes “unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks.” Ma ’437, 1:16-18. Ma ’437 explains that OFDM symbol prefixes can be used to treat interference: “[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix.” *Id*. at 5:61-64. Ma ’437 also explains how mobile terminals can access base stations in an OFDM network. For example, “a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)].” *Id.* at 7:56-8:12. Jeong ’589 also discloses techniques to reduce interference. Jeong ’589 teaches and describes “a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access (“OFDMA”) type wireless communication system in a point-to-multipoint broadband wireless access (“BWA”) system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process.” Jeong ’589 at Abstract. One goal of Jeong ’589 is to “provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system

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capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Jeong '589 at least because Jeong '589 provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

- **Jeong '589 and Walton '944:** Walton '944 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '944 describes "an effective and eficient random access scheme for wireless multiple-access communications systems." Walton '944, 1:60-62. "A random access channel (RACH) is defined to comprise a 'fast' RACH (F-RACH) and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used

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to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Jeong '589 also discloses techniques to reduce interference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. One goal of Jeong '589 is to "provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these references were in the same

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field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '944 with Jeong '589 at least because Jeong '589 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '944) to optimize system resources for initial random access.

- **Jeong '589 and Tonello:** Tonello teaches and describes "the insertion of appropriate time and frequency guard intervals . . . effectively reduce the [multiple access interference], so that a proper trade off with spectral efficiency can be met to optimize system performance." Tonello at 1094 (Abstract). As Tonello describes, "multiple access interference (MAI) arise[s] in [a multi-carrier uplink] in the presence of time offsets, frequency offsets, and multi-path fading." *Id.* at 1094. According to Tonello, "[t]he MAI due to the time offsets and the multipath fading can be completely removed by inserting a guard time longer than the sum of the maximum channel delay spread and the propagation delay." *Id.* Tonello teaches that "spectral efficiency for large outdoor cell sizes [can be maximized by] the use of time and frequency guards . . . if it is applied together with a centralized base station time and frequency alignment control." *Id.* at 1094-95. Thus, these references were in the same field of endeavor and shared at least the goal of reducing interference in a multiple access wireless communications system. For example, Jeong '589 teaches that "the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process."

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Jeogn ’589 at Abstract. It would have been obvious for a POSITA to combine Jeong ’589 with Tonello at least because Jeong ’589 provides methods and techniques for reducing interference in a multi-carrier wireless communication system (such as those disclosed in Tonello) to optimize system performance.

(iv) Benedittis ’812 in combination with the knowledge of a skilled artisan, Ma ’546, Jeong ’589, Walton ’301, Suh ’464, Walton ’705, C802.16e-03/53r2, Engstrom ’436, Wahlqvist, Kanemoto ’414, Li ’422, Lee ’481, Kanterakis, Kaiser, Gibson, Frank, HiperLAN Standard, Walton ’269, Ma ’437, and/or Walton ’944

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Benedittis ’812 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Benedittis ’812 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’908 patent was filed. Specifically:

- Walton ’301, Ma ’546, Jeong ’589, Benedittis ’812, Suh ’464, Walton ’705, C802.16e-03/53r2, Engstrom ’436, Wahlqvist, Kanemoto ’414, Li ’422, Lee ’481, Kanterakis, Kaiser, Gibson, Frank, HiperLAN Standard, Walton ’269, Ma ’437, and Walton ’944 are all directed to systems and methods for initial random access

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and synchronization by mobile devices in a communication system. For example, they relate to wireless communications, and in particular to uplink communication and resource allocation for initial mobile device access and synchronization. They involve communication protocols and standards, transmission methods (e.g., OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Benedittis '812 and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 teaches and describes "[a] wireless terminal and network terminal . . . for implementing a new uplink OFDM protocol" with two distinct frequency bands for, respectively, "transmitting a low rate mode OFDM transmission" and "a burst-mode transmission[.]" Ma '546 at Abstract. Ma '546 further teaches that a random access channel, RACH, can be "overlaid atop the entire common wireless channel" where it "is transmitted simultaneously both in time and frequency with the other . . . signals by other users." *Id.* at 19:56-61. One goal of the Ma '546 RACH scheme is to reduce interference with other users in the system by using, for example, pseudo-noise ("PN") spreading such that the RACH can be transmitted at a very low power level. *See id.* at 19:62-20:16. Interference between cells is reduced by providing a unique PN code for neighboring base stations. *Id.* at 21:1-5. These references were therefore in the same field of endeavor and share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine Benedittis '812 with Ma '546 at least

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because Benedittis ’812 provides methods and techniques for reducing inter-channel interference (such as those disclosed in Ma ’546) in order to optimize system resources and maintain quality of service.

- **Benedittis ’812 and Jeong ’589:** Jeong ’589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong ’589 teaches and describes “a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access (“OFDMA”) type wireless communication system in a point-to-multipoint broadband wireless access (“BWA”) system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process.” Jeong ’589 at Abstract. One goal of Jeong ’589 is to “provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself.” *Id.* at 4. To achieve this goal, the method “is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay

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time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these references were in the same field of endeavor and shared at least the goal of providing a means for users to access the system before resources have been allocated. It would have been obvious for a POSITA to combine Benedittis '812 with Jeong '589 at least because Benedittis '812 provides methods and techniques for reducing system access time and resource usage (such as those disclosed in Jeong '589) in order to optimize system resources for initial random access.

- **Benedittis '812 and Walton '301:** Walton '301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '301 teaches and describes "[r]andom access techniques to allow user terminals to access the system [that] support system access by multiple user terminals, fast acknowledgment of system access attempts, and quick assignment of downlink/uplink resources." Walton '301 at 2:63-67. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." Benedittis '812 at [0021]. Benedittis '812 has as a further object to optimize assignment of "uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination" throughout the system. *Id.* at [0022]. For example, Benedittis '812 teaches "a radon access procedure in a TD-CDMA

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network," Benedittis '812 at [0023], by "creating complete associative links" between "signature bursts assigned to the serving cell" and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Benedittis '812 with Walton '301 at least because Benedittis '812 provides methods and techniques for reducing system access time and resource usage (such as those disclosed in Walton '301) in order to optimize system resources for initial random access.

- **Benedittis '812 and Suh '464:** Suh '464 teaches and describes "[a] method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system" by "generating a first preamble sequence in which odd data of the preamble sequence becomes null data and even data of the preamble sequence becomes data" and "generating a second preamble sequence in which even data of the preamble sequence becomes null data and odd data of the preamble sequence becomes data[.]" Suh '464 at Abstract. Suh '454 further teaches that "[p]referably, a preamble sequence having a low peak-to-

average power ratio (PAPR) is used . . . in the OFDM communication system . . . because . . . a high PAPR leads to increased power consumption of a radio frequency (FR) amplifier." *Id.* at [0006]. According to Suh '454, such preambles allow user devices to synchronize with the system: "The UE should be synchronized to a start point of data in order to receive the data, and to this end, the UE must acquire a preamble sequence that is commonly used by all systems for synchronization before receiving signals." *Id.* at [0008]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Benedittis '812 with Suh '454 at least because Benedittis '812 provides methods and techniques for initial system access by user equipment (such as those disclosed in Suh '454) in order to optimize system resources for initial random access.

- **Benedittis '812 and Walton '705:** Walton '705 teaches and describes "[t]ransmitter and receiver units for use in a communications system and configurable to provide antenna, frequency, or temporal diversity, or a combination thereof, for transmitted signals." Walton '705 at Abstract. In particular, Walton '705 describes "a . . . communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility." *Id.* at [0002]. The system described by Walton '705 was intended to increase efficiency by improving support for both voice and data services. *Id.* at [0011]. According to Walton '705, "it is a challenge to design a communications system capable of efficiently supporting both voice and data services" because of differences in the two data streams. *Id.* at [0006]-[0010]. To address this difficulty,

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Walton ’705 provides a configurable transmitter “that includes a system data processor, one or more modulators, and one or more antennas.” *Id.* at [0013]. The system data processor can include one or more encoders that generate a channel data stream, which is modulated using multi-carrier modulation (e.g., orthogonal frequency division multiplexing (ODFM) modulation).” *Id.* at [0015]-[0016]. Thus, these references were in the same field of endeavor and shared at least the goal of providing efficient data service in wireless communications systems. It would have been obvious for a POSITA to combine Benedittis ‘812 with Walton ’705 at least because Benedittis ’812 provides methods and techniques for modulating data (such as those disclosed in Walton ’705) in order to improve system service, throughput, and reliability.

- **Benedittis ’812 and C802.16e-03/53r2:** C802.16e-03/53r2 teaches and describes “a modification to the initial ranging transmission . . . to improve the initial ranging performance.” C802.16e-03/53r2 at 1. C802.16e-03/53r2 has as its object reducing interference between multiple subscriber stations (“SS”) transmitting a simultaneous or near-simultaneous initial ranging signal, while also reducing required system resources for initial ranging. *Id.* at 2. Thus, these references were in the same field of endeavor and shared at least the goal of minimizing system resource usage for initial random access. It would have been obvious for a POSITA to combine Benedittis ’812 with C802.16e-03/53r2 at least because Benedittis ’812 provides methods and techniques for initial random access (such as those disclosed in C802.16e-03/53r2) in order to minimize system resource usage.

- **Benedittis ’812 and Engstrom ’436:** Engstrom ’436 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Engstrom ’436 teaches and describes “[a] random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital radio communication system, including the steps of cyclically repeating a random access sequence and transmitting each cyclically repeated random access sequence in an orthogonal frequency division multiplex format from the mobile station as an uplink transmission.” Engstrom ’436 at Abstract. One goal of Engstrom ’436 is “to facilitate connection of a mobile station to a base station upon call initiation or upon call handover.” *Id.* at 2:45-47. Thus, these references were in the same field of endeavor and shared at least the goal of facilitating system access by mobile devices. It would have been obvious for a POSITA to combine Benedittis ’812 with Engstrom ’436 at least because Benedittis ’812 provides methods and techniques for random access (such as those disclosed in Engstrom ’436) in order to facilitate efficient, seamless system access and resource allocation.
- **Benedittis ’812 and Wahlqvist:** Wahlqvist is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wahlqvist teaches and describes “a new scheme for initial [uplink] time synchronisation [sic]” with “a random access protocol [that] will have good performance in a mobile radio environment.” Wahlqvist at 1569 (Abstract). As described by Wahlqvist, the base station and mobile station must by synchronized in both time and frequency to maintain the orthogonality that is characteristic of OFDM systems. *Id.* at 1569.

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Any loss or lack of synchronization can lead to interference between subcarriers, reducing system performance. *Id.* It is therefore a goal of Wahlqvist to reduce inter symbol interference by providing a random access protocol that is cyclically repeated. *Id.* at 1570. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Benedittis '812 with Wahlqvist at least because Benedittis '812 provides methods and techniques for reducing interference between symbols (such as those disclosed in Wahlqvist) in order to improve system performance.

- **Benedittis '812 and Kanemoto '414:** Kanemoto '414 teaches and describes systems and methods directed to improving spectral efficiency "by assigning only a small number of subcarriers to an access channel as compared with a traffic channel to which a large number of subcarriers are assigned [and] by grouping users and assigning the access channel of each group to an individual subcarrier" to improve power consumption and processing by user devices. Kanemoto '414 at Abstract. Thus, these references were in the same field of endeavor and shared at least the goal of improving spectral efficiency. It would have been obvious for a POSITA to combine Benedittis '812 with Kanemoto '414 at least because Benedittis '812 provides methods and techniques for improving spectral efficiency in multi-carrier wireless communication systems (such as those disclosed in Kanemoto '414).
- **Benedittis '812 and Li '422:** Li '422 teaches and describes "[a] method and apparatus for wireless communication . . . [by] transmitting orthogonal frequency

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domain multiplexing (OFDM) signals to the subscriber, and receiving direct-sequence spread spectrum (DSSS) signals from the subscriber." Li '422 at Abstract. Li '422 describes the inherent advantages and disadvantages of both OFDM and CDMA schemes for multiple access wireless communications systems. *Id.* at [0004]-[0008]. To optimize these advantages and disadvantages, Li '422 teaches the use of OFDM on the downlink and DSSS (CDMA) on the uplink. *Id.* at [0009]. According to Li '422, the techniques disclosed "increase, and potentially maximize, the downlink throughput while increasing, and potentially optimizing, the power efficiency of uplink, and at the same time, maintain the multiple-access flexibility of the overall system." *Id.* at [0031]. Thus, these references were in the same field of endeavor and shared at least the object of providing wireless multiple access communications systems capable of efficient throughput and resource usage. It would have been obvious for a POSITA to combine Benedittis '812 with Li '422 at least because Benedittis provides methods and techniques for controlling uplink transmit power at the mobile station (such as those disclosed in Li '422) in order to conserve uplink resources in a multiple access wireless communication system.

- **Benedittis '812 and Lee '481:** Lee '481 teaches and describes "[a] transmitter device [that] comprises an OFDM transmission unit, a MC-CDMA transmission unit, and a control unit for selecting either the OFDM transmission unit or the MC-CDMA transmission unit at slot time assigned to a receiver device in response to propagation conditions for the receiver device." Lee '481 at Abstract. Lee '481 describes certain advantages and disadvantages of using OFDM and CDMA schemes for multiple access in wireless communication systems. Lee '481 at

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[0004]-[0009]. To leverage the advantages and disadvantages of these schemes, Lee '481 discloses "a transmitter device and transmitting method for a mobile communication system . . . using OFDM and MC-CDMA schemes in order to solve the problems in each scheme . . . ." *Id.* at [0011]. Thus, these references were in the same field of endeavor and shared at least the goal of providing wireless multiple access communications systems capable of efficient throughput and resource usage. It would have been obvious for a POSITA to combine Benedittis '812 with Lee '481 at least because Benedittis '812 provides methods and techniques for multiple access resource allocation (such as those disclosed in Lee '481) in order to operate a wireless communication system with high data throughput and reliability.

- **Benedittis '812 and Kanterakis:** Kanterakis discloses a random-access preamble followed by a guard period that is used in a channel allocation procedure. Kanterakis, 1:12-21, 2:47-54, 7:24-26, 7:56-57, 8:53-65, FIG. 10. As Figure 10 of Kanterakis shows, Kanterakis's random-access frame format includes a preamble, followed by a time interval T_D, followed by a message data portion. Kanterakis also explains how the base station responds with an acknowledgement signal. Kanterakis, 8:54-62. It explains: "[t]here is one acknowledgement message corresponding to each possible preamble signal." *Id.* at 10:63-64. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Benedittis '812 with Kanterakis at least because Kanterakis provides methods and techniques for initial system access by user equipment (such as those

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disclosed in Benedittis ’812) to optimize system resources for initial random access. For example, a POSITA would have been motivated to include, in the base station’s response message, the additional data suggested by Kanterakis because they provide the mobile station with useful information that facilitates progression into subqequent steps of an access procedure. As a POSITA would have appreciated, including the full data sequence corresponding to the original preamble would allow a mobile station to recognize the response as a message that (1) originated from the same base station to which the random-access preamble was sent (as opposed to a base station of another cell), and (2) was specifically intended for the mobile station (as opposed to a different mobile station from the same cell0. The power control information, in turn, would allow the mobile station “to increase or decrease the transmitted power accordingly,” (8:63-9:3), further movitating the combination. The combined system would have predictably resulted in a base station’s response message to the mobile station’s random access preamble signal that includes: (1) assignment information for a dedicated control channel; and (2) the full data sequence contained in the original preamble as well as power control information, as disclosed by Kanterakis. *See id.* at 8:54-9:3, 10:63-66, 18:1-4, 18:31-35, 8:63-9:3. And because the combination would require nothing more than the predictable use of prior art elements (e.g., certain data in Kanterakis’s ACK message) according to their established funcitons, a POSITA would have reasonably expected the combination to succeed.

- **Benedittis ’812 and Kaiser:** Kaiser is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kaiser discloses a

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system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Beneditis '812 also discloses techniques to reduce interference. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." Benedittis '812 at [0021]. Benedittis '812 has as a further object to optimize assignment of "uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination" throughout the system. *Id.* at [0022]. For example, Benedittis '812 teaches "a random access procedure in a TD-CDMA network," Benedittis '812 at [0023], by "creating complete associative links" between "signature bursts assigned to the serving cell" and various channels for data

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transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Benedittis '812 at least because Benedittis '812 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Benedittis '812 and Gibson**: Gibson also discloses techniques to reduce interference. Gibson is a treatise on mobile communications that "covers the entire field—from principles of analog and digital communications to cordless telephones, wireless local area networks (LANs), and international technology standards." Gibson, 0003. Gibson, for example, discloses initial channel (or sub-carrier) assignment. Gibson, 0319. As Gibson explains, "[i]n both FDMA and TDMA systems, channels should not be assigned to a mobile on a permanent basis" because such "[a] fixed assignment strategy would either be extremely wasteful of precious bandwidth or highly susceptible to cochannel interference." *Id*. "Instead, channels must be assigned on demand." *Id*. Gibson therefore discloses using "a separate uplink channel on which mobiles can notify the base station of their need

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for a traffic channel. This uplink channel is referred to as the random-access channel because of the type of strategy used to regulate access to it." *Id*. Because the random-access channel is shared for all users in range of the base station, Gibson explains that "[a] random access protocol is employed to arbitrate access to this channel." Gibson, 0324. Thus, these references were in the same field of endeavor and shared at least the goal of providing a means to reduce interference in a mobile telecommunications system. It would have also been obvious to a POSITA to (1) include a random-access channel as a separate uplink channel and (2) perform the channel-assignment procedure, as disclosed in Gibson. Doing so would have predictably resulted in a system in which (1) the uplink includes Kaiser's dedicated sub-channels and Gibson's separate, shared random-access channel and (2) the system uses Gibson's procedure to assign channels. Gibson's express teachings would have motivated a POSITA to make this combination because it teaches that "[i]n both FDMA and TDMA systems . . . channels must be assigned on demad" because "[a] fixed assignment strategy would be either extremely wasteful or precious bandwidth or highly susceptible to cochannel interference." Gibson, 0319. Gibson thus teaches employing a "random-access channel" as "a separate uplink channel." *Id*. Gibson also teaches that a "successful procedure" showing the exchange between a mobile station seeking channel assignment and a base station performing channel assignment that uses the random-access channel. *Id*. at 0319-20, FIG. 17.3. A POSITA would have also had a reasonable expectation of success in making this combination and because Gibson's teachniques were well-known and commonly implemented in existing

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cellular systems by 2004. Accordingly, the Kaiser-Gibson combination is nothing more than the combination of well-known, prior-art elements (e.g., Kaiser's FDMA and TDMA access methods and Gibson's random-access channel and channel-assignment procedure) according to their established functions, yielding predictable results (e.g., channel/carrier assignment in a system employing FDMA and/or TDMA.

- **Benedittis '812 and Frank:** Frank teaches and describes "[a]n uplink common physical channel (random access channel) frame structure is disclosed with a separate preamble and data portion." Frank at Abstract. Frank recognized that at the time "the number of calls being made is expected to increase significantly, which will result in much higher traffic density on random access channels (RACHs)" and "in increased collisions and access failures." Frank, 1:18-23. Frank further recognized that these "systems will have to use much faster and flexible random access procedures, in order to increase their access success rates and reduce their access request processing times." Frank, 1:23-26. To meet this demand, Frank describes a random-access technique that improved upon then-existing approaches. Frank, 2:9-5:31. For example, it uses a guard interval: "[a] guard interval is preferably inserted between the preamble and data portion of the frame, which enables detection of the preamble before the data arrives (requiring less buffering)." Frank, 8:19-22. "[D]uring the guard time interval, T_G, the signature detection processing can be performed at the base station receiver . . . and the base station can determine more quickly whether a random access request has been made." Frank, 9:24-27. Thus, these references were in the same field of endeavor and

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shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Benedittis '812 with Frank at least because Benedittis '812 provides methods and techniques for initial system access by user equipment (such as those disclosed in Frank) to optimize system resources for initial random access.

- **Benedittis '812 and HiperLAN Standard:** HiperLAN Standard is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art

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as a viable solution. Benedittis '812 also discloses techniques to reduce interference. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." Benedittis '812 at [0021]. Benedittis '812 has as a further object to optimize assignment of "uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination" throughout the system. *Id.* at [0022]. For example, Benedittis '812 teaches "a random access procedure in a TD-CDMA network," Benedittis '812 at [0023], by "creating complete associative links" between "signature bursts assigned to the serving cell" and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Benedittis '812 at least because Benedittis '812 provides methods

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and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **Benedittis '812 and Walton '269**: Walton '269 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Benedittis also discloses techniques to reduce interference. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." Benedittis '812 at [0021]. Benedittis '812 has as a further object to optimize assignment of "uplink and downlink synchronization sequences,

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as well as midambles and scrambling codes for cell discrimination" throughout the system. *Id.* at [0022]. For example, Benedittis '812 teaches "a random access procedure in a TD-CDMA network," Benedittis '812 at [0023], by "creating complete associative links" between "signature bursts assigned to the serving cell" and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Benedittis '812 at least because Benedittis '812 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

- **Benedittis '812 and Ma '437:** Ma '437 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at

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5:61-64. Ma ’437 also explains how mobile terminals can access base stations in an OFDM network. For example, “a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)].” *Id.* at 7:56-8:12. Benedittis ’812 also discloses techniques to reduce interference. Benedittis ’812 teaches and describes “a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization.” Benedittis ’812 at Abstract. Benedittis ’812 achieves this optimization object by “minimizing the overall time and effort spent before entering the dedicated channel.” Benedittis ’812 at [0021]. Benedittis ’812 has as a further object to optimize assignment of “uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination” throughout the system. *Id.* at [0022]. For example, Benedittis ’812 teaches “a random access procedure in a TD-CDMA network,” Benedittis ’812 at [0023], by “creating complete associative links” between “signature bursts assigned to the serving cell” and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize “access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request).” *Id.* at [0030]-[0031]. Further, it will “limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be

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co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Benedittis '812 at least because Benedittis '812 provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

- **Benedittis '812 and Walton '944:** Walton '944 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '944 describes "an effective and eficient random access scheme for wireless multiple-access communications systems." Walton '944, 1:60-62. "A random access channel (RACH) is defined to comprise a 'fast' RACH (F-RACH) and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Benedittis '812 also discloses techniques to reduce interference. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." Benedittis '812 at [0021]. Benedittis '812 has as a further object to optimize assignment of

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"uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination" throughout the system. *Id.* at [0022]. For example, Benedittis '812 teaches "a random access procedure in a TD-CDMA network," Benedittis '812 at [0023], by "creating complete associative links" between "signature bursts assigned to the serving cell" and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '944 with Benedittis '812 at least because Benedittis '812 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '944) to optimize system resources for initial random access.

(v) Kaiser in combination with the knowledge of a skilled artisan, HiperLAN Standard, Walton '944, Walton '269, Walton '301, Ma '437, Ma '546, Jeong '589, Suh '464, Benedittis '812, Kanterakis, Gibson, and/or Frank

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Kaiser with each of these references. A person of ordinary skill in the art would have found it obvious to combine Kaiser with, or modify it based on, the disclosures of one or more of the other references because, for

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example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

- Kaiser, HiperLAN Standard, Walton '944, Walton '269, Walton '301, Ma '437, Ma '546, Jeong '589, Suh '464, Benedittis '812, Kanterakis, Gibson, and Frank are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using RACH. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Kaiser and HiperLAN Standard:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-

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carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. HiperLAN Standard also discloses techniques to reduce interference. HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with

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propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. HiperLAN Standard also discloses techniques to reduce interference. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with the HiperLAN Standard at least because the HiperLAN Standard provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Kaiser and Walton '944:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Walton '944 also discloses techniques to reduce interference. Walton '944 describes "an effective and efficient random access scheme for wireless multiple-access communications systems." Walton '944, 1:60-62. "A random access channel (RACH) is defined to comprise a 'fast' RACH (F-RACH)

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and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Walton '944 at least because Walton '944 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Kaiser and Walton '269:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Walton '269 also discloses techniques to reduce interference. Walton '269 discloses a broadcast channel (BCH), which is "[u]sed

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by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Walton '269 at least because Walton '269 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Kaiser and Walton '301:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals

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according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Walton '301 also discloses techniques to reduce interference. Walton '301 teaches techniques for reducing RACH interference at the receiving antenna by, for example, employing a beam-steering mode. *See* Walton '301 at 28:54-67, Table 24. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Walton '301 at least because Walton '301 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Kaiser and Ma '437:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own

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sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Ma '437 also discloses techniques to reduce interference. Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)]." *Id.* at 7:56-8:12. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Ma '437 at least because Ma '437 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Kaiser and Ma '546:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for

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the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Ma '546 also discloses techniques to reduce interference. Ma '546 teaches and describes "[a] wireless terminal and network terminal . . . for implementing a new uplink OFDM protocol" with two distinct frequency bands for, respectively, "transmitting a low rate mode OFDM transmission" and "a burst-mode transmission[.]" Ma '546 at Abstract. Ma '546 further teaches that a random access channel, RACH, can be "overlaid atop the entire common wireless channel" where it "is transmitted simultaneously both in time and frequency with the other . . . signals by other users." *Id.* at 19:56-61. One goal of the Ma '546 RACH scheme is to reduce interference with other users in the system by using, for example, pseudo-noise ("PN") spreading such that the RACH can be transmitted at a very low power level. *See id.* at 19:62-20:16. Interference between cells is reduced by providing a unique PN code for neighboring base stations. *Id.* at 21:1-5. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Ma '546 at least because Ma '546 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

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- **Kaiser and Jeong ’589:** Kaiser discloses a system and “multiple access scheme designed for mobile multi-media applications” that “is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation.” Kaiser, 0001. Kaiser explains that the system is “a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its “SS-MC-MA separates the users’ signals according to an FDMA scheme on [the] sub-carrier level,” which advantageously “avoids multiple access interference (MAI) within a cell.” Kaiser, 0001, Abstract. To avoid interference, Kaiser’s “SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme,” which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Jeong ’589 also discloses techniques to reduce interference. Jeong ’589 teaches and describes “a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access (“OFDMA”) type wireless communication system in a point-to-multipoint broadband wireless access (“BWA”) system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process.” Jeong ’589 at Abstract. One goal of Jeong ’589 is to “provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of

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a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Jeong '589 at least because Jeong '589 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Kaiser and Suh '464:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract.

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To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Suh '464 also discloses techniques to reduce interference. Suh '464 teaches and describes "[a] method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system" by "generating a first preamble sequence in which odd data of the preamble sequence becomes null data and even data of the preamble sequence becomes data" and "generating a second preamble sequence in which even data of the preamble sequence becomes null data and odd data of the preamble sequence becomes data[.]" Suh '464 at Abstract. Suh '454 further teaches that "[p]referably, a preamble sequence having a low peak-to-average power ratio (PAPR) is used . . . in the OFDM communication system . . . because . . . a high PAPR leads to increased power consumption of a radio frequency (FR) amplifier." *Id.* at [0006]. According to Suh '454, such preambles allow user devices to synchronize with the system: "The UE should be synchronized to a start point of data in order to receive the data, and to this end, the UE must acquire a preamble sequence that is commonly used by all systems for synchronization before receiving signals." *Id.* at [0008]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Suh '464 at least because Suh '464 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

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- **Kaiser and Benedittis '812:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Beneditis '812 also discloses techniques to reduce interference. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." Benedittis '812 at [0021]. Benedittis '812 has as a further object to optimize assignment of "uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination" throughout the system. *Id.* at [0022]. For example, Benedittis '812 teaches "a random access procedure in a TD-CDMA network," Benedittis '812 at [0023], by "creating complete associative links" between

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"signature bursts assigned to the serving cell" and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Benedittis '812 at least because Benedittis '812 provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access.

- **Kaiser and Kanterakis:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own

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sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Kanterakis also discloses techniques to reduce interference using a guard period. Kanterakis discloses a random-access preamble followed by a guard period that is used in a channel allocation procedure. Kanterakis, 1:12-21, 2:47-54, 7:24-26, 7:56-57, 8:53-65, FIG. 10. As Figure 10 of Kanterakis shows, Kanterakis's random-access frame format includes a preamble, followed by a time interval T_D, followed by a message data portion. Kanterakis also explains how the base station responds with an acknowledgement signal. Kanterakis, 8:54-62. It explains: "[t]here is one acknowledgement message corresponding to each possible preamble signal." *Id.* at 10:63-64. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Kaiser with Kanterakis at least because Kanterakis provides methods and techniques for initial system access by user equipment (such as those disclosed in Kaiser) to optimize system resources for initial random access. For example, a POSITA would have been motivated to include, in the base station's response message, the additional data suggested by Kanterakis because they provide the mobile station with useful information that facilitates progression into subqequent steps of an access procedure. As a POSITA would have appreciated, including the full data sequence corresponding to the original preamble would allow a mobile station to recognize the response as a message that (1) originated from the same base station to which the random-access preamble was sent (as opposed to a base station of another cell), and (2) was specifically intended for the mobile station (as opposed to a different mobile station

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from the same cell0. The power control information, in turn, would allow the mobile station "to increase or decrease the transmitted power accordingly," (8:63-9:3), further movitating the combination. The combined system would have predictably resulted in a base station's response message to the mobile station's random access preamble signal that includes: (1) assignment information for a dedicated control channel; and (2) the full data sequence contained in the original preamble as well as power control information, as disclosed by Kanterakis. *See id.* at 8:54-9:3, 10:63-66, 18:1-4, 18:31-35, 8:63-9:3. And because the combination would require nothing more than the predictable use of prior art elements (e.g., certain data in Kanterakis's ACK message) according to their established funcitons, a POSITA would have reasonably expected the combination to succeed.

- **Kaiser and Gibson:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Gibson also discloses techniques to reduce interference.

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Gibson is a treatise on mobile communications that "covers the entire field—from principles of analog and digital communications to cordless telephones, wireless local area networks (LANs), and international technology standards." Gibson, 0003. Gibson, for example, discloses initial channel (or sub-carrier) assignment. Gibson, 0319. As Gibson explains, "[i]n both FDMA and TDMA systems, channels should not be assigned to a mobile on a permanent basis" because such "[a] fixed assignment strategy would either be extremely wasteful of precious bandwidth or highly susceptible to cochannel interference." *Id*. "Instead, channels must be assigned on demand." *Id*. Gibson therefore discloses using "a separate uplink channel on which mobiles can notify the base station of their need for a traffic channel. This uplink channel is referred to as the random-access channel because of the type of strategy used to regulate access to it." *Id*. Because the random-access channel is shared for all users in range of the base station, Gibson explains that "[a] random access protocol is employed to arbitrate access to this channel." Gibson, 0324. Thus, these references were in the same field of endeavor and shared at least the goal of providing a means to reduce interference in a mobile telecommunications system. It would have also been obvious to a POSITA to (1) include a random-access channel as a separate uplink channel and (2) perform the channel-assignment procedure, as disclosed in Gibson. Doing so would have predictably resulted in a system in which (1) the uplink includes Kaiser's dedicated sub-channels and Gibson's separate, shared random-access channel and (2) the system uses Gibson's procedure to assign channels. Gibson's express teachings would have motivated a POSITA to make this combination because it teaches that

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"[i]n both FDMA and TDMA systems . . . channels must be assigned on demad" because "[a] fixed assignment strategy would be either extremely wasteful or precious bandwidth or highly susceptible to cochannel interference." Gibson, 0319. Gibson thus teaches employing a "random-access channel" as "a separate uplink channel." *Id*. Gibson also teaches that a "successful procedure" showing the exchange between a mobile station seeking channel assignment and a base station performing channel assignment that uses the random-access channel. *Id*. at 0319-20, FIG. 17.3. A POSITA would have also had a reasonable expectation of success in making this combination and because Gibson's teachniques were well-known and commonly implemented in existing cellular systems by 2004. Accordingly, the Kaiser-Gibson combination is nothing more than the combination of well-known, prior-art elements (e.g., Kaiser's FDMA and TDMA access methods and Gibson's random-access channel and channel-assignment procedure) according to their established functions, yielding predictable results (e.g., channel/carrier assignment in a system employing FDMA and/or TDMA.

- **Kaiser and Frank:** Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously

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"avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Frank also discloses techniques to reduce interference. Frank is directed to "next generation mobile communications systems, such as . . . Universal Mobile Telecommunications Systems (UMTS)." Frank, 1:12-15. Frank recognized that at the time "the number of calls being made is expected to increase significantly, which will result in much higher traffic density on random access channels (RACHs)" and "in increased collisions and access failures." Frank, 1:18-23. Frank further recognized that these "systems will have to use much faster and flexible random access procedures, in order to increase their access success rates and reduce their access request processing times." Frank, 1:23-26. To meet this demand, Frank describes a random-access technique that improved upon then-existing approaches. Frank, 2:9-5:31. For example, it uses a guard interval: "[a] guard interval is preferably inserted between the preamble and data portion of the frame, which enables detection of the preamble before the data arrives (requiring less buffering)." Frank, 8:19-22. "[D]uring the guard time interval, T_G, the signature detection processing can be performed at the base station receiver . . . and the base station can determine more quickly whether a random access request has been made." Frank, 9:24-27. Thus, Frank provides explicit teachings that would have motivated a POSITA to use a guard period. These references were also in the same field of endeavor and shared at least the goal of providing a means to reduce interference in a mobile telecommunications system. *See* Kaiser, 0002; Frank, 9:26

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(both describing similar spread-spectrum technologies with similar spreading codes such as Walsh-Hadamard). It would have thus been obvious to combine Kaiser with Frank at least because Frank provides methods and techniques for reducing system access time and resource usage (such as those disclosed in Kaiser) to optimize system resources for initial random access. This combination would have predictably resulted in a system in which (1) the uplink includes Kaiser's dedicated sub-channels and (2) Frank's random-access preamble transmitted in a separate, shared random-access channel. Design incentives and market forces (e.g., increased user traffic) driving 3G system development would have also motivated the POSITA to make this combination. As Frank teaches, random-access techniques were designed to address the "much higher traffic density on random access channels (RACHS)" resulting in "increased collisions and access failures" in 3G systems, such as UMTS. Frank, 1:12-28. The Kaiser-Frank combination is therefore nothing more than a combination of well-known prior-art elements (e.g., Kaiser's FDMA and TDMA access methods and Frank's random-access techniques) according to their established functions, yielding predictable results (e.g., channel/carrier assignment in a system employing FDMA and/or TDMA).

(vi) HiperLAN Standard in combination with the knowledge of a skilled artisan, Kaiser, Walton '944, Walton '269, Walton '301, Ma '437, Ma '546, Jeong '589, Suh '464, Benedittis '812, Kanterakis, Gibson, and/or Frank

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine the HiperLAN Standard with each of these references. A person of ordinary skill in the art would have found it obvious to combine the HiperLAN Standard with, or modify it based on, the disclosures of one or more of

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the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

- HiperLAN Standard, Kaiser, Walton '944, Walton '269, Walton '301, Ma '437, Ma '546, Jeong '589, Suh '464, Benedittis '812, Kanterakis, Gibson, and Frank are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using RACH. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **HiperLAN Standard and Kaiser:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications

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and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Kaiser also discloses techniques to reduce interference. Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-

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carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Kaiser at least because Kaiser provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **HiperLAN Standard and Walton '944:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was

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known in the art as a viable solution. Walton '944 also discloses techniques to reduce interference. Walton '944 describes "an effective and efficient random access scheme for wireless multiple-access communications systems." Walton '944, 1:60-62. "A random access channel (RACH) is defined to comprise a 'fast' RACH (F-RACH) and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Walton '944 at least because Walton '944 provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **HiperLAN Standard and Walton '269:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and

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DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Walton '269 also discloses techniques to reduce interference. Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with

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Walton ’269 at least because Walton ’269 provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **HiperLAN Standard and Walton ’301:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for “anywhere, anytime” communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 (“Between RCHs shall be space for preamble and guard time”). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Walton 301 also discloses techniques to reduce interference. Walton ’301 teaches techniques for reducing RACH interference at the receiving antenna by, for example, employing a beam-steering mode. *See* Walton ’301 at 28:54-67, Table 24. Thus, these references were in the same field

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of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Walton '301 at least because Walton '301 provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **HiperLAN Standard and Ma '437:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Ma '437 also discloses techniques to reduce interference. Ma '437 describes "unsynchronized communication networks, and in

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particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)]." *Id.* at 7:56-8:12. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Ma '437 at least because Ma '437 provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **HiperLAN Standard and Ma '546:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and

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DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Ma '546 also discloses OFDM techniques to reduce interference. Ma '546 teaches and describes "[a] wireless terminal and network terminal . . . for implementing a new uplink OFDM protocol" with two distinct frequency bands for, respectively, "transmitting a low rate mode OFDM transmission" and "a burst-mode transmission[.]" Ma '546 at Abstract. Ma '546 further teaches that a random access channel, RACH, can be "overlaid atop the entire common wireless channel" where it "is transmitted simultaneously both in time and frequency with the other . . . signals by other users." *Id.* at 19:56-61. One goal of the Ma '546 RACH scheme is to reduce interference with other users in the system by using, for example, pseudo-noise ("PN") spreading such that the RACH can be transmitted at a very low power level. *See id.* at 19:62-20:16. Interference between cells is reduced by providing a unique PN code for neighboring base stations. *Id.* at 21:1-5. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Ma '546 at least

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because Ma ’546 provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **HiperLAN Standard and Jeong ’589:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for “anywhere, anytime” communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 (“Between RCHs shall be space for preamble and guard time”). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Jeong ’589 also discloses techniques to reduce interference. Jeong ’589 teaches and describes “a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access (“OFDMA”) type wireless communication

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system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. One goal of Jeong '589 is to "provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Jeong '589 at least because Jeong '589 provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

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- **HiperLAN Standard and Suh '464:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Suh '464 also discloses techniques to reduce interference. Suh '464 teaches and describes "[a] method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system" by "generating a first preamble sequence in which odd data of the preamble sequence becomes null data and even data of the preamble sequence becomes data" and "generating a second preamble sequence in which

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even data of the preamble sequence becomes null data and odd data of the preamble sequence becomes data[.]" Suh '464 at Abstract. Suh '454 further teaches that "[p]referably, a preamble sequence having a low peak-to-average power ratio (PAPR) is used . . . in the OFDM communication system . . . because . . . a high PAPR leads to increased power consumption of a radio frequency (FR) amplifier." *Id.* at [0006]. According to Suh '454, such preambles allow user devices to synchronize with the system: "The UE should be synchronized to a start point of data in order to receive the data, and to this end, the UE must acquire a preamble sequence that is commonly used by all systems for synchronization before receiving signals." *Id.* at [0008]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Suh '454 at least because Suh '454 provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **HiperLAN Standard and Benedittis '812:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard

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describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Benedittis '812 also discloses techniques to reduce interference. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." Benedittis '812 at [0021]. Benedittis '812 has as a further object to optimize assignment of "uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination" throughout the system. *Id.* at [0022]. For example, Benedittis '812 teaches "a random access procedure in a TD-CDMA network," Benedittis '812 at [0023], by "creating complete associative links" between "signature bursts assigned to the serving cell" and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance

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which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Benedittis '812 at least because Benedittis '812 provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **HiperLAN Standard and Kanterakis:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification

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Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Kanterakis also discloses techniques to reduce interference using a guard period. Kanterakis discloses a random-access preamble followed by a guard period that is used in a channel allocation procedure. Kanterakis, 1:12-21, 2:47-54, 7:24-26, 7:56-57, 8:53-65, FIG. 10. As Figure 10 of Kanterakis shows, Kanterakis's random-access frame format includes a preamble, followed by a time interval T_D, followed by a message data portion. Kanterakis also explains how the base station responds with an acknowledgement signal. Kanterakis, 8:54-62. It explains: "[t]here is one acknowledgement message corresponding to each possible preamble signal." *Id.* at 10:63-64. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Kanterakis at least because Kanterakis provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **HiperLAN Standard and Gibson:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for

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broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Gibson also discloses techniques to reduce interference. Gibson is a treatise on mobile communications that "covers the entire field—from principles of analog and digital communications to cordless telephones, wireless local area networks (LANs), and international technology standards." Gibson, 0003. Gibson, for example, discloses initial channel (or sub-carrier) assignment. Gibson, 0319. As Gibson explains, "[i]n both FDMA and TDMA systems, channels should not be assigned to a mobile on a permanent basis" because such "[a] fixed assignment strategy would either be extremely wasteful of precious bandwidth or highly susceptible to cochannel interference." *Id*. "Instead, channels must be assigned on demand." *Id*. Gibson therefore discloses using "a separate uplink channel on which mobiles can notify the base station of their need for a traffic channel. This uplink channel is referred to as the random-access channel

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because of the type of strategy used to regulate access to it." *Id*. Because the random-access channel is shared for all usersin range of the base station, Gibson explains that "[a] random access protocol is employed to arbitrate access to this channel." Gibson, 0324. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Gibson at least because Gibson provides methods and techniques for initial system access by user equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

- **HiperLAN Standard and Frank:** HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In

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addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Frank also discloses techniques to reduce interference. Like the HiperLAN Standard, Frank is directed to "next generation mobile communications systems, such as . . . Universal Mobile Telecommunications Systems (UMTS)." Frank, 1:12-15. Frank recognized that at the time "the number of calls being made is expected to increase significantly, which will result in much higher traffic density on random access channels (RACHs)" and "in increased collisions and access failures." Frank, 1:18-23. Frank further recognized that these "systems will have to use much faster and flexible random access procedures, in order to increase their access success rates and reduce their access request processing times." Frank, 1:23-26. To meet this demand, Frank describes a random-access technique that improved upon then-existing approaches. Frank, 2:9-5:31. For example, it uses a guard interval: "[a] guard interval is preferably inserted between the preamble and data portion of the frame, which enables detection of the preamble before the data arrives (requiring less buffering)." Frank, 8:19-22. "[D]uring the guard time interval, T_G, the signature detection processing can be performed at the base station receiver . . . and the base station can determine more quickly whether a random access request has been made." Frank, 9:24-27. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine the HiperLAN Standard with Frank at least because Frank provides methods and techniques for initial system access by user

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equipment (such as those disclosed in the HiperLAN Standard) to optimize system resources for initial random access.

(vii) Walton ’944 in combination with the knowledge of a skilled artisan, Kaiser, HiperLAN Standard, Walton ’269, Walton ’301, Ma ’437, Ma ’546, Jeong ’589, Suh ’464, Benedittis ’812, Kanterakis, Gibson, and/or Frank

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Walton ’944 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Walton ’944 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’908 patent was filed. Specifically:

- Walton ’944, Kaiser, HiperLAN Standard, Walton ’944, Walton ’269, Walton ’301, Ma ’437, Ma ’546, Jeong ’589, Suh ’464, Benedittis ’812, Kanterakis, Gibson, and Frank are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using RACH. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols

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and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Walton '944 and Kaiser:** Walton '944 describes "an effective and efficient random access scheme for wireless multiple-access communications systems." Walton '944, 1:60-62. "A random access channel (RACH) is defined to comprise a 'fast' RACH (F-RACH) and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Kaiser also discloses techniques to reduce interference. Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-

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carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '944 with Kaiser at least because Kaiser provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '944) to optimize system resources for initial random access.

- **Walton '944 and HiperLAN Standard:** Walton '944 describes "an effective and eficient random access scheme for wireless multiple-access communications systems." Walton '944, 1:60-62. "A random access channel (RACH) is defined to comprise a 'fast' RACH (F-RACH) and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. HiperLAN Standard also discloses techniques to reduce interference. HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio

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access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable solution. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '944 with the HiperLAN Standard at least because the HiperLAN standard provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '944) to optimize system resources for initial random access.

- **Walton '944 and Walton '269:** Walton '944 describes "an effective and eficient random access scheme for wireless multiple-access communications systems." Walton '944, 1:60-62. "A random access channel (RACH) is defined to comprise a 'fast' RACH (F-RACH) and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the

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next TDD frame." *Id.* at 5:27-30. Walton '269—a reference by the same inventor—also discloses techniques to reduce interference. Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '944 with Walton '269 at least because Walton '269 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '944) to optimize system resources for initial random access.

- **Walton '944 and Walton '301:** Walton '944 describes "an effective and eficient random access scheme for wireless multiple-access communications systems." Walton '944, 1:60-62. "A random access channel (RACH) is defined to comprise a 'fast' RACH (F-RACH) and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at

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5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Walton '301—a reference by the same inventor—also discloses techniques to reduce interference. Walton '301 teaches techniques for reducing RACH interference at the receiving antenna by, for example, employing a beam-steering mode. *See* Walton '301 at 28:54-67, Table 24. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '944 with Walton '301 at least because Walton '301 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '944) to optimize system resources for initial random access.

- **Walton '944 and Ma '437:** Walton '944 describes "an effective and eficient random access scheme for wireless multiple-access communications systems." Walton '944, 1:60-62. "A random access channel (RACH) is defined to comprise a 'fast' RACH (F-RACH) and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Ma '437 also discloses techniques to reduce interference. Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks."

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Ma ’437, 1:16-18. Ma ’437 explains that OFDM symbol prefixes can be used to treat interference: “[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix.” *Id*. at 5:61-64. Ma ’437 also explains how mobile terminals can access base stations in an OFDM network. For example, “a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)].” *Id.* at 7:56-8:12. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton ’944 with Ma ’437 at least because Ma ’437 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton ’944) to optimize system resources for initial random access.

- **Walton ’944 and Ma ’546:** Walton ’944 describes “an effective and eficient random access scheme for wireless multiple-access communications systems.” Walton ’944, 1:60-62. “A random access channel (RACH) is defined to comprise a ‘fast’ RACH (F-RACH) and a ‘slow’ RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton ’944 then uses a guard period: “The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame.” *Id.* at 5:27-30. Ma ’546 also discloses techniques to reduce

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interference. Ma ’546 teaches and describes “[a] wireless terminal and network terminal . . . for implementing a new uplink OFDM protocol” with two distinct frequency bands for, respectively, “transmitting a low rate mode OFDM transmission” and “a burst-mode transmission[.]”Ma ’546 at Abstract. Ma ’546 further teaches that a random access channel, RACH, can be “overlaid atop the entire common wireless channel” where it “is transmitted simultaneously both in time and frequency with the other . . . signals by other users.” *Id.* at 19:56-61. One goal of the Ma ’546 RACH scheme is to reduce interference with other users in the system by using, for example, pseudo-noise (“PN”) spreading such that the RACH can be transmitted at a very low power level. *See id.* at 19:62-20:16. Interference between cells is reduced by providing a unique PN code for neighboring base stations. *Id.* at 21:1-5. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton ’944 with Ma ’546 at least because Ma ’546 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton ’944) to optimize system resources for initial random access.

- **Walton ’944 and Jeong ’589:** Walton ’944 describes “an effective and eficient random access scheme for wireless multiple-access communications systems.” Walton ’944, 1:60-62. “A random access channel (RACH) is defined to comprise a ‘fast’ RACH (F-RACH) and a ‘slow’ RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton ’944 then uses a guard period: “The guard

segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Jeong '589 also discloses techniques to reduce interference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. One goal of Jeong '589 is to "provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these

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references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton ’944 with Jeong ’589 at least because Jeong ’589 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton ’944) to optimize system resources for initial random access.

- **Walton ’944 and Suh ’464:** Walton ’944 describes “an effective and eficient random access scheme for wireless multiple-access communications systems.” Walton ’944, 1:60-62. “A random access channel (RACH) is defined to comprise a ‘fast’ RACH (F-RACH) and a ‘slow’ RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton ’944 then uses a guard period: “The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame.” *Id.* at 5:27-30. Suh ’464 also discloses techniques to reduce interference. Suh ’464 teaches and describes “[a] method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system” by “generating a first preamble sequence in which odd data of the preamble sequence becomes null data and even data of the preamble sequence becomes data” and “generating a second preamble sequence in which even data of the preamble sequence becomes null data and odd data of the preamble sequence becomes data[.]” Suh ’464 at Abstract. Suh ’454 further teaches that “[p]referably, a preamble sequence having a low peak-to-average power ratio

(PAPR) is used . . . in the OFDM communication system . . . because . . . a high PAPR leads to increased power consumption of a radio frequency (FR) amplifier." *Id.* at [0006]. According to Suh '454, such preambles allow user devices to synchronize with the system: "The UE should be synchronized to a start point of data in order to receive the data, and to this end, the UE must acquire a preamble sequence that is commonly used by all systems for synchronization before receiving signals." *Id.* at [0008]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '944 with Suh '464 at least because Suh '464 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '944) to optimize system resources for initial random access.

- **Walton '944 and Benedittis '812:** Walton '944 describes "an effective and eficient random access scheme for wireless multiple-access communications systems." Walton '944, 1:60-62. "A random access channel (RACH) is defined to comprise a 'fast' RACH (F-RACH) and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Benedittis '812 also discloses techniques to reduce interference. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony

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systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." Benedittis '812 at [0021]. Benedittis '812 has as a further object to optimize assignment of "uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination" throughout the system. *Id.* at [0022]. For example, Benedittis '812 teaches "a random access procedure in a TD-CDMA network," Benedittis '812 at [0023], by "creating complete associative links" between "signature bursts assigned to the serving cell" and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '944 with Benedittis '812 at least because Benedittis '812 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '944) to optimize system resources for initial random access.

- **Walton '944 and Kanterakis:** Walton '944 describes "an effective and eficient random access scheme for wireless multiple-access communications systems."

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Walton ’944, 1:60-62. “A random access channel (RACH) is defined to comprise a ‘fast’ RACH (F-RACH) and a ‘slow’ RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton ’944 then uses a guard period: “The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame.” *Id.* at 5:27-30. Kanterakis also discloses techniques to reduce interference using a guard period. Kanterakis discloses a random-access preamble followed by a guard period that is used in a channel allocation procedure. Kanterakis, 1:12-21, 2:47-54, 7:24-26, 7:56-57, 8:53-65, FIG. 10. As Figure 10 of Kanterakis shows, Kanterakis’s random-access frame format includes a preamble, followed by a time interval T_D, followed by a message data portion. Kanterakis also explains how the base station responds with an acknowledgement signal. Kanterakis, 8:54-62. It explains: “[t]here is one acknowledgement message corresponding to each possible preamble signal.” *Id.* at 10:63-64. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton ’944 with Kanterakis at least because Kanterakis provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton ’944) to optimize system resources for initial random access.

- **Walton ’944 and Gibson:** Walton ’944 describes “an effective and eficient random access scheme for wireless multiple-access communications systems.” Walton ’944, 1:60-62. “A random access channel (RACH) is defined to comprise a ‘fast’ RACH

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(F-RACH) and a 'slow' RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Gibson also discloses techniques to reduce interference. Gibson is a treatise on mobile communications that "covers the entire field—from principles of analog and digital communications to cordless telephones, wireless local area networks (LANs), and international technology standards." Gibson, 0003. Gibson, for example, discloses initial channel (or sub-carrier) assignment. Gibson, 0319. As Gibson explains, "[i]n both FDMA and TDMA systems, channels should not be assigned to a mobile on a permanent basis" because such "[a] fixed assignment strategy would either be extremely wasteful of precious bandwidth or highly susceptible to cochannel interference." *Id*. "Instead, channels must be assigned on demand." *Id*. Gibson therefore discloses using "a separate uplink channel on which mobiles can notify the base station of their need for a traffic channel. This uplink channel is referred to as the random-access channel because of the type of strategy used to regulate access to it." *Id*. Because the random-access channel is shared for all usersin range of the base station, Gibson explains that "[a] random access protocol is employed to arbitrate access to this channel." Gibson, 0324. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '944 with Gibson at least because Gibson provides methods and

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techniques for initial system access by user equipment (such as those disclosed in Walton ’944) to optimize system resources for initial random access.

- **Walton ’944 and Frank:** Walton ’944 describes “an effective and eficient random access scheme for wireless multiple-access communications systems.” Walton ’944, 1:60-62. “A random access channel (RACH) is defined to comprise a ‘fast’ RACH (F-RACH) and a ‘slow’ RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton ’944 then uses a guard period: “The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame.” *Id.* at 5:27-30. Frank also discloses techniques to reduce interference. Like Walton ’944, Frank is directed to “next generation mobile communications systems, such as . . . Universal Mobile Telecommunications Systems (UMTS).” Frank, 1:12-15. Frank recognized that at the time “the number of calls being made is expected to increase significantly, which will result in much higher traffic density on random access channels (RACHs)” and “in increased collisions and access failures.” Frank, 1:18-23. Frank further recognized that these “systems will have to use much faster and flexible random access procedures, in order to increase their access success rates and reduce their access request processing times.” Frank, 1:23-26. To meet this demand, Frank describes a random-access technique that improved upon then-existing approaches. Frank, 2:9-5:31. For example, it uses a guard interval: “[a] guard interval is preferably inserted between the preamble and data portion of the frame, which enables detection of the

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preamble before the data arrives (requiring less buffering)." Frank, 8:19-22. "[D]uring the guard time interval, T_G, the signature detection processing can be performed at the base station receiver . . . and the base station can determine more quickly whether a random access request has been made." Frank, 9:24-27. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '944 with Frank at least because Frank provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '944) to optimize system resources for initial random access.

(viii) Walton '269 in combination with the knowledge of a skilled artisan, Kaiser, HiperLAN Standard, Walton '944, Walton '301, Ma '437, Ma '546, Jeong '589, Suh '464, Benedittis '812, Kanterakis, Gibson, and/or Frank

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Walton '269 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Walton '269 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

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- Walton ’269, Kaiser, HiperLAN Standard, Walton ’944, Walton ’301, Ma ’437, Ma ’546, Jeong ’589, Suh ’464, Benedittis ’812, Kanterakis, Gibson, and Frank are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using RACH. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Walton ’269 and Kaiser:** Walton ’269 discloses a broadcast channel (BCH), which is “[u]sed by the access point to transmit pilot and system parameters to the user terminals.” Walton ’269, 8:55-56. It discloses “an exemplary BCH message format,” which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. “The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame.” *Id.* at 13:41-44. Walton ’269 also discloses an “RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . .” *Id.* at 16:9-22. “The timing adjustment is used to reduce interference in a TDD-based frame structure . . . .” *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Kaiser also discloses

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techniques to reduce interference. Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Kaiser at least because Kaiser provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

- **Walton '269 and HiperLAN Standard:** Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next

TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. HiperLAN Standard also discloses techniques to reduce interference. HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable

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solution. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton ’269 with the HiperLAN Standard at least because the HiperLAN Standard provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton ’269) to optimize system resources for initial random access.

- **Walton ’269 and Walton ’944:** Walton ’269 discloses a broadcast channel (BCH), which is “[u]sed by the access point to transmit pilot and system parameters to the user terminals.” Walton ’269, 8:55-56. It discloses “an exemplary BCH message format,” which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. “The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame.” *Id.* at 13:41-44. Walton ’269 also discloses an “RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . .” *Id.* at 16:9-22. “The timing adjustment is used to reduce interference in a TDD-based frame structure . . . .” *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Walton ’944 also discloses techniques to reduce interference. Walton ’944 describes “an effective and eficient random access scheme for wireless multiple-access communications systems.” Walton ’944, 1:60-62. “A random access channel (RACH) is defined to comprise a ‘fast’ RACH (F-RACH) and a ‘slow’ RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at

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5:19-27. To reduce interference, Walton '944 then uses a guard period: "The guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Walton '944 at least because Walton '944 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

- **Walton '269 and Walton '301:** Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Walton '301—a reference by the same inventor—also discloses techniques to reduce interference. Walton '301 teaches techniques for reducing RACH interference at the receiving

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antenna by, for example, employing a beam-steering mode. *See* Walton '301 at 28:54-67, Table 24. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Walton '301 at least because Walton '301 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

- **Walton '269 and Ma '437:** Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Ma '437 also discloses techniques to reduce interference. Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring

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broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)]." *Id.* at 7:56-8:12. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Ma '437 at least because Ma '437 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

- **Walton '269 and Ma '546:** Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce

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interference and propagation delay within the network. Ma '546 also discloses techniques to reduce interference. Ma '546 teaches and describes "[a] wireless terminal and network terminal . . . for implementing a new uplink OFDM protocol" with two distinct frequency bands for, respectively, "transmitting a low rate mode OFDM transmission" and "a burst-mode transmission[.]" Ma '546 at Abstract. Ma '546 further teaches that a random access channel, RACH, can be "overlaid atop the entire common wireless channel" where it "is transmitted simultaneously both in time and frequency with the other . . . signals by other users." *Id.* at 19:56-61. One goal of the Ma '546 RACH scheme is to reduce interference with other users in the system by using, for example, pseudo-noise ("PN") spreading such that the RACH can be transmitted at a very low power level. *See id.* at 19:62-20:16. Interference between cells is reduced by providing a unique PN code for neighboring base stations. *Id.* at 21:1-5. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Ma '546 at least because Ma '546 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

- **Walton '269 and Jeong '589:** Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time

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between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Jeong '589 also discloses techniques to reduce interference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system in a point-to-multipoint broadband wireless access ("BWA") system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process." Jeong '589 at Abstract. One goal of Jeong '589 is to "provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself." *Id.* at 4. To achieve this goal, the method "is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel,

and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time." *Id.* Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Jeong '589 at least because Jeong '589 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

- **Walton '269 and Suh '464:** Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Suh '464 also discloses techniques to reduce interference. Suh '464 teaches and describes "[a] method for

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generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system" by "generating a first preamble sequence in which odd data of the preamble sequence becomes null data and even data of the preamble sequence becomes data" and "generating a second preamble sequence in which even data of the preamble sequence becomes null data and odd data of the preamble sequence becomes data[.]" Suh '464 at Abstract. Suh '454 further teaches that "[p]referably, a preamble sequence having a low peak-to-average power ratio (PAPR) is used . . . in the OFDM communication system . . . because . . . a high PAPR leads to increased power consumption of a radio frequency (FR) amplifier." *Id.* at [0006]. According to Suh '454, such preambles allow user devices to synchronize with the system: "The UE should be synchronized to a start point of data in order to receive the data, and to this end, the UE must acquire a preamble sequence that is commonly used by all systems for synchronization before receiving signals." *Id.* at [0008]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Suh '464 at least because Suh '464 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

- **Walton '269 and Benedittis '812:** Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH

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message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Benedittis also discloses techniques to reduce interference. Benedittis '812 teaches and describes "a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization." Benedittis '812 at Abstract. Benedittis '812 achieves this optimization object by "minimizing the overall time and effort spent before entering the dedicated channel." Benedittis '812 at [0021]. Benedittis '812 has as a further object to optimize assignment of "uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination" throughout the system. *Id.* at [0022]. For example, Benedittis '812 teaches "a random access procedure in a TD-CDMA network," Benedittis '812 at [0023], by "creating complete associative links" between "signature bursts assigned to the serving cell" and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize "access to shared channels P-RACH, as the network knows in advance

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which physical channel will be selected by the mobile station for the next transmitted message (Channel Request)." *Id.* at [0030]-[0031]. Further, it will "limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel." *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Benedittis '812 at least because Benedittis '812 provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

- **Walton '269 and Kanterakis:** Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Kanterakis also discloses techniques to reduce interference. Kanterakis also discloses techniques to reduce

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interference using a guard period. Kanterakis discloses a random-access preamble followed by a guard period that is used in a channel allocation procedure. Kanterakis, 1:12-21, 2:47-54, 7:24-26, 7:56-57, 8:53-65, FIG. 10. As Figure 10 of Kanterakis shows, Kanterakis's random-access frame format includes a preamble, followed by a time interval T_D, followed by a message data portion. Kanterakis also explains how the base station responds with an acknowledgement signal. Kanterakis, 8:54-62. It explains: "[t]here is one acknowledgement message corresponding to each possible preamble signal." *Id.* at 10:63-64. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Kanterakis at least because Kanterakis provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

- **Walton '269 and Gibson:** Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA

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would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Gibson also discloses techniques to reduce interference. Gibson is a treatise on mobile communications that "covers the entire field—from principles of analog and digital communications to cordless telephones, wireless local area networks (LANs), and international technology standards." Gibson, 0003. Gibson, for example, discloses initial channel (or sub-carrier) assignment. Gibson, 0319. As Gibson explains, "[i]n both FDMA and TDMA systems, channels should not be assigned to a mobile on a permanent basis" because such "[a] fixed assignment strategy would either be extremely wasteful of precious bandwidth or highly susceptible to cochannel interference." *Id*. "Instead, channels must be assigned on demand." *Id*. Gibson therefore discloses using "a separate uplink channel on which mobiles can notify the base station of their need for a traffic channel. This uplink channel is referred to as the random-access channel because of the type of strategy used to regulate access to it." *Id*. Because the random-access channel is shared for all usersin range of the base station, Gibson explains that "[a] random access protocol is employed to arbitrate access to this channel." Gibson, 0324. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Gibson at least because Gibson provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

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- **Walton ’269 and Frank:** Walton ’269 discloses a broadcast channel (BCH), which is “[u]sed by the access point to transmit pilot and system parameters to the user terminals.” Walton ’269, 8:55-56. It discloses “an exemplary BCH message format,” which includes a RACH Guard interval at the end of the RACH. *Id.* at 12:36-13:10. “The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame.” *Id.* at 13:41-44. Walton ’269 also discloses an “RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . .” *Id.* at 16:9-22. “The timing adjustment is used to reduce interference in a TDD-based frame structure . . . .” *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Frank also discloses techniques to reduce interference. Like Walton ’269, Frank is directed to “next generation mobile communications systems, such as . . . Universal Mobile Telecommunications Systems (UMTS).” Frank, 1:12-15. Frank recognized that at the time “the number of calls being made is expected to increase significantly, which will result in much higher traffic density on random access channels (RACHs)” and “in increased collisions and access failures.” Frank, 1:18-23. Frank further recognized that these “systems will have to use much faster and flexible random access procedures, in order to increase their access success rates and reduce their access request processing times.” Frank, 1:23-26. To meet this demand, Frank describes a random-access technique that improved upon then-existing approaches. Frank, 2:9-5:31. For example, it uses a guard interval: “[a] guard interval is

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preferably inserted between the preamble and data portion of the frame, which enables detection of the preamble before the data arrives (requiring less buffering)." Frank, 8:19-22. "[D]uring the guard time interval, T_G, the signature detection processing can be performed at the base station receiver . . . and the base station can determine more quickly whether a random access request has been made." Frank, 9:24-27. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Walton '269 with Frank at least because Frank provides methods and techniques for initial system access by user equipment (such as those disclosed in Walton '269) to optimize system resources for initial random access.

(ix) Ma '437 in combination with the knowledge of a skilled artisan, Kaiser, HiperLAN Standard, Walton '944, Walton '269, Walton '301, Ma '546, Jeong '589, Suh '464, Benedittis '812, Kanterakis, Gibson, and/or Frank

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Ma '437 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Ma '437 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed

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disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

- Ma '437, Kaiser, HiperLAN Standard, Walton '944, Walton '269, Walton '301, Ma '546, Jeong '589, Suh '464, Benedittis '812, Kanterakis, Gibson, and Frank are all directed to systems and methods for transmitting information in a wireless packet system and disclose random access processes, including using RACH. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Ma '437 and Kaiser:** Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock

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onto a serving BTS [(base transceiver station)]." *Id.* at 7:56-8:12. Kaiser also discloses techniques to reduce interference. Kaiser discloses a system and "multiple access scheme designed for mobile multi-media applications" that "is referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA) and exploits the advantages given by the combination of the spread-spectrum technique with multi-carrier modulation." Kaiser, 0001. Kaiser explains that the system is "a good candidate for the future universal mobile telecommunications systems (UMTS). Kaiser, 0001, Abstract. Kaiser also discloses that its "SS-MC-MA separates the users' signals according to an FDMA scheme on [the] sub-carrier level," which advantageously "avoids multiple access interference (MAI) within a cell." Kaiser, 0001, Abstract. To avoid interference, Kaiser's "SS-MC-MA assigns each user exclusively its own sub-carriers according to an FDMA scheme," which is based on OFDM. Kaiser, 0001-04, FIGS. 1, 2, 4. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Kaiser at least because Kaiser provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

- **Ma '437 and HiperLAN Standard:** Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper

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design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)]." *Id.* at 7:56-8:12. The HiperLAN Standard also discloses techniques to reduce interference. HiperLAN is a standard based on OFDM and was publicly available for European Telecommunications Standards Institute (ETSI) members and non-members. *See* HiperLAN/2 DLC Specification Part 1, pp. 7, 14. At the time, increasing demand for "anywhere, anytime" communications and the merging of voice, video, and data communications created a demand for broadband wireless networks. In response to this demand, ETSI created the BRAN project to develop standards and specifications—including HiperLAN—for broadband radio access networks. The HiperLAN Standard describes the PHY and DLC layers, which are core network independent, and the core network specific convergence layer. As taught throughout the specifications, the HiperLAN Standard uses techniques to reduce interference from the increase in demand traffic. For example, the HiperLAN Standard uses a guard period in the frequency band between random access channels (RCH). *See, e.g.*, HiperLAN/2 DLC Specification Part 1, p. 52 ("Between RCHs shall be space for preamble and guard time"). In addition to reducing interference, this guard period was designed to cope with propagation delay. *Id.* at 86. Accordingly, this guard time between RCHs was known in the art as a viable

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solution. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma ’437 with the HiperLAN Standard at least because the HiperLAN Standard provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma ’437) to optimize system resources for initial random access.

- **Ma ’437 and Walton ’944:** Ma ’437 describes “unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks.” Ma ’437, 1:16-18. Ma ’437 explains that OFDM symbol prefixes can be used to treat interference: “[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix.” *Id*. at 5:61-64. Ma ’437 also explains how mobile terminals can access base stations in an OFDM network. For example, “a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)].” *Id.* at 7:56-8:12. Walton ’944 also discloses techniques to reduce interference. Walton ’944 describes “an effective and eficient random access scheme for wireless multiple-access communications systems.” Walton ’944, 1:60-62. “A random access channel (RACH) is defined to comprise a ‘fast’ RACH (F-RACH) and a ‘slow’ RACH (S-RACH). *Id*., Abstract. The F-RACH segment is the first segment in the RACH, followed by the S-RACH. *Id.* at 5:19-27. To reduce interference, Walton ’944 then uses a guard period: “The

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guard segment follows the S-RACH segment and is used to prevent S-RACH transmissions from interfering with the downlink transmission for the BCH in the next TDD frame." *Id.* at 5:27-30. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Walton '944 at least because Walton '944 provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

- **Ma '437 and Walton '269:** Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)]." *Id.* at 7:56-8:12. Walton '269 also discloses techniques to reduce interference. Walton '269 discloses a broadcast channel (BCH), which is "[u]sed by the access point to transmit pilot and system parameters to the user terminals." Walton '269, 8:55-56. It discloses "an exemplary BCH message format," which includes a RACH Guard interval at the end of the

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RACH. *Id.* at 12:36-13:10. "The RACH Guard Interval field indicates the amount of time between the last RACH slot and the start of the BCH segment for the next TDD frame." *Id.* at 13:41-44. Walton '269 also discloses an "RCH Timing Adjustment field [that] includes two bits used to adjust the timing of the uplink transmission from the user terminal . . . ." *Id.* at 16:9-22. "The timing adjustment is used to reduce interference in a TDD-based frame structure . . . ." *Id.* at 16:23-25. As a POSITA would have understood, these guard intervals and timing adjustments would reduce interference and propagation delay within the network. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Walton '269 at least because Walton '269 provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

- **Ma '437 and Walton '301:** Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock

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onto a serving BTS [(base transceiver station)]." *Id.* at 7:56-8:12. Walton '301 also discloses techniques to reduce interference. Walton '301 teaches techniques for reducing RACH interference at the receiving antenna by, for example, employing a beam-steering mode. *See* Walton '301 at 28:54-67, Table 24. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Walton '301 at least because Walton '301 provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

- **Ma '437 and Ma '546:** Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)]." *Id.* at 7:56-8:12. Ma '546—a reference by the same inventor—also discloses techniques to reduce interference. Ma '546 teaches and describes "[a] wireless terminal and network terminal . . . for implementing a new uplink OFDM protocol" with two distinct frequency bands for,

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respectively, "transmitting a low rate mode OFDM transmission" and "a burst-mode transmission[.]" Ma '546 at Abstract. Ma '546 further teaches that a random access channel, RACH, can be "overlaid atop the entire common wireless channel" where it "is transmitted simultaneously both in time and frequency with the other . . . signals by other users." *Id.* at 19:56-61. One goal of the Ma '546 RACH scheme is to reduce interference with other users in the system by using, for example, pseudo-noise ("PN") spreading such that the RACH can be transmitted at a very low power level. *See id.* at 19:62-20:16. Interference between cells is reduced by providing a unique PN code for neighboring base stations. *Id.* at 21:1-5. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Ma '546 at least because Ma '546 provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

- **Ma '437 and Jeong '589:** Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization,

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and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)].” *Id.* at 7:56-8:12. Jeong ’589 also discloses techniques to reduce interference. Jeong ’589 teaches and describes “a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access (“OFDMA”) type wireless communication system in a point-to-multipoint broadband wireless access (“BWA”) system. To this end, the present invention designates several specific time slots composed of a predetermined number of OFDM symbols as the initial ranging interval in the MAC in order to remove interference on the data sub-channel arising from the long ranging sub-channel during the initial ranging process.” Jeong ’589 at Abstract. One goal of Jeong ’589 is to “provide [a] ranging interval and ranging sub-channel allocation method for initial ranging in OFDMA wireless communication system capable of allowing the subscriber station to perform the transmission operation in advance of a predetermined transmission time by the processing delay of the subscriber station itself.” *Id.* at 4. To achieve this goal, the method “is characterized by including the processes of: receiving system information necessary for initial ranging including a reception interval of the ranging signal from the base station through a predetermined broadcast channel, and determining an arbitrary ranging sub-channel and a ranging code from the system information class; and adjusting a transmission time of an initial ranging signal in consideration of a processing delay time for initial ranging, and transmitting the initial ranging signal using the ranging sub-channel and the ranging code at the adjusted transmission time.” *Id.* Thus, these references were in the same

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field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma ’437 with Jeong ’589 at least because Jeong ’589 provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma ’437) to optimize system resources for initial random access.

- **Ma ’437 and Suh ’464:** Ma ’437 describes “unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks.” Ma ’437, 1:16-18. Ma ’437 explains that OFDM symbol prefixes can be used to treat interference: “[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix.” *Id*. at 5:61-64. Ma ’437 also explains how mobile terminals can access base stations in an OFDM network. For example, “a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)].” *Id.* at 7:56-8:12. Suh ’464 also discloses techniques to reduce interference. Suh ’464 teaches and describes “[a] method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system” by “generating a first preamble sequence in which odd data of the preamble sequence becomes null data and even data of the preamble sequence becomes data” and “generating a second preamble sequence in which even data of the preamble sequence becomes null data and odd

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data of the preamble sequence becomes data[.]" Suh '464 at Abstract. Suh '454 further teaches that "[p]referably, a preamble sequence having a low peak-to-average power ratio (PAPR) is used . . . in the OFDM communication system . . . because . . . a high PAPR leads to increased power consumption of a radio frequency (FR) amplifier." *Id.* at [0006]. According to Suh '454, such preambles allow user devices to synchronize with the system: "The UE should be synchronized to a start point of data in order to receive the data, and to this end, the UE must acquire a preamble sequence that is commonly used by all systems for synchronization before receiving signals." *Id.* at [0008]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Suh '464 at least because Suh '464 provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

- **Ma '437 and Benedittis '812:** Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization,

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and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)].” *Id.* at 7:56-8:12. Benedittis ’812 also discloses techniques to reduce interference. Benedittis ’812 teaches and describes “a method for optimizing [sic] the random access procedures in third generation CDMA cellular telephony systems. The particular embodiment of the example concerns a TD-SCDMA-TDD synchronous realization.” Benedittis ’812 at Abstract. Benedittis ’812 achieves this optimization object by “minimizing the overall time and effort spent before entering the dedicated channel.” Benedittis ’812 at [0021]. Benedittis ’812 has as a further object to optimize assignment of “uplink and downlink synchronization sequences, as well as midambles and scrambling codes for cell discrimination” throughout the system. *Id.* at [0022]. For example, Benedittis ’812 teaches “a random access procedure in a TD-CDMA network,” Benedittis ’812 at [0023], by “creating complete associative links” between “signature bursts assigned to the serving cell” and various channels for data transmission. *See* Benedittis at [0024]-[0029]. This series of associative links serves to optimize “access to shared channels P-RACH, as the network knows in advance which physical channel will be selected by the mobile station for the next transmitted message (Channel Request).” *Id.* at [0030]-[0031]. Further, it will “limit[] collisions on the shared channels (P-RACH) at the benefit of the incoming mobile stations as well as of the other users which may be co-located with that specific shared channel.” *Id.* at [0032]. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma ’437 with Benedittis ’812

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at least because Benedittis ’812 provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma ’437) to optimize system resources for initial random access.

- **Ma ’437 and Kanterakis:** Ma ’437 describes “unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks.” Ma ’437, 1:16-18. Ma ’437 explains that OFDM symbol prefixes can be used to treat interference: “[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix.” *Id*. at 5:61-64. Ma ’437 also explains how mobile terminals can access base stations in an OFDM network. For example, “a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)].” *Id.* at 7:56-8:12. Kanterakis also discloses techniques to reduce interference using a guard period. Kanterakis discloses a random-access preamble followed by a guard period that is used in a channel allocation procedure. Kanterakis, 1:12-21, 2:47-54, 7:24-26, 7:56-57, 8:53-65, FIG. 10. As Figure 10 of Kanterakis shows, Kanterakis’s random-access frame format includes a preamble, followed by a time interval T_D, followed by a message data portion. Kanterakis also explains how the base station responds with an acknowledgement signal. Kanterakis, 8:54-62. It explains: “[t]here is one acknowledgement message corresponding to each possible preamble signal.” *Id.* at 10:63-64. Thus, these references were in the same field of endeavor and shared at

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least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Kanterakis at least because Kanterakis provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

- **Ma '437 and Gibson:** Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)]." *Id.* at 7:56-8:12. Gibson also discloses techniques to reduce interference. Gibson is a treatise on mobile communications that "covers the entire field—from principles of analog and digital communications to cordless telephones, wireless local area networks (LANs), and international technology standards." Gibson, 0003. Gibson, for example, discloses initial channel (or sub-carrier) assignment. Gibson, 0319. As Gibson explains, "[i]n both FDMA and TDMA systems, channels should not be assigned to a mobile on a permanent basis" because such "[a] fixed assignment strategy would either be extremely wasteful of precious bandwidth or highly susceptible to cochannel

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interference." *Id*. "Instead, channels must be assigned on demand." *Id*. Gibson therefore discloses using "a separate uplink channel on which mobiles can notify the base station of their need for a traffic channel. This uplink channel is referred to as the random-access channel because of the type of strategy used to regulate access to it." *Id*. Because the random-access channel is shared for all usersin range of the base station, Gibson explains that "[a] random access protocol is employed to arbitrate access to this channel." Gibson, 0324. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Gibson at least because Gibson provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

- **Ma '437 and Frank:** Ma '437 describes "unsynchronized communication networks, and in particular to physical layer structures and access schemes for use in such networks." Ma '437, 1:16-18. Ma '437 explains that OFDM symbol prefixes can be used to treat interference: "[I]nterference from neighboring broadcast stations is treated as an active echo, which can be handled by the proper design of the OFDM symbol prefix." *Id*. at 5:61-64. Ma '437 also explains how mobile terminals can access base stations in an OFDM network. For example, "a mobile terminal first performs a network search by synchronizing to the common synchronization code to establish the correct timing and frame/slot synchronization, and then performs a cell search for the cell-specific synchronization code to lock onto a serving BTS [(base transceiver station)]." *Id.* at 7:56-8:12. Frank also

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discloses techniques to reduce interference. Like Ma '437, Frank is directed to "next generation mobile communications systems, such as . . . Universal Mobile Telecommunications Systems (UMTS)." Frank, 1:12-15. Frank recognized that at the time "the number of calls being made is expected to increase significantly, which will result in much higher traffic density on random access channels (RACHs)" and "in increased collisions and access failures." Frank, 1:18-23. Frank further recognized that these "systems will have to use much faster and flexible random access procedures, in order to increase their access success rates and reduce their access request processing times." Frank, 1:23-26. To meet this demand, Frank describes a random-access technique that improved upon then-existing approaches. Frank, 2:9-5:31. For example, it uses a guard interval: "[a] guard interval is preferably inserted between the preamble and data portion of the frame, which enables detection of the preamble before the data arrives (requiring less buffering)." Frank, 8:19-22. "[D]uring the guard time interval, T_G, the signature detection processing can be performed at the base station receiver . . . and the base station can determine more quickly whether a random access request has been made." Frank, 9:24-27. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine Ma '437 with Frank at least because Frank provides methods and techniques for initial system access by user equipment (such as those disclosed in Ma '437) to optimize system resources for initial random access.

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(x) IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems—Amendment 2: Medium Access Control Modification and Additional Physical Layer Specifications for 2-11 GHz, IEEE 802.16a-2003 ("WiMAX 2003") in combination with the knowledge of a skilled artisan, Walton '301, Ma '546, Suh '464, Walton '705, C802.16e-03/53r2, Engstrom '436, Wahlqvist, Kanemoto '414, Li '422, and/or Lee '481

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine WiMAX 2003 with each of these references. A person of ordinary skill in the art would have found it obvious to combine WiMAX 2003 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

- Walton '301, Ma '546, Suh '464, Walton '705, C802.16e-03/53r2, Engstrom '436, Wahlqvist, Kanemoto '414, Li '422, and Lee '481 are all directed to systems and methods for initial random access and synchronization by mobile devices in a communication system. For example, they relate to wireless communications, and in particular to uplink communication and resource allocation for initial mobile device access and synchronization. They involve communication protocols and

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standards, transmission methods (e.g., OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **WiMAX 2003 and Walton '301:** Walton '301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '301 teaches and describes techniques for reducing RACH interference at the receiving antenna by, for example, employing a beam-steering mode. *See* Walton '301 at 28:54-67, Table 24. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. These references were therefore in the same field of endeavor and share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine WiMAX 2003 with Walton '301 at least because Walton '301 teaches methods and techniques for reducing inter-channel interference in order to optimize system resources and maintain quality of service (e.g. in the WiMAX 2003 standard). Finally, the proposed combination of WiMAX 2003 and Walton '301 would involve nothing more than incorporating well-known concepts (i.e., Walton '301's teaching of reducing

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RACH interference) into a well-known system (i.e., WiMAX 2003's OFDM system).

- **WiMAX 2003 and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 teaches and describes "[a] wireless terminal and network terminal . . . for implementing a new uplink OFDM protocol" with two distinct frequency bands for, respectively, "transmitting a low rate mode OFDM transmission" and "a burst-mode transmission[.]" Ma '546 at Abstract. Ma '546 further teaches that a random access channel, RACH, can be "overlaid atop the entire common wireless channel" where it "is transmitted simultaneously both in time and frequency with the other . . . signals by other users." *Id.* at 19:56-61. One goal of the Ma '546 RACH scheme is to reduce interference with other users in the system by using, for example, pseudo-noise ("PN") spreading such that the RACH can be transmitted at a very low power level. *See id.* at 19:62-20:16. Interference between cells is reduced by providing a unique PN code for neighboring base stations. *Id.* at 21:1-5. These references were therefore in the same field of endeavor and share at least the goal of reducing interference between the RACH and other uplink signals. It would have been obvious for a POSITA to combine WiMAX 2003 with Ma '546 at least because WiMAX 2003 provides methods and techniques for reducing inter-channel interference (such as those disclosed in Ma '546) in order to optimize system resources and maintain quality of service. Finally, the proposed combination of WiMAX 2003 and Ma '546 would involve nothing more than incorporating well-known concepts (i.e., Ma '546's RACH scheme that reduces interference with other

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users in the system) into a well-known system (i.e., WiMAX 2003's OFDM system).

- **WiMAX 2003 and Suh '464:** Suh '464 teaches and describes "[a] method for generating a preamble sequence for decreasing a peak-to-average power ratio (PAPR) through at least two antennas in an orthogonal frequency division multiplexing (OFDM) communication system" by "generating a first preamble sequence in which odd data of the preamble sequence becomes null data and even data of the preamble sequence becomes data" and "generating a second preamble sequence in which even data of the preamble sequence becomes null data and odd data of the preamble sequence becomes data[.]" Suh '464 at Abstract. Suh '464 further teaches that "[p]referably, a preamble sequence having a low peak-to-average power ratio (PAPR) is used . . . in the OFDM communication system . . . because . . . a high PAPR leads to increased power consumption of a radio frequency (FR) amplifier." *Id.* at [0006]. According to Suh '464, such preambles allow user devices to synchronize with the system: "The UE should be synchronized to a start point of data in order to receive the data, and to this end, the UE must acquire a preamble sequence that is commonly used by all systems for synchronization before receiving signals." *Id.* at [0008]. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at

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https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine WiMAX 2003 with Suh '464 at least because WiMAX 2003 provides methods and techniques for initial system access by user equipment (such as those disclosed in Suh '464) in order to optimize system resources for initial random access. Finally, the proposed combination of WiMAX 2003 and Suh '464 would involve nothing more than incorporating well-known concepts (i.e., Suh '464's preamble sequence) into a well-known system (i.e., WiMAX 2003's OFDM system).

- **WiMAX 2003 and Walton '705:** Walton '705 teaches and describes "[t]ransmitter and receiver units for use in a communications system and configurable to provide antenna, frequency, or temporal diversity, or a combination thereof, for transmitted signals." Walton '705 at Abstract. In particular, Walton '705 describes "a . . . communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility." *Id.* at [0002]. The system described by Walton '705 was intended to increase efficiency by improving support for both voice and data services. *Id.* at [0011]. According to Walton '705, "it is a challenge to design a communications system capable of efficiently supporting both voice and data services" because of differences in the two data streams. *Id.* at [0006]-[0010]. To address this difficulty, Walton '705 provides a configurable transmitter "that includes a system data processor, one or more modulators, and one or more antennas." *Id.* at [0013]. The system data processor can include one or more encoders that generate a channel data stream, which is

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modulated using multi-carrier modulation (e.g., orthogonal frequency division multiplexing (ODFM) modulation)." *Id.* at [0015]-[0016]. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine WiMAX 2003 with Walton '705 at least because WiMAX 2003 provides methods and techniques for modulating data (such as those disclosed in Walton '705) in order to improve system service, throughput, and reliability. Finally, the proposed combination of WiMAX 2003 and Walton '705 would involve nothing more than incorporating well-known concepts (i.e., Walton '705's multi-carrier modulation scheme) into a well-known system (i.e., WiMAX 2003's OFDM system).

- **WiMAX 2003 and C802.16e-03/53r2:** C802.16e-03/53r2 teaches and describes "a modification to the initial ranging transmission . . . to improve the initial ranging performance." C802.16e-03/53r2 at 1. C802.16e-03/53r2 has as its object reducing interference between multiple subscriber stations ("SS") transmitting a simultaneous or near-simultaneous initial ranging signal, while also reducing required system resources for initial ranging. *Id.* at 2. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and

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OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Thus, these references were in the same field of endeavor and shared at least a set of techniques for establishing a random access (initial rangin) protocol for wireless communication systems. It would have been obvious for a POSITA to combine WiMAX 2003 with C802.16e-03/53r2 at least because WiMAX 2003 provides methods and techniques for initial random access (such as those disclosed in C802.16e-03/53r2) in order to minimize system resource usage and facilitate efficient system access. Finally, the proposed combination of WiMAX 2003 and C802.16e-03/53r2 would involve nothing more than incorporating well-known concepts (i.e., C802.16e-03/53r2's initial ranging scheme) into a well-known system (i.e., WiMAX 2003's OFDM system).

- **WiMAX 2003 and Engstrom '436:** Engstrom '436 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Engstrom '436 teaches and describes "[a] random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital radio communication system, including the steps of cyclically repeating a random access sequence and transmitting each cyclically repeated random access sequence in an orthogonal frequency division multiplex format from the mobile station as an uplink transmission." Engstrom '436 at Abstract. One

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goal of Engstrom ’436 is “to facilitate connection of a mobile station to a base station upon call initiation or upon call handover.” *Id.* at 2:45-47. WiMAX 2003 teaches and describes that “the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station.” WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a “contention slot for initial ranging,” followed by a “contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Thus, these references were in the same field of endeavor and shared at least the goal of facilitating system access by mobile devices. It would have been obvious for a POSITA to combine WiMAX 2003 with Engstrom ’436 at least because WiMAX 2003 provides methods and techniques for random access (such as those disclosed in Engstrom ’436) in order to facilitate efficient, seamless system access and resource allocation. Finally, the proposed combination of WiMAX 2003 and Engstrom ’436 would involve nothing more than incorporating well-known concepts (i.e., Engstrom ’436’s cyclically repeated random access sequence) into a well-known system (i.e., WiMAX 2003’s OFDM system).

- **WiMAX 2003 and Wahlqvist:** Wahlqvist is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wahlqvist teaches and describes “a new scheme for initial [uplink] time synchronisation [sic]” with “a random access protocol [that] will have good performance in a mobile radio environment.” Wahlqvist at 1569 (Abstract). As described by Wahlqvist, the base station and mobile station must by synchronized in both time and frequency to

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maintain the orthogonality that is characteristic of OFDM systems. *Id.* at 1569. Any loss or lack of synchronization can lead to interference between subcarriers, reducing system performance. *Id.* It is therefore a goal of Wahlqvist to reduce inter symbol interference by providing a random access protocol that is cyclically repeated. *Id.* at 1570. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Thus, these references were in the same field of endeavor and shared at least the goal of improving initial system access. It would have been obvious for a POSITA to combine WiMAX 2003 with Wahlqvist at least because WiMAX 2003 provides methods and techniques for reducing interference between symbols (such as those disclosed in Wahlqvist) in order to improve system performance. Finally, the proposed combination of WiMAX 2003 and Wahlqvist would involve nothing more than incorporating well-known concepts (i.e., Wahlqvist's initial time synchronization scheme) into a well-known system (i.e., WiMAX 2003's OFDM system).

- **WiMAX 2003 and Kanemoto '414:** Kanemoto '414 teaches and describes systems and methods directed to improving spectral efficiency "by assigning only a small number of subcarriers to an access channel as compared with a traffic channel to which a large number of subcarriers are assigned [and] by grouping users

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and assigning the access channel of each group to an individual subcarrier" to improve power consumption and processing by user devices. Kanemoto '414 at Abstract. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Thus, these references were in the same field of endeavor and shared at least the goal of increasing spectral efficiency. It would have been obvious for a POSITA to combine WiMAX 2003 with Kanemoto '414 at least because WiMAX 2003 provides methods and techniques for improving spectral efficiency in multi-carrier wireless communication systems (such as those disclosed in Kanemoto '414). Finally, the proposed combination of WiMAX 2003 and Kanemoto '414 would involve nothing more than incorporating well-known concepts (i.e., Kanemoto '414's teachings for grouping users and assigning the access channel of each group to an individual subcarrier) into a well-known system (i.e., WiMAX 2003's OFDM system).

- **WiMAX 2003 and Li '422:** Li '422 teaches and describes "[a] method and apparatus for wireless communication . . . [by] transmitting orthogonal frequency domain multiplexing (OFDM) signals to the subscriber, and receiving direct-sequence spread spectrum (DSSS) signals from the subscriber." Li '422 at Abstract. Li '422 describes the inherent advantages and disadvantages of both

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OFDM and CDMA schemes for multiple access wireless communications systems. *Id.* at [0004]-[0008]. To optimize these advantages and disadvantages, Li '422 teaches the use of OFDM on the downlink and DSSS (CDMA) on the uplink. *Id.* at [0009]. According to Li '422, the techniques disclosed "increase, and potentially maximize, the downlink throughput while increasing, and potentially optimizing, the power efficiency of uplink, and at the same time, maintain the multiple-access flexibility of the overall system." *Id.* at [0031]. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Thus, these references were in the same field of endeavor and shared at least the object of providing wireless multiple access communications systems capable of efficient throughput and resource usage. It would have been obvious for a POSITA to combine WiMAX 2003 with Li '422 at least because WiMAX 2003 provides methods and techniques for controlling uplink transmit power at the mobile station (such as those disclosed in Li '422) in order to conserve uplink resources in a multiple access wireless communication system. Finally, the proposed combination of WiMAX 2003 and Li '422 would involve nothing more than incorporating well-known concepts (i.e., Li '422's DSSS's uplink scheme) into a well-known system (i.e., WiMAX 2003's OFDM system).

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- **WiMAX 2003 and Lee '481:** Lee '481 teaches and describes "[a] transmitter device [that] comprises an OFDM transmission unit, a MC-CDMA transmission unit, and a control unit for selecting either the OFDM transmission unit or the MC-CDMA transmission unit at slot time assigned to a receiver device in response to propagation conditions for the receiver device." Lee '481 at Abstract. Lee '481 describes certain advantages and disadvantages of using OFDM and CDMA schemes for multiple access in wireless communication systems. Lee '481 at [0004]-[0009]. To leverage the advantages and disadvantages of these schemes, Lee '481 discloses "a transmitter device and transmitting method for a mobile communication system . . . using OFDM and MC-CDMA schemes in order to solve the problems in each scheme . . . ." *Id.* at [0011]. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Thus, these references were in the same field of endeavor and shared at least the goal of providing wireless multiple access communications systems capable of efficient throughput and resource usage. It would have been obvious for a POSITA to combine WiMAX 2003 with Lee '481 at least because WiMAX 2003 provides methods and techniques for multiple access resource allocation (such as those disclosed in Lee '481) in order to operate a wireless communication system with

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high data throughput and reliability. Finally, the proposed combination of WiMAX 2003 and Lee '481 would involve nothing more than incorporating well-known concepts (i.e., Lee '481's OFDM or MC-CDMA transmission selection scheme) into a well-known system (i.e., WiMAX 2003's OFDM system).

(xi) Eklund in combination with the knowledge of a skilled artisan, Johnston, Walton '131, Engstrom, Wahlqvist, Mantha, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton '301, Walton '944, Walton '269, Jeong '589, Kaiser, Benedittis '812, Ma '437, Ma '546, Ma '429, Mody, Kriedte '196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh '464, Kanterakis, and/or Frank.

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Eklund with each of these references. A person of ordinary skill in the art would have found it obvious to combine Eklund with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

- Eklund, Johnston, Walton '131, Engstrom, Wahlqvist, Mantha, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton '301, Walton '944, Walton '269,

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Jeong ’589, Kaiser, Benedittis ’812, Ma ’437, Ma ’546, Ma ’429, Mody, Kriedte ’196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh ’464, Kanterakis, and/or Frank are all directed to systems and methods for a broadband wireless communication system related transmission. For example, they relate to broadband wireless communication between a mobile station and a base station using OFDM transmission and/or a related transmission scheme, and in particular to uplink and random access signal protocols. They involve communication protocols, standards, OFDM and/or related transmission methods, and access schemes that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Eklund and Johnston**: Johnston is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Johnston teaches and describes “key technical elements defined under the 802.16a [WiMAX] specification,” including the “specification, . . . physical layer requirements, and . . . the frame and media access control structures” of a WiMAX system. Johnston at 1. “The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS).” Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, “the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . .” Johnston at 3. Johnston further discloses “initial ranging” and “bandwidth request” slots in the uplink. Johnston at 6. Eklund teaches and

describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of the IEEE 802.16 standard for WiMAX wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Johnston at least because Eklund provides specifications of a 802.16 WiMAX wireless communication system that uses OFDM transmission (such as that disclosed in Johnston) in order to carry out uplink and random access protocols. In addition, Eklund and Johnston identify the common problem of providing enhancements to the medium access control in wireless communication systems to accommodate more demanding physical environments. *See* Eklund at 4; *see* Johnston at 1–2. A POSITA would have been motivated to combine Eklund with Johnston because Johnston provides the OFDM PHY mode specified for use between 2–11 GHz to the problem identified by Eklund. *See* Eklund at 4; Johnston at 1–5.

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- **Eklund and Walton ’131:** Walton ’131 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ’131 teaches and describes “data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency.” Walton ’131 at [0003]. Walton ’131 teaches “an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)” for uplink and downlink communication. Walton ’131 at [0048]. Walton ’131 further teaches “uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton ’131 is “to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency.” *Id.* at [0012]. Eklund teaches and describes the “IEEE Standard 802.16, with its WirelessMAN air interface,” and overviews “the technical medium access control and physical layer features” of this standard. Eklund at Abstract. “WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform.” Eklund at 3, 5. WirelessMAN also “provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS).” Eklund at 3. Eklund further discloses “initial access” opportunities that are followed by “requests for bandwidth in either random access slots or dedicated transmission opportunities.” Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile

stations and base stations. It would have been obvious for a POSITA to combine Eklund with Walton '131 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '131) in order to carry out uplink and random access protocols. In addition, Eklund and Walton '131 identify the common problem of providing greater efficiency for OFDM systems in wireless communication systems by, for example, improving packing efficiency. *See* Eklund at 4–5, 7–8; *see* Walton '131 at Abstract, [0009]–[0010], [0035], [0055]. A POSITA would have been motivated to combine Eklund with Walton '131 because Walton '131 provides techniques to use OFDM symbols of different sizes to the problem identified by Eklund. *See* Eklund at 4–5, 7–8; *see* Walton '131 at Abstract, [0009]–[0010], [0035], [0055].

- **Eklund and Engstrom:** Engstrom is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Engstrom teaches and describes "a random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital communication system . . . ." Engstrom at Abstract. Engstrom further describes "using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence. . . ." *Id.* at 2:51–3:8. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas

communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Engstrom at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Engstrom) in order to carry out uplink and random access protocols. In addition, Eklund and Engstrom identify the common problem of establishing effective initialization procedures in wireless communication systems. *See* Eklund at 10–11; *see* Engstrom at 2:43–48. A POSITA would have been motivated to combine Eklund with Engstrom because Engstrom provides a random access protocol in which a random access sequence can be cyclically repeated to the problem identified by Eklund. *See* Eklund at 10–11; *see* Engstrom at 2:43–48.

- **Eklund and Wahlqvist:** Wahlqvist is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wahlqvist teaches and describes "[the] use of orthogonal frequency division multiplex[ing] [OFDM] in a cellular system requir[ing] that the base station and the mobile station are time and frequency synchronized in order to preserve orthogonality between the subcarriers." Wahlqvist at Abstract. Wahlqvist further discloses "an initial time synchronization scheme for the uplink that can be used as a part in a random access

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protocol." *Id.* at 1. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Wahlqvist at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Wahlqvist) in order to carry out uplink and random access protocols. In addition, Eklund and Wahlqvist identify the common problem of establishing effective initialization procedures in wireless communication systems. *See* Eklund at 10–11; *see* Wahlqvist at 1. A POSITA would have been motivated to combine Eklund with Wahlqvist because Wahlqvist provides an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol to the problem identified by Eklund. *See* Eklund at 10–11; *see* Wahlqvist at 1–4.

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- **Eklund and Mantha:** Mantha is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Mantha teaches and describes a "communication channel structure and method in a wireless communication system," where "the communication system includes a base station and a plurality of subscriber stations and the subscriber stations are given access to a variety of channels, including at least one uplink data channel." Mantha at Abstract. "The uplink data channel can operate in at least a random access mode . . . ." *Id.* "[W]ireless link employs CDMA as a multiple access technique to channelize and share link, although other multiple access techniques such as OFDM, etc. can be used." *Id.* at [0050]. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Mantha at least because Eklund provides specifications of a wireless

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communication system that uses OFDM transmission (such as that disclosed in Mantha) in order to carry out uplink and random access protocols. In addition, Eklund and Mantha identify the common problem of providing lower latency, lower error rates, and overall greater efficiency in OFDM systems in wireless communication systems. *See* Eklund at 4–5, 7–8, 10, 12; *see* Mantha at [0004], [0010], [0013]–[0014]. A POSITA would have been motivated to combine Eklund with Mantha because Mantha provides a channel structure and method of monitoring the uplink channels and switching between a random access or polled mode to the problem identified by Eklund. *See* Eklund at 4–5, 7–8, 10, 12; *see* Mantha at [0015]–[0040].

- **Eklund and WiMAX 2003:** WiMAX 2003 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Defendants also incorporate by reference the citations in the WiMAX 2003 invalidity chart into the invalidity chart for Eklund. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund

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at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of WiMAX wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with WiMAX 2003 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in WiMAX 2003) in order to carry out uplink and random access protocols. In addition, Eklund and WiMAX 2003 identify the common problem of providing enhancements to OFDM wireless communication systems by, for example, improving physical and medium access control layers. *See* Eklund at 4; *see* WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2. A POSITA would have been motivated to combine Eklund with WiMAX 2003 because WiMAX 2003 provides enhancements to PHY and MAC to address operational frequencies from 2–11 GHz to the problem identified by Eklund. *See* Eklund at 4; WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2. A POSITA would further be motivated to combine Eklund and WiMAX 2003 because they share the same author, Roger Marks.

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- **Eklund and HiperLAN/2 DLC Specification Part 1:** HiperLAN/2 DLC Specification Part 1 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. HiperLAN/2 DLC Specification Part 1 teaches and describes a "Mobile Terminal (MT) . . . that communicates with an access point or with each other via a radio link." HiperLAN/2 DLC Specification Part 1 at 9. HiperLAN/2 DLC Specification Part 1 further discloses "Medium Access Control protocol" and "physical (PHY) layer of HIPERLAN/2 . . . ." *Id.* at 13–14. The PHY layer "is based on the modulation scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* at 14. HiperLAN/2 DLC Specification Part 1 discloses both an "uplink phase" and a "random access phase." *Id.* at 8–10. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with

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HiperLAN/2 DLC Specification Part 1 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 1) in order to carry out uplink and random access protocols. In addition, Eklund and HiperLAN/2 DLC Specification Part 1 identify the common problem of greater efficiency and reliability in OFDM wireless communication systems. *See* Eklund at 4, 8, 10, 12; *see* HiperLAN/2 DLC Specification Part 1 at 14. A POSITA would have been motivated to combine Eklund with HiperLAN/2 DLC Specification Part 1 because HiperLAN/2 DLC Specification Part 1 provides a multi-rate PHY layer, where the appropriate mode can be selected by a link adaptation scheme based on different interferences situations and distances among MTs and an AP, to the problem identified by Eklund. *See* Eklund at 4, 8, 10, 12; *see* HiperLAN/2 DLC Specification Part 1 at 14.

- **Eklund and Walton '301:** Walton '301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '301 teaches and describes "a multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. Walton '301 further describes "a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 3:54–63. Walton '301 further describes an "uplink phase" that consists of "one or more [Reverse Channel] PDUs [] transmitted in a fourth segment and one more [Random Access Channel] PDUs transmitted in a fifth segment . . . ." *Id.* at Walton '301 at 11:7–16. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and

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overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Walton '301 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '301) in order to carry out uplink and random access protocols. In addition, Eklund and Walton '301 identify the common problem of providing improved performance of OFDM systems in wireless communication systems. *See* Eklund at 4–5, 7–10, 12; *see* Walton '301 at 1:35–51, 2:3. A POSITA would have been motivated to combine Eklund with Walton '301 because Walton '301 provides a MIMO structure to the problem identified by Eklund. *See* Eklund at 4–5, 7–10, 12; *see* Walton '301 at Abstract, 1:11–3:2.

- **Eklund and Walton '944:** Walton '944 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '944 teaches and describes "techniques for facilitating random access in wireless

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multiple-access communication systems," where the system employs orthogonal frequency division multiplexing (OFDM) . . . ." Walton '944 at Abstract, 3:34–37. Walton '944 further describes "a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 2:57–3:10. "[T]he uplink transport channels include a reverse channel (RCH) and a random access channel (RACH) . . . ." *Id.* at 3:49–4:9. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Walton '944 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '944) in order to carry out uplink and random access protocols. In addition, Eklund and Walton '944 identify the common problem of providing effective and efficient system access in wireless communication systems. *See* Eklund at 4, 8–10;

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see Walton ’944 at Abstract, 1:60–62. A POSITA would have been motivated to combine Eklund with Walton ’944 because Walton ’944 provides a fast and slow random access channel option to the problem identified by Eklund. *See* Eklund at 4, 8–10; *see* Walton ’301 at Abstract, 2:1–18.

- **Eklund and Walton ’269:** Walton ’269 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ’ 269 teaches and describes “data communication and processing . . . for providing an efficient control channel structure in a wireless local area network (WLAN) communication system.” Walton ’269 at 1:9–13. “MIMO and orthogonal frequency division multiplexing (OFDM) may be employed to obtain high throughput, combat deleterious path effects, and provide other benefits.” *Id.* at 1:66–2:3. Walton ’269 further discloses a system that “includes a number of access points (APs) that support communication for a number of user terminals (UTs).” *Id.* at 3:26–28. Walton ’269 discloses “uplink transport channels used by the UTs” that include a “Reverse Channel” and a “Random Access Channel.” *Id.* at 9:14–15, and Figures 4 and 5. Eklund teaches and describes the “IEEE Standard 802.16, with its WirelessMAN air interface,” and overviews “the technical medium access control and physical layer features” of this standard. Eklund at Abstract. “WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform.” Eklund at 3, 5. WirelessMAN also “provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS).” Eklund at 3. Eklund further discloses “initial access” opportunities that are followed by “requests for bandwidth in either random access slots or dedicated

transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Walton '269 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '269) in order to carry out uplink and random access protocols. In addition, Eklund and Walton '269 identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems, for example, by improving channel structure. *See* Eklund at 4–5; *see* Walton '269 at Abstract, 2:8–36. A POSITA would have been motivated to combine Eklund with Walton '269 because Walton '269 discloses a more efficient control channel structure that is able to accommodate different users operating at different rates to the problem identified by Eklund. *See* Eklund at 4–5; *see* Walton '269 at Abstract, 2:36–40.

- **Eklund and Jeong '589:** Jeong '589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system . . . ." Jeong '589 Translation at Abstract. Jeong '589 further discloses that "[i]n IEEE 802.16ab, OFDMA wireless communication system is defined such that data can be transmitted between a base station ("BS") and a subscriber station ("SS") using a microwave frequency band

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between 2 GHz and 11 GHz." *Id.* at 2. Jeong '589 discloses that "the SS transmits a ranging signal to the BS using a ranging sub-channel and a ranging code arbitrarily selected in a ranging interval section." *Id.* at 9. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDMA [in the 2–11 GHz band] uses orthogonal frequency-division multiple access with a 2048-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDMA transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Jeong '589 at least because Eklund provides specifications of a wireless communication system that uses OFDMA transmission (such as that disclosed in Jeong '589) in order to carry out uplink and random access protocols. In addition, Eklund and Jeong '589 identify the common problem of improving initial ranging and channel allocation in wireless communication systems. *See* Eklund at 8, 11; *see* Jeong '589 Translation at Abstract, 2–3. A POSITA would have been motivated to combine Eklund with Jeong '589 because Jeong '589 provides an initial ranging interval and ranging subchannel allocation method for initial ranging of multi-user OFDMA to the problem identified by Eklund. *See* Eklund at 8, 11; *see* Jeong '589 Translation at Abstract, 2–3.

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- **Eklund and Kaiser:** Kaiser is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kaiser teaches and describes "a multiple access scheme for mobile multi-media applications. . . . referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA)" for "the uplink of a mobile radio system . . . ." Kaiser at Abstract, p.100. Kaiser further discloses "applying OFDM" to SS-MC-MA such that "data transmission can be based on OFDM-frames, where each frame consists of several OFDM-symbols." *Id.* at pp.102–103. Kaiser discloses a transmitter and receiver using "OFDM with [a] user-specific frequency mapper." *Id.* at p.101. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Kaiser at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kaiser) in order to carry out uplink and random access protocols. In addition, Eklund and Kaiser identify the common problem of improving flexibility of bandwidth allocation and effective error

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correction in wireless communication systems. *See* Eklund at 5–10; *see* Kaiser at 1. A POSITA would have been motivated to combine Eklund with Kaiser because Kaiser provides a scheme with variable sub-carrier allocation and effective error protection to the problem identified by Eklund. *See* Eklund at 5–10; *see* Kaiser at 1.

- **Eklund and Benedittis '812:** Benedittis '812 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Benedittis '812 teaches and describes a "third generation (3G) cellular system of UMTS (Universal Mobile Telecommunication System)," including "a method for optimizing the random access procedures in the CDMA cellular networks," where "[t]he spreading code sequences [are] reciprocally orthogonal . . . ." Benedittis '812 at [0001]–[0002]. Benedittis '812 also discloses "MS (Mobile Stations or Mobile Units), also vehicular ones, and portable User Equipment units UE, [] radio connected with relevant TRC transceivers [] belonging to relevant base transceiver stations BTSC (Base Transceiver Station for CDMA) spread on the territory." *Id.* at [0053]–[0054]. Benedittis '812 discloses "m uplink time slots . . . coming from the mobile stations MS/UE . . . ." *Id.* at [0057]. Benedittis '812 further discloses sending "the first SYNC1 signatures sent from the mobile" followed by "a successive CHANNEL REQUEST message sent from the mobile on a [Random Access Channel.]" *Id.* at [0104]–[0106], and Figure 7. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal

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frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Benedittis '812 at least because Eklund provides specifications of a wireless communication system that utilizes a first uplink signal followed by a random access protocol (such as that disclosed in Benedittis '812). In addition, Eklund and Benedittis '812 identify the common problem of improving efficiency and minimizing delay in accessing the network in wireless communication systems. *See* Eklund at 10; *see* Benedittis '812 at [0021]–[0022]. A POSITA would have been motivated to combine Eklund with Benedittis '812 because Benedittis '812 provides an optimized random access procedure to the problem identified by Eklund. *See* Eklund at 10; *see* Benedittis '812 at Abstract, [0021]–[0022].

- **Eklund and Ma '437:** Ma '437 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '437 teaches and describes "physical layer structures and related access schemes for unsynchronized [wireless] communication networks," Ma '437 at Abstract, where "the communication signal is an OFDM signal," *id.* at 2:25–26. Ma '437 further

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discloses "a wireless communication network . . . . [that] includes base transceiver stations (BTSs)," and "[u]ser equipment (UE) [that] is adapted to communicate with any of the BTSs that are within its range[.]" Ma '437 at 4:61–67. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Ma '437 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '437) in order to carry out uplink and random access protocols. In addition, Eklund and Ma '437 identify the common problem of improving access to the network and base station identification in OFDM wireless communication systems. *See* Eklund at 8–11; *see* Ma '437 at Abstract, 1:41–2:3. A POSITA would have been motivated to combine Eklund with Ma '437 because Ma '437 provides common and cell-specific synchronization codes, preambles, and/or pilots to the problem identified by Eklund. *See* Eklund at 8–11; *see* Ma '437 at Abstract, 1:41–2:3, 2:14–62.

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- **Eklund and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 teaches and describes "[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network." Ma '546 at 1:20–22. "[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . ." *Id.* at 2:48–50. Ma '546 further describes "a Random Access Channel (RACH) for UE's new to a particular wireless network to access the system." *Id.* at 19:45–48. "A dedicated long complex PN/Golay code set is reserved for RACH of each base station," and "[t]he covering PN code for each base station is different from those of the neighboring base stations . . . ." *Id.* at 20:50–51, 21:1–5. "The base station can broadcast this information through a DL signaling channel." *Id.* at 20:54–55. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." *Id.* at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." *Id.* at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." *Id.* at 8–9, and Figure 2. And that "[SSs] may be programmed to register with a specified BS, referring to a programmable BS ID broadcast by each." *Id.* at 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless

communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Ma '546 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '546) in order to carry out uplink and random access protocols. In addition, Eklund and Ma '546 identify the common problem of improving efficiency of multiple-access OFDM wireless communication systems. *See* Eklund at 4; *see* Ma '546 at 2:6–44. A POSITA would have been motivated to combine Eklund with Ma '546 because Ma '546 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Eklund. *See* Eklund at 4; *see* Ma '546 at Abstract, 2:48–56.

- **Eklund and Ma '429:** Ma '429 teaches and describes "[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network." Ma '429 at [0003]. "[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . ." *Id.* at [0010]. Ma '429 further describes "a Random Access Channel (RACH) for UE's new to a particular wireless network to access the system." *Id.* at [0205]. "A dedicated long complex PN/Golay code set is reserved for RACH of each base station," and "[t]he covering PN code for each base station is different from those of the neighboring base stations . . . ." *Id.* at [0215], [0217]. "The base station can broadcast this information through a DL signaling channel." *Id.* at [0215]. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and

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overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." *Id.* at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." *Id.* at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." *Id.* at 8–9, and Figure 2. And that "[SSs] may be programmed to register with a specified BS, referring to a programmable BS ID broadcast by each." *Id.* at 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Ma '429 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '429) in order to carry out uplink and random access protocols. In addition, Eklund and Ma '429 identify the common problem of improving efficiency of multiple-access OFDM wireless communication systems. *See* Eklund at 4; *see* Ma '429 at [0007]–[0009]. A POSITA would have been motivated to combine Eklund with Ma '429 because Ma '429 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Eklund. *See* Eklund at 4; *see* Ma '429 at Abstract, [0010].

- **Eklund and Mody:** Mody teaches and describes "a wireless Orthogonal Frequency Division Multiplexing (OFDM) communication system[.]" Mody at Abstract. Mody further discloses "a system for synchronizing data transmitted across a channel." *Id.* The communication system of Mody "may be part of a . . . Wireless[MAN] system." Mody at 3:41–44. Mody further discloses communication between "a number of transmitting antennas [and] a number of receiving antennas [] used to receive the transmitted signals." Mody at 2:32–35. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Mody at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Mody) in order to carry out uplink and random access protocols. In addition, Eklund and Mody identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems. *See* Eklund at 4, 6, 11; *see* Mody at Abstract, [0008]. A POSITA would have been motivated to combine Eklund with Mody because Mody

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provides a sequence of training symbols and/or preambles and improved synchronization and channel estimation in MIMO systems to the problem identified by Eklund. *See* Eklund at 8–11; *see* Mody at Abstract, [0008]–[0012].

- **Eklund and Kriedte '196:** Kriedte '196 teaches and describes "a wireless communication system, such as a multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) wireless LAN system[.]" Kriedte '196 at Abstract. Kriedte '196 further discloses communication between "N_t transmit antennas and N_t receive antennas[.]" Kriedte '196 at 3:29–30. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Kriedte '196 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kriedte '196) in order to carry out uplink and random access protocols. In addition, Eklund and Kriedte '196 identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems. *See* Eklund at 4–5, 8–11; *see* Kriedte '196 at

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Abstract, 1:17–59. A POSITA would have been motivated to combine Eklund with Kriedte '196 because Kriedte '196 provides symbol timing techniques to the problem identified by Eklund. *See* Eklund at 4–5, 8–11; *see* Kriedte '196 at Abstract, 1:61–2:41.

- **Eklund and Boehnke:** Boehnke teaches and describes "wireless communication systems with high-speed mobile access, . . . wherein Orthogonal Frequency Division Multiplexing (OFDM) is applied as a multi-carrier modulation technique." Boehnke at Abstract. Boehnke further describes a system in which "mobile stations" or "mobile terminals" communicate on the uplink and downlink with an "Access Point (AP)." Boehnke at [0036]–[0038]. Boehnke teaches transmission phases of an "Uplink Phase" followed by a "Random Access Phase." *Id.* .Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine

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Eklund with Boehnke at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Boehnke) in order to carry out uplink and random access protocols. In addition, Eklund and Boehnke identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems. *See* Eklund at 4–5, 7–11; *see* Boehnke at Abstract, [0052]–[0058]. A POSITA would have been motivated to combine Eklund with Boehnke because Boehnke provides a new pilot pattern and insertion of reference symbols to support channel estimation and synchronization to the problem identified by Eklund. *See* Eklund at 4–5, 7–11; *see* Boehnke at Abstract, [0052]–[0068].

- **Eklund and Chheda:** Chheda teaches and describes "using . . . OFDM for broadband wireless systems." Chheda further describes "User Terminals," "Subscriber Units," and "Customer Premise Equipment" in communication with "Base Stations," "Wireless Base Stations" or "Base Transceiver Stations." Chheda at 22, 30, and 105. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile

stations and base stations. It would have been obvious for a POSITA to combine Eklund with Chheda at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Chheda) in order to carry out uplink and random access protocols. In addition, Eklund and Chheda identify the common problem of improving effectiveness and efficiency of wireless communication systems. *See* Eklund at 4–5, 7–11; *see* Chheda at 1–10. A POSITA would have been motivated to combine Eklund with Chheda because Chheda provides OFDM multiple-access techniques to the problem identified by Eklund. *See* Eklund at 4–5, 7–11; *see* Chheda at 1–10, 74–95.

- **Eklund and HiperLAN/2 DLC Specification Part 2:** HiperLAN/2 DLC Specification Part 2 teaches and describes "the basic Radio Link Control (RLC) sublayer of HIPERLAN/2" which "is confined to . . . the physical and the data link control layer." HiperLAN/2 DLC Specification Part 2 at 9. Among other things, the "scope of HIPERLAN/2 standards" covers both the "Physical Layer" and "Medium Access Control." *Id.* at 14, Figures 1–2. HiperLAN/2 DLC Specification Part 2 further describes communication between "Mobile Terminals" and "Access Points." *Id.* at 19. For example, the "Uplink phase" is "part of the MAC frame in which data is transmitted from the mobile terminals to an access point or a central controller. *Id.* at 12. HiperLAN/2 DLC Specification Part 2 further describes various uplink channels, including a "Random Access CHannel [RACH]," and a "Random CHannel [RCH]." *Id.* HiperLAN/2 DLC Specification Part 2 uses a "normal" and "short" "OFDM symbol guard interval" in the PHY layer. *Id.* at 178.

Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with HiperLAN/2 DLC Specification Part 2 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 2) in order to carry out uplink and random access protocols. In addition, Eklund and HiperLAN/2 DLC Specification Part 2 identify the common problem of greater efficiency and reliability in OFDM wireless communication systems. *See* Eklund at 4–5, 8–9; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13. A POSITA would have been motivated to combine Eklund with HiperLAN/2 DLC Specification Part 2 because HiperLAN/2 DLC Specification Part 2 provides radio link control layer functions, messages, and formats to the problem identified

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by Eklund. *See* Eklund at 4–5, 8–9; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13.

- **Eklund and HiperLAN/2 PHY Specification:** HiperLAN/2 PHY Specification teaches and describes "the physical layer specifications for HIgh PErformance Radio Local Area Network type 2 (HIPERLAN/2)," HiperLAN/2 PHY Specification at 5–6. "The PHY layer of HIPERLAN/2 . . . provides for functions to map different DLC PDU trains into framing formats called PHY bursts appropriate for transmitting and receiving management and user information between an [Access Point] and a [Mobile Terminal] . . . ." *Id.* at 10. "The PHY layer of HIPERLAN/2 is based on the modulation scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* HiperLAN/2 PHY Specification further describes a "Random CHannel (RCH)" used to "carr[y] the logical channels random access channel and association channel," and that "[t]he BCH includes 2 bits which announce the guard time between random access bursts." *Id.* at 7, 33. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the

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same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with HiperLAN/2 PHY Specification at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 PHY Specification) in order to carry out uplink and random access protocols. In addition, Eklund and HiperLAN/2 PHY Specification identify the common problem of greater efficiency and reliability in OFDM wireless communication systems. *See* Eklund at 4–12; *see* HiperLAN/2 PHY Specification at 6, 9. A POSITA would have been motivated to combine Eklund with HiperLAN/2 PHY Specification because HiperLAN/2 PHY Specification provides a multi-rate PHY layer and link adaptation scheme to the problem identified by Eklund. *See* Eklund at 4–12; *see* HiperLAN/2 PHY Specification at 6, 9, 11.

- **Eklund and Gibson:** Gibson teaches and describes "wireless communication systems" using "[frequency division multiple access [with] signals assigned to different users [that] are clearly orthogonal . . . ." Gibson at p.17-4. Gibson discloses a "mobile station" which "initiates the procedure by transmitting a request [to the base station] on a random-access channel." *Id.* at p.17-8–17-9. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund

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at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Gibson at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Gibson). In addition, Eklund and Gibson identify the common problem of improving efficiency in wireless communication systems. *See* Eklund at 4–12; *see* Gibson at 17-4–17-12. A POSITA would have been motivated to combine Eklund with Gibson because Gibson provides channel assignment and multiple access techniques to the problem identified by Eklund. *See* Eklund at 4–12; *see* Gibson at 17-4–17-12, and Figure 17.3.

- **Eklund and Suh '464:** Suh '464 teaches and describes "an orthogonal frequency division multiplexing (OFDM) communication system . . . ." Suh '464 at [0003]. "[A] wireless communication system is comprised of Node Bs and user equipments (UEs)," where "[t]he Node B's and the UEs transmit data by the frame for a wireless communication service." *Id.* at [0005]. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the

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technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Suh '464 at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Suh '464) in order to carry out uplink and random access protocols. In addition, Eklund and Suh '464 identify the common problem of improving efficiency in OFDM wireless communication systems. *See* Eklund at 4–12; *see* Suh '464 at Abstract, [0002]–[0044]. A POSITA would have been motivated to combine Eklund with Suh '464 because Suh '464 provides generating a preamble sequence for low peak-to-average power ration and improved channel estimation to the problem identified by Eklund. *See* Eklund at 4–12; *see* Suh '464 at Abstract, [0042]–[0049].

- **Eklund and Kanterakis:** Kanterakis teaches and describes "spread-spectrum communications," where "[t]he CMDA system has a base station (BS) and a plurality of remote stations." Kanterakis at 1:5, 27–28. Kanterakis further describes "a random-access burst structure which has a preamble followed by a data portion," where "the preamble sequence [is] spread by an orthogonal Gold code."

Id. at 1:5–18. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Kanterakis at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Kanterakis). In addition, Eklund and Kanterakis identify the common problem of improving efficiency and reliability in wireless communication systems. *See* Eklund at 4–6, 10–11; Kanterakis at Abstract, 1:10–23. A POSITA would have been motivated to combine Eklund with Kanterakis because Kanterakis provides spread spectrum modulation to the problem identified by Eklund. *See* Eklund at 4–6, 10–11; *see* Kanterakis at Abstract, 1:10–2:11.

- **Eklund and Frank:** Frank teaches and describes a "mobile telecommunications system" with "a method and system for processing multiple random access calls in

a [CDMA] . . . system." Frank at 1:5-13. Frank further describes "[a]n uplink common physical channel (random access channel) frame structure . . . with a separate preamble and data portion," where "[t]he preamble is used by a base station to detect that a mobile station is attempting a random access request." *Id.* at Abstract. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Eklund with Frank at least because Eklund provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Frank). In addition, Eklund and Frank identify the common problem of improving efficiency and effectiveness in wireless communication systems. *See* Eklund at 4–12; Frank at Abstract, 1:11–5:31. A POSITA would have been motivated to combine Eklund with Frank because Frank provides a random access

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channel frame structure with separate preamble and data portions to the problem identified by Eklund. *See* Eklund at 4–12; *see* Frank at Abstract, 6:1–7:11.

(xii) Johnston in combination with the knowledge of a skilled artisan, Eklund, Walton '131, Engstrom, Wahlqvist, Mantha, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton '301, Walton '944, Walton '269, Jeong '589, Kaiser, Benedittis '812, Ma '437, Ma '546, Ma '429, Mody, Kriedte '196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh '464, Kanterakis, and/or Frank.

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Johnston with each of these references. A person of ordinary skill in the art would have found it obvious to combine Johnston with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '450 patent was filed. Specifically:

- Johnston, Eklund, Walton '131, Engstrom, Wahlqvist, Mantha, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton '301, Walton '944, Walton '269, Jeong '589, Kaiser, Benedittis '812, Ma '437, Ma '546, Ma '429, Mody, Kriedte '196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2,

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HiperLAN/2 PHY Specification, Gibson, Suh '464, Kanterakis, and/or Frank are all directed to systems and methods for a broadband wireless communication system related transmission. For example, they relate to broadband wireless communication between a mobile station and a base station using OFDM transmission and/or a related transmission scheme, and in particular to uplink and random access signal protocols. They involve communication protocols, standards, OFDM and/or related transmission methods, and access schemes that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Johnston and Eklund:** Eklund is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a

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WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of the IEEE 802.16 standard for WiMAX wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Eklund at least because Johnston provides specifications of a 802.16 WiMAX wireless communication system that uses OFDM transmission (such as that disclosed in Eklund) in order to carry out uplink and random access protocols. In addition, Johnston and Eklund identify the common problem of providing enhancements to the medium access control in wireless communication systems to accommodate more demanding physical environments. *See* Johnston at 1–2; s*ee* Eklund at 4–5. A POSITA would have been motivated to combine Johnston with Eklund because Eklund provides medium access control designed for point-to-multipoint broadband wireless access and OFDM PHY layer specified for use between 10–66 GHz to the problem identified by Johnston. *See* Johnston at 1–5; s*ee* Eklund at 4–12.

- **Johnston and Walton '131:** Walton '131 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '131

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teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Walton '131 at least

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because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '131) in order to carry out uplink and random access protocols. In addition, Johnston and Walton '131 identify the common problem of providing greater efficiency for OFDM systems in wireless communication systems by, for example, improving packing efficiency and random access. *See* Johnston at 2–6; *see* Walton '131 at Abstract, [0009]–[0010], [0035], [0050]–[0055]. A POSITA would have been motivated to combine Johnston with Walton '131 because Walton '131 provides techniques to use OFDM symbols of different sizes to the problem identified by Johnston. *See* Johnston at 2-6; *see* Walton '131 at Abstract, [0009]–[0010], [0035], [0050]–[0055].

- **Johnston and Engstrom:** Engstrom is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Engstrom teaches and describes "a random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital communication system . . . ." Engstrom at Abstract. Engstrom further describes "using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence. . . ." *Id.* at 2:51–3:8. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling

format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Engstrom at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Engstrom) in order to carry out uplink and random access protocols. In addition, Johnston and Engstrom identify the common problem of establishing effective initialization procedures in wireless communication systems. *See* Johnston at 5–6; *see* Engstrom at 2:43–48. A POSITA would have been motivated to combine Johnston with Engstrom because Engstrom provides a random access protocol in which a random access sequence can be cyclically repeated to the problem identified by Johnston. *See* Johnston at 5–6; *see* Engstrom at 2:43–48.

- **Johnston and Wahlqvist:** Wahlqvist is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wahlqvist teaches and describes "[the] use of orthogonal frequency division multiplex[ing] [OFDM] in a cellular system requir[ing] that the base station and the mobile station are time and frequency synchronized in order to preserve orthogonality between the subcarriers." Wahlqvist at Abstract. Wahlqvist further discloses "an initial time synchronization scheme for the uplink that can be used as a part in a random access

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protocol." *Id.* at 1. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Wahlqvist at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Wahlqvist) in order to carry out uplink and random access protocols. In addition, Johnston and Wahlqvist identify the common problem of establishing effective initialization procedures in wireless communication systems. *See* Johnston at 5–6; *see* Wahlqvist at 1. A POSITA would have been motivated to combine Johnston with Wahlqvist because Wahlqvist provides an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol to the problem identified by Johnston. *See* Johnston at 5–6; *see* Wahlqvist at 1–4.

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- **Johnston and Mantha:** Mantha is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Mantha teaches and describes a "communication channel structure and method in a wireless communication system," where "the communication system includes a base station and a plurality of subscriber stations and the subscriber stations are given access to a variety of channels, including at least one uplink data channel." Mantha at Abstract. "The uplink data channel can operate in at least a random access mode . . . ." *Id.* "[W]ireless link employs CDMA as a multiple access technique to channelize and share link, although other multiple access techniques such as OFDM, etc. can be used." *Id.* at [0050]. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Mantha at least because

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Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Mantha) in order to carry out uplink and random access protocols. In addition, Johnston and Mantha identify the common problem of providing lower latency, lower error rates, and overall greater efficiency in OFDM systems in wireless communication systems. *See* Johnston at 3–6; *see* Mantha at [0004], [0010], [0013]–[0014]. A POSITA would have been motivated to combine Johnston with Mantha because Mantha provides a channel structure and method of monitoring the uplink channels and switching between a random access or polled mode to the problem identified by Johnston. *See* Johnston at 3–6; *see* Mantha at [0015]–[0040].

- **Johnston and WiMAX 2003:** WiMAX 2003 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Defendants also incorporate by reference the citations in the WiMAX 2003 invalidity chart into the invalidity chart for Johnston. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX

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system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of WiMAX wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with WiMAX 2003 at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in WiMAX 2003) in order to carry out uplink and random access protocols. In addition, Johnston and WiMAX 2003 identify the common problem of providing enhancements to OFDM wireless communication systems by, for example, improving physical and medium access control layers. *See* Johnston at 1–6; *see* WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2. A POSITA would have been motivated to combine Johnston with WiMAX 2003 because WiMAX 2003 provides enhancements to PHY and MAC to address operational frequencies from 2–11 GHz to the problem identified by Johnston. *See* Johnston at 1–6; WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2.

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- **Johnston and HiperLAN/2 DLC Specification Part 1:** HiperLAN/2 DLC Specification Part 1 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. HiperLAN/2 DLC Specification Part 1 teaches and describes a "Mobile Terminal (MT) . . . that communicates with an access point or with each other via a radio link." HiperLAN/2 DLC Specification Part 1 at 9. HiperLAN/2 DLC Specification Part 1 further discloses "Medium Access Control protocol" and "physical (PHY) layer of HIPERLAN/2 . . . ." *Id.* at 13–14. The PHY layer "is based on the modulation scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* at 14. HiperLAN/2 DLC Specification Part 1 discloses both an "uplink phase" and a "random access phase." *Id.* at 8–10. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a

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POSITA to combine Johnston with HiperLAN/2 DLC Specification Part 1 at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 1) in order to carry out uplink and random access protocols. In addition, Johnston and HiperLAN/2 DLC Specification Part 1 identify the common problem of improving efficiency and reliability in OFDM wireless communication systems. *See* Johnston at 1, 3–6; *see* HiperLAN/2 DLC Specification Part 1 at 14. A POSITA would have been motivated to combine Johnston with HiperLAN/2 DLC Specification Part 1 because HiperLAN/2 DLC Specification Part 1 provides a multi-rate PHY layer, where the appropriate mode can be selected by a link adaptation scheme based on different interference situations and distances among MTs and an AP, to the problem identified by Johnston. *See* Johnston at 3–6; *see* HiperLAN/2 DLC Specification Part 1 at 14.

- **Johnston and Walton '301:** Walton '301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '301 teaches and describes "a multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. Walton '301 further describes "a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 3:54–63. Walton '301 further describes an "uplink phase" that consists of "one or more [Reverse Channel] PDUs [] transmitted in a fourth segment and one more [Random Access Channel] PDUs transmitted in a fifth segment . . . ." *Id.* at Walton '301 at 11:7–16. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX]

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specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Walton '301 at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '301) in order to carry out uplink and random access protocols. In addition, Johnston and Walton '301 identify the common problem of providing improved performance of OFDM systems in wireless communication systems. *See* Johnston at 1–2; *see* Walton '301 at 1:35–51, 2:3. A POSITA would have been motivated to combine Johnston with Walton '301 because Walton '301 provides a MIMO structure to the problem identified by Johnston. *See* Johnston 1–2; *see* Walton '301 at Abstract, 1:11–3:2.

- **Johnston and Walton '944:** Walton '944 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '944 teaches and describes "techniques for facilitating random access in wireless

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multiple-access communication systems," where the system employs orthogonal frequency division multiplexing (OFDM) . . . ." Walton '944 at Abstract, 3:34–37. Walton '944 further describes "a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 2:57–3:10. "[T]he uplink transport channels include a reverse channel (RCH) and a random access channel (RACH) . . . ." *Id.* at 3:49–4:9. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Walton '944 at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '944) in order to carry out uplink and random access protocols. In addition, Johnston and Walton '944 identify the common problem of providing effective and efficient system access in

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wireless communication systems. *See* Johnston at 1–2, 5–6; *see* Walton '944 at Abstract, 1:60–62. A POSITA would have been motivated to combine Johnston with Walton '944 because Walton '944 provides a fast and slow random access channel option to the problem identified by Johnston. *See* Johnston at 1–2, 5–6; *see* Walton '301 at Abstract, 2:1–18.

- **Johnston and Walton '269:** Walton '269 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ' 269 teaches and describes "data communication and processing . . . for providing an efficient control channel structure in a wireless local area network (WLAN) communication system." Walton '269 at 1:9–13. "MIMO and orthogonal frequency division multiplexing (OFDM) may be employed to obtain high throughput, combat deleterious path effects, and provide other benefits." *Id.* at 1:66–2:3. Walton '269 further discloses a system that "includes a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 3:26–28. Walton '269 discloses "uplink transport channels used by the UTs" that include a "Reverse Channel" and a "Random Access Channel." *Id.* at 9:14–15, and Figures 4 and 5. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in

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preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Walton '269 at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '269) in order to carry out uplink and random access protocols. In addition, Johnston and Walton '269 identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems, for example, by improving channel structure. *See* Johnston at 1–2, 4–6; *see* Walton '269 at Abstract, 2:8–36. A POSITA would have been motivated to combine Johnston with Walton '269 because Walton '269 discloses a more efficient control channel structure that is able to accommodate different users operating at different rates to the problem identified by Johnston. *See* Johnston at 1–2, 4–6; *see* Walton '269 at Abstract, 2:36–40.

- **Johnston and Jeong '589:** Jeong '589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system . . . ." Jeong '589 Translation at Abstract. Jeong '589 further discloses that "[i]n IEEE 802.16ab,

OFDMA wireless communication system is defined such that data can be transmitted between a base station ("BS") and a subscriber station ("SS") using a microwave frequency band between 2 GHz and 11 GHz." *Id.* at 2. Jeong '589 discloses that "the SS transmits a ranging signal to the BS using a ranging sub-channel and a ranging code arbitrarily selected in a ranging interval section." *Id.* at 9. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDMA transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Jeong '589 at least because Johnston provides specifications of a wireless communication system that uses OFDMA transmission (such as that disclosed in Jeong '589) in order to carry out uplink and random access protocols. In addition, Johnston and Jeong '589 identify the common problem of improving initial ranging and channel allocation in wireless communication systems. *See*

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Johnston at 2–6; *see* Jeong '589 Translation at Abstract, 2–3. A POSITA would have been motivated to combine Johnston with Jeong '589 because Jeong '589 provides an initial ranging interval and ranging subchannel allocation method for initial ranging of multi-user OFDMA to the problem identified by Johnston. *See* Johnston at 2–6; *see* Jeong '589 Translation at Abstract, 2–3.

- **Johnston and Kaiser:** Kaiser is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kaiser teaches and describes "a multiple access scheme for mobile multi-media applications. . . . referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA)" for "the uplink of a mobile radio system . . . ." Kaiser at Abstract, p.100. Kaiser further discloses "applying OFDM" to SS-MC-MA such that "data transmission can be based on OFDM-frames, where each frame consists of several OFDM-symbols." *Id.* at pp.102–103. Kaiser discloses a transmitter and receiver using "OFDM with [a] user-specific frequency mapper." *Id.* at p.101. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were

in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Kaiser at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kaiser) in order to carry out uplink and random access protocols. In addition, Johnston and Kaiser identify the common problem of improving flexibility of bandwidth allocation and effective error correction in wireless communication systems. *See* Johnston at 2–5; *see* Kaiser at 1. A POSITA would have been motivated to combine Johnston with Kaiser because Kaiser provides a scheme with variable sub-carrier allocation and effective error protection to the problem identified by Johnston. *See* Johnston at 2–5; *see* Kaiser at 1.

- **Johnston and Benedittis '812:** Benedittis '812 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Benedittis '812 teaches and describes a "third generation (3G) cellular system of UMTS (Universal Mobile Telecommunication System)," including "a method for optimizing the random access procedures in the CDMA cellular networks," where "[t]he spreading code sequences [are] reciprocally orthogonal . . . ." Benedittis '812 at [0001]–[0002]. Benedittis '812 also discloses "MS (Mobile Stations or Mobile Units), also vehicular ones, and portable User Equipment units UE, [] radio connected with relevant TRC transceivers [] belonging to relevant base transceiver stations BTSC (Base Transceiver Station for CDMA) spread on the territory." *Id.*

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at [0053]–[0054]. Benedittis '812 discloses "m uplink time slots . . . coming from the mobile stations MS/UE . . . ." *Id.* at [0057]. Benedittis '812 further discloses sending "the first SYNC1 signatures sent from the mobile" followed by "a successive CHANNEL REQUEST message sent from the mobile on a [Random Access Channel.]" *Id.* at [0104]–[0106], and Figure 7. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Benedittis '812 at least because Johnston provides specifications of a wireless communication system that utilizes a first uplink signal followed by a random access protocol (such as that disclosed in Benedittis '812). In addition, Johnston and Benedittis '812 identify the common problem of improving efficiency and minimizing delay in accessing the network in wireless communication systems. *See* Johnston at 4–6; *see* Benedittis '812 at

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[0021]–[0022]. A POSITA would have been motivated to combine Johnston with Benedittis '812 because Benedittis '812 provides an optimized random access procedure to the problem identified by Johnston. *See* Johnston at 4–6; *see* Benedittis '812 at Abstract, [0021]–[0022].

- **Johnston and Ma '437:** Ma '437 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '437 teaches and describes "physical layer structures and related access schemes for unsynchronized [wireless] communication networks," Ma '437 at Abstract, where "the communication signal is an OFDM signal," *id.* at 2:25–26. Ma '437 further discloses "a wireless communication network . . . . [that] includes base transceiver stations (BTSs)," and "[u]ser equipment (UE) [that] is adapted to communicate with any of the BTSs that are within its range[.]" Ma '437 at 4:61–67. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control,

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using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Ma '437 at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '437) in order to carry out uplink and random access protocols. In addition, Johnston and Ma '437 identify the common problem of improving access to the network and base station identification in OFDM wireless communication systems. *See* Johnston at 1–2, 5–6; *see* Ma '437 at Abstract, 1:41–2:3. A POSITA would have been motivated to combine Johnston with Ma '437 because Ma '437 provides common and cell-specific synchronization codes, preambles, and/or pilots to the problem identified by Johnston. *See* Johnston at 1–2, 5–6; *see* Ma '437 at Abstract, 1:41–2:3, 2:14–62.

- **Johnston and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 teaches and describes "[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network." Ma '546 at 1:20–22. "[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . ." *Id.* at 2:48–50. Ma '546 further describes "a Random Access Channel (RACH) for UE's new to a particular wireless network to access the system." *Id.* at 19:45–48. "A dedicated long complex PN/Golay code set is reserved for RACH of each base station," and "[t]he covering PN code for each base station is different from those of the neighboring base stations . . . ." *Id.* at 20:50–51, 21:1–5. "The base station can broadcast this information through a DL

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signaling channel." *Id.* at 20:54–55. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Ma '546 at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '546) in order to carry out uplink and random access protocols. In addition, Johnston and Ma '546 identify the common problem of improving efficiency of multiple-access OFDM wireless communication systems. *See* Johnston at 1–2, 4–6; *see* Ma '546 at 2:6–44. A POSITA would have been motivated to combine Johnston with Ma '546 because Ma '546 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Johnston. *See* Johnston at 1–2, 4–6; *see* Ma '546 at Abstract, 2:48–56.

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- **Johnston and Ma '429:** Ma '429 teaches and describes "[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network." Ma '429 at [0003]. "[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . ." *Id.* at [0010]. Ma '429 further describes "a Random Access Channel (RACH) for UE's new to a particular wireless network to access the system." *Id.* at [0205]. "A dedicated long complex PN/Golay code set is reserved for RACH of each base station," and "[t]he covering PN code for each base station is different from those of the neighboring base stations . . . ." *Id.* at [0215], [0217]. "The base station can broadcast this information through a DL signaling channel." *Id.* at [0215]. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Ma '429 at least

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because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '429) in order to carry out uplink and random access protocols. In addition, Johnston and Ma '429 identify the common problem of improving efficiency of multiple-access OFDM wireless communication systems. *See* Johnston at 1–2, 4–6; *see* Ma '429 at [0007]–[0009]. A POSITA would have been motivated to combine Johnston with Ma '429 because Ma '429 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Johnston. *See* Johnston at 1–2, 4–6; *see* Ma '429 at Abstract, [0010].

- **Johnston and Mody:** Mody teaches and describes "a wireless Orthogonal Frequency Division Multiplexing (OFDM) communication system[.]" Mody at Abstract. Mody further discloses "a system for synchronizing data transmitted across a channel." *Id.* The communication system of Mody "may be part of a . . . Wireless[MAN] system." Mody at 3:41–44. Mody further discloses communication between "a number of transmitting antennas [and] a number of receiving antennas [] used to receive the transmitted signals." Mody at 2:32–35. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing

formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Mody at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Mody) in order to carry out uplink and random access protocols. In addition, Johnston and Mody identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems. *See* Johnston at 1–6; *see* Mody at Abstract, [0008]. A POSITA would have been motivated to combine Johnston with Mody because Mody provides a sequence of training symbols and/or preambles and improved synchronization and channel estimation in MIMO systems to the problem identified by Johnston. *See* Johnston at 1–6; *see* Mody at Abstract, [0008]–[0012].

- **Johnston and Kriedte '196:** Kriedte '196 teaches and describes "a wireless communication system, such as a multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) wireless LAN system[.]" Kriedte '196 at Abstract. Kriedte '196 further discloses communication between "N_t transmit antennas and N_t receive antennas[.]" Kriedte '196 at 3:29–30. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer

requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Kriedte '196 at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kriedte '196) in order to carry out uplink and random access protocols. In addition, Johnston and Kriedte '196 identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems. *See* Johnston at 2, 4–6; *see* Kriedte '196 at Abstract, 1:17–59. A POSITA would have been motivated to combine Johnston with Kriedte '196 because Kriedte '196 provides symbol timing techniques to the problem identified by Johnston. *See* Johnston at 2, 4–6; *see* Kriedte '196 at Abstract, 1:61–2:41.

- **Johnston and Boehnke:** Boehnke teaches and describes "wireless communication systems with high-speed mobile access, . . . wherein Orthogonal Frequency Division Multiplexing (OFDM) is applied as a multi-carrier modulation technique."

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Boehnke at Abstract. Boehnke further describes a system in which "mobile stations" or "mobile terminals" communicate on the uplink and downlink with an "Access Point (AP)." Boehnke at [0036]–[0038]. Boehnke teaches transmission phases of an "Uplink Phase" followed by a "Random Access Phase." *Id.* Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Boehnke at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Boehnke) in order to carry out uplink and random access protocols. In addition, Johnston and Boehnke identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems. *See* Johnston at 1–2, 4–6; *see* Boehnke at Abstract, [0052]–[0058]. A POSITA would have been motivated to combine Johnston with

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Boehnke because Boehnke provides a new pilot pattern and insertion of reference symbols to support channel estimation and synchronization to the problem identified by Johnston. *See* Johnston at 1–2, 4–6; *see* Boehnke at Abstract, [0052]–[0068].

- **Johnston and Chheda:** Chheda teaches and describes "using . . . OFDM for broadband wireless systems." Chheda further describes "User Terminals," "Subscriber Units," and "Customer Premise Equipment" in communication with "Base Stations," "Wireless Base Stations" or "Base Transceiver Stations." Chheda at 22, 30, and 105. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Chheda at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that

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disclosed in Chheda) in order to carry out uplink and random access protocols. In addition, Johnston and Chheda identify the common problem of improving effectiveness and efficiency of wireless communication systems. *See* Johnston at 1, 5–6; *see* Chheda at 1–10. A POSITA would have been motivated to combine Johnston with Chheda because Chheda provides OFDM multiple-access techniques to the problem identified by Johnston. *See* Johnston at 1, 5–6; *see* Chheda at 1–10, 74–95.

- **Johnston and HiperLAN/2 DLC Specification Part 2:** HiperLAN/2 DLC Specification Part 2 teaches and describes "the basic Radio Link Control (RLC) sublayer of HIPERLAN/2" which "is confined to . . . the physical and the data link control layer." HiperLAN/2 DLC Specification Part 2 at 9. Among other things, the "scope of HIPERLAN/2 standards" covers both the "Physical Layer" and "Medium Access Control." *Id.* at 14, Figures 1–2. HiperLAN/2 DLC Specification Part 2 further describes communication between "Mobile Terminals" and "Access Points." *Id.* at 19. For example, the "Uplink phase" is "part of the MAC frame in which data is transmitted from the mobile terminals to an access point or a central controller. *Id.* at 12. HiperLAN/2 DLC Specification Part 2 further describes various uplink channels, including a "Random Access CHannel [RACH]," and a "Random CHannel [RCH]." *Id.* HiperLAN/2 DLC Specification Part 2 uses a "normal" and "short" "OFDM symbol guard interval" in the PHY layer. *Id.* at 178. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX

system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with HiperLAN/2 DLC Specification Part 2 at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 2) in order to carry out uplink and random access protocols. In addition, Johnston and HiperLAN/2 DLC Specification Part 2 identify the common problem of greater efficiency and reliability in OFDM wireless communication systems. *See* Johnston at 1–6; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13. A POSITA would have been motivated to combine Johnston with HiperLAN/2 DLC Specification Part 2 because HiperLAN/2 DLC Specification Part 2 provides radio link control layer functions, messages, and formats to the problem identified by Johnston. *See* Johnston at 1–6; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13.

- **Johnston and HiperLAN/2 PHY Specification:** HiperLAN/2 PHY Specification teaches and describes "the physical layer specifications for HIgh PErformance

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Radio Local Area Network type 2 (HIPERLAN/2)," HiperLAN/2 PHY Specification at 5–6. "The PHY layer of HIPERLAN/2 . . . provides for functions to map different DLC PDU trains into framing formats called PHY bursts appropriate for transmitting and receiving management and user information between an [Access Point] and a [Mobile Terminal] . . . ." *Id.* at 10. "The PHY layer of HIPERLAN/2 is based on the modulation scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* HiperLAN/2 PHY Specification further describes a "Random CHannel (RCH)" used to "carr[y] the logical channels random access channel and association channel," and that "[t]he BCH includes 2 bits which announce the guard time between random access bursts." *Id.* at 7, 33. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine

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Johnston with HiperLAN/2 PHY Specification at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 PHY Specification) in order to carry out uplink and random access protocols. In addition, Johnson and HiperLAN/2 PHY Specification identify the common problem of greater efficiency and reliability in OFDM wireless communication systems. *See* Johnston at 1–6; *see* HiperLAN/2 PHY Specification at 6, 9. A POSITA would have been motivated to combine Johnston with HiperLAN/2 PHY Specification because HiperLAN/2 PHY Specification provides a multi-rate PHY layer and link adaptation scheme to the problem identified by Johnston. *See* Johnston at 1–6; *see* HiperLAN/2 PHY Specification at 6, 9, 11.

- **Johnston and Gibson:** Gibson teaches and describes "wireless communication systems" using "[frequency division multiple access [with] signals assigned to different users [that] are clearly orthogonal . . . ." Gibson at p.17-4. Gibson discloses a "mobile station" which "initiates the procedure by transmitting a request [to the base station] on a random-access channel." *Id.* at p.17-8–17-9. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC)

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and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Gibson at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Gibson). In addition, Johnston and Gibson identify the common problem of improving efficiency in wireless communication systems. *See* Johnston 1–2, 5–6; *see* Gibson at 17-4–17-12. A POSITA would have been motivated to combine Johnston with Gibson because Gibson provides channel assignment and multiple access techniques to the problem identified by Johnston. *See* Johnston at 1–2, 5–6; *see* Gibson at 17-4–17-12, and Figure 17.3.

- **Johnston and Suh '464:** Suh '464 teaches and describes "an orthogonal frequency division multiplexing (OFDM) communication system . . . ." Suh '464 at [0003]. "[A] wireless communication system is comprised of Node Bs and user equipments (UEs)," where "[t]he Node B's and the UEs transmit data by the frame for a wireless communication service." *Id.* at [0005]. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base

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station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Suh '464 at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Suh '464) in order to carry out uplink and random access protocols. In addition, Johnston and Suh '464 identify the common problem of improving efficiency in OFDM wireless communication systems. *See* Johnston at 1–2, 5–6; *see* Suh '464 at Abstract, [0002]–[0044]. A POSITA would have been motivated to combine Johnston with Suh '464 because Suh '464 provides generating a preamble sequence for low peak-to-average power ration and improved channel estimation to the problem identified by Johnston. *See* Johnston at 1–2, 5–6; *see* Suh '464 at Abstract, [0042]–[0049].

- **Johnston and Kanterakis:** Kanterakis teaches and describes "spread-spectrum communications," where "[t]he CMDA system has a base station (BS) and a plurality of remote stations." Kanterakis at 1:5, 27–28. Kanterakis further describes "a random-access burst structure which has a preamble followed by a data portion," where "the preamble sequence [is] spread by an orthogonal Gold code."

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Id. at 1:5–18. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Kanterakis at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Kanterakis). In addition, Johnston and Kanterakis identify the common problem of improving efficiency and reliability in wireless communication systems. *See* Johnston at 1–5; Kanterakis at Abstract, 1:10–23. A POSITA would have been motivated to combine Johnston with Kanterakis because Kanterakis provides spread spectrum modulation to the problem identified by Johnston. *See* Johnston at 1–5; *see* Kanterakis at Abstract, 1:10–2:11.

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- **Johnston and Frank:** Frank teaches and describes a "mobile telecommunications system" with "a method and system for processing multiple random access calls in a [CDMA] . . . system." Frank at 1:5-13. Frank further describes "[a]n uplink common physical channel (random access channel) frame structure . . . with a separate preamble and data portion," where "[t]he preamble is used by a base station to detect that a mobile station is attempting a random access request." *Id.* at Abstract. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Johnston with Frank at least because Johnston provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Frank). In addition, Johnston and Frank identify the common problem of improving efficiency and

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effectiveness in wireless communication systems. *See* Johnston at 1–6; Frank at Abstract, 1:11–5:31. A POSITA would have been motivated to combine Johnston with Frank because Frank provides a random access channel frame structure with separate preamble and data portions to the problem identified by Johnston. *See* Johnston at 1–6; *see* Frank at Abstract, 6:1–7:11.

(xiii) Walton ’131 in combination with the knowledge of a skilled artisan, Eklund, Johnston, Engstrom, Wahlqvist, Mantha, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton ’301, Walton ’944, Walton ’269, Jeong ’589, Kaiser, Benedittis ’812, Ma ’437, Ma ’546, Ma ’429, Mody, Kriedte ’196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh ’464, Kanterakis, and/or Frank.

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Walton ’131 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Walton ’131 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’450 patent was filed. Specifically:

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- Walton ’131, Eklund, Johnston, Engstrom, Wahlqvist, Mantha, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton ’301, Walton ’944, Walton ’269, Jeong ’589, Kaiser, Benedittis ’812, Ma ’437, Ma ’546, Ma ’429, Mody, Kriedte ’196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh ’464, Kanterakis, and/or Frank are all directed to systems and methods for a broadband wireless communication system related transmission. For example, they relate to broadband wireless communication between a mobile station and a base station using OFDM transmission and/or a related transmission scheme, and in particular to uplink and random access signal protocols. They involve communication protocols, standards, OFDM and/or related transmission methods, and access schemes that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Walton ’131 and Eklund:** Eklund is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Eklund teaches and describes the “IEEE Standard 802.16, with its WirelessMAN air interface,” and overviews “the technical medium access control and physical layer features” of this standard. Eklund at Abstract. WirelessMAN also “provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS).” Eklund at 3. “WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform.” Eklund at 3, 5. Eklund further discloses “initial access” opportunities that are followed by “requests for bandwidth in either

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random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Eklund at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Eklund) in order to carry out uplink and random access protocols. In addition, Walton '131 and Eklund identify the common problem of providing greater efficiency for OFDM systems in wireless communication systems by, for example, improving packing efficiency. *See* Walton '131 at Abstract, [0009]–[0010], [0035], [0055]; *see* Eklund at 4–5, 7–8. A POSITA would have been motivated to combine Walton '131 with Eklund because

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Eklund provides medium access control designed for point-to-multipoint broadband wireless access and OFDM PHY layer techniques specified for use between 10–66 GHz to the problem identified by Walton '131. *See* Walton '131 at Abstract, [0009]–[0010], [0035], [0055]; *see* Eklund at 4–5, 7–8.

- **Walton '131 and Johnston:** Johnston is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" and "bandwidth request" slots in the uplink. Johnston at 6. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is

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"to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Johnston at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Johnston) in order to carry out uplink and random access protocols. In addition, Walton '131 and identify the common problem of providing greater efficiency for OFDM systems in wireless communication systems by, for example, improving packing efficiency and random access. *See* Walton '131 at Abstract, [0009]–[0010], [0035], [0050]–[0055]; *see* Johnston at 2–6. A POSITA would have been motivated to combine Walton '131 with Johnston because Johnston provides OFDM PHY mode for use between 2 and 11 GHz and medium access control techniques to the problem identified by Walton '131. *See* Walton '131 at Abstract, [0009]–[0010], [0035], [0050]–[0055]; *see* Johnston at 2–6.

- **Walton '131 and Engstrom:** Engstrom is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Engstrom teaches and describes "a random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital communication system . . . ." Engstrom at Abstract. Engstrom further describes "using OFDM for an uplink between a mobile station and base station in which a

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mobile station transmits a random access sequence. . . ." *Id.* at 2:51–3:8. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Engstrom at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Engstrom) in order to carry out uplink and random access protocols. In addition, Walton '131 and Engstrom identify the common problem of improving initialization and random access procedures. *See* Walton '131 at Abstract, [0009]–[0010], [0050]–[0056], [0063], [0134]; *see* Engstrom at 2:51–3:18, 5:3–7, 6:36–7:67. A POSITA would have been motivated to combine Walton '131 with Engstrom because Engstrom provides a random access protocol in which a random

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access sequence can be cyclically repeated to the problem identified by Walton '131. *See* Walton '131 at Abstract, [0009]–[0010], [0050]–[0056], [0063], [0134]; *see* Engstrom at 2:43–48.

- **Walton '131 and Wahlqvist:** Wahlqvist is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wahlqvist teaches and describes "[the] use of orthogonal frequency division multiplex[ing] [OFDM] in a cellular system requir[ing] that the base station and the mobile station are time and frequency synchronized in order to preserve orthogonality between the subcarriers." Wahlqvist at Abstract. Wahlqvist further discloses "an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol." *Id.* at 1. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission

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between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Wahlqvist at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Wahlqvist) in order to carry out uplink and random access protocols. In addition, Walton '131 and Wahlqvist identify the common problem of providing greater efficiency for OFDM systems in wireless communication systems by, for example, improving random access procedures. *See* Walton '131 at Abstract, [0009]–[0010], [0050]-[0056], [0063], [0134]; *see* Wahlqvist at 1–3. A POSITA would have been motivated to combine Walton '131 with Wahlqvist because Wahlqvist provides an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol to the problem identified by Walton '131. *See* Walton '131 at Abstract, [0009]–[0010], [0050]-[0056], [0063], [0134]; *see* Wahlqvist 1–4.

- **Walton '131 and Mantha:** Mantha is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Mantha teaches and describes a "communication channel structure and method in a wireless communication system," where "the communication system includes a base station and a plurality of subscriber stations and the subscriber stations are given access to a variety of channels, including at least one uplink data channel." Mantha at Abstract. "The uplink data channel can operate in at least a random access mode . . . ." *Id.* "[W]ireless link employs CDMA as a multiple access technique to channelize and share link, although other multiple access techniques such as OFDM, etc. can be used." *Id.* at [0050]. Walton '131 teaches and describes "data

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communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Mantha at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Mantha) in order to carry out uplink and random access protocols. In addition, Walton '131 and Mantha identify the common problem of providing lower latency, lower error rates, and overall greater efficiency in OFDM systems in wireless communication systems. *See* Walton '131 at Abstract, [0003]–[0015], [0028], [0030]–[0035], [0045], [0054]–[0055], [0076]; *see* Mantha at [0004], [0010], [0013]–[0014]. A POSITA would have been motivated to combine Walton '131 with Mantha because Mantha provides a channel structure and method of monitoring the uplink channels and switching

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between a random access or polled mode to the problem identified by Walton '131. *See* Walton '131 at Abstract, [0003]–[0015], [0028], [0030]–[0035], [0045], [0054]–[0055], [0076]; *see* Mantha at [0015]–[0040].

- **Walton '131 and WiMAX 2003:** WiMAX 2003 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Defendants also incorporate by reference the citations in the WiMAX 2003 invalidity chart into the invalidity chart for Walton '131. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at

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[0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with WiMAX 2003 at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in WiMAX 2003) in order to carry out uplink and random access protocols. In addition, Walton '131 and WiMAX 2003 identify the common problem of providing enhancements to OFDM wireless communication systems by, for example, improving physical and medium access control layers. *See* Walton '131 at [0001]–[0015], [0050]–[0063], [0080]–[0134]; *see* WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2. A POSITA would have been motivated to combine Walton '131 with WiMAX 2003 because WiMAX 2003 provides enhancements to PHY and MAC layers that support difficult user environments, high bandwidth, continuous and burst traffic, and efficient spectrum use to the problem identified by Wahlqvist. *See* Walton '131 at [0001]–[0015], [0050]–[0063], [0080]–[0134]; *see* WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2 and https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 18.

- **Walton '131 and HiperLAN/2 DLC Specification Part 1:** HiperLAN/2 DLC Specification Part 1 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. HiperLAN/2 DLC Specification Part 1 teaches and describes a "Mobile Terminal (MT) . . . that communicates with

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an access point or with each other via a radio link." HiperLAN/2 DLC Specification Part 1 at 9. HiperLAN/2 DLC Specification Part 1 further discloses "Medium Access Control protocol" and "physical (PHY) layer of HIPERLAN/2 . . . ." *Id.* at 13–14. The PHY layer "is based on the modulation scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* at 14. HiperLAN/2 DLC Specification Part 1 discloses both an "uplink phase" and a "random access phase." *Id.* at 8–10. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with HiperLAN/2 DLC Specification Part 1 at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that

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disclosed in HiperLAN/2 DLC Specification Part 1) in order to carry out uplink and random access protocols. In addition, Walton '131 and HiperLAN/2 DLC Specification Part 1 identify the common problem of greater efficiency and reliability in OFDM wireless communication systems. *See* Walton '131 at [0001]–[0015], [0030], [0080]–[0101]; *see* HiperLAN/2 DLC Specification Part 1 at 14. A POSITA would have been motivated to combine Walton '131 with HiperLAN/2 DLC Specification Part 1 because HiperLAN/2 DLC Specification Part 1 provides a multi-rate PHY layer, where the appropriate mode can be selected by a link adaptation scheme based on different interferences situations and distances among MTs and an AP, to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0030], [0080]–[0101]; *see* HiperLAN/2 DLC Specification Part 1 at 14.

- **Walton '131 and Walton '301:** Walton '301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '301 teaches and describes "a multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. Walton '301 further describes "a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 3:54–63. Walton '301 further describes an "uplink phase" that consists of "one or more [Reverse Channel] PDUs [] transmitted in a fourth segment and one more [Random Access Channel] PDUs transmitted in a fifth segment . . . ." *Id.* at Walton '301 at 11:7–16. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques

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for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Walton '301 at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '301) in order to carry out uplink and random access protocols. In addition, Walton '131 and Walton '301 identify the common problem of providing improved performance of OFDM systems in wireless communication systems. *See* Walton '131 at Abstract, [0001]–[0015]; *see* Walton '301 at 1:35–51, 2:3. A POSITA would have been motivated to combine Walton '131 with Walton '301 because Walton '301 provides additional MIMO structure to the problem identified by Walton '131. *See* Walton '131 at Abstract, [0001]–[0015]; *see* Walton '301 at Abstract, 1:11–3:2. A POSITA would further be motivated to combine Walton '131 with Walton '301

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because they share the same inventors and claim priority to the same provisional application No. 60/421,309 (Walton '309).

- **Walton '131 and Walton '944:** Walton '944 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '944 teaches and describes "techniques for facilitating random access in wireless multiple-access communication systems," where the system employs orthogonal frequency division multiplexing (OFDM) . . . ." Walton '944 at Abstract, 3:34–37. Walton '944 further describes "a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 2:57–3:10. "[T]he uplink transport channels include a reverse channel (RCH) and a random access channel (RACH) . . . ." *Id.* at 3:49–4:9. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM

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transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Walton '944 at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '944) in order to carry out uplink and random access protocols. In addition, Walton '131 and Walton '944 identify the common problem of providing effective and efficient system access in wireless communication systems. *See* Walton '131 at [0001]–[0015], [0050]–[0056]; *see* Walton '944 at Abstract, 1:60–62. A POSITA would have been motivated to combine Walton '131 with Walton '944 because Walton '944 provides a fast and slow random access channel option to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0050]–[0056]; *see* Walton '301 at Abstract, 2:1–18. A POSITA would further be motivated to combine Walton '131 with Walton '944 because they share the same inventors and claim priority to the same provisional application No. 60/421,309 (Walton '309).

- **Walton '131 and Walton '269:** Walton '269 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ' 269 teaches and describes "data communication and processing . . . for providing an efficient control channel structure in a wireless local area network (WLAN) communication system." Walton '269 at 1:9–13. "MIMO and orthogonal frequency division multiplexing (OFDM) may be employed to obtain high throughput, combat deleterious path effects, and provide other benefits." *Id.* at 1:66–2:3. Walton '269 further discloses a system that "includes a number of access points (APs) that support communication for a number of user terminals (UTs)."

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Id. at 3:26–28. Walton '269 discloses "uplink transport channels used by the UTs" that include a "Reverse Channel" and a "Random Access Channel." *Id.* at 9:14–15, and Figures 4 and 5. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Walton '269 at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '269) in order to carry out uplink and random access protocols. In addition, Walton '131 and Walton '269 identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems, for example, by improving channel structure. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0063], [0069]–[0079], [0080]–

[0133]; *see* Walton ’269 at Abstract, 2:8–36. A POSITA would have been motivated to combine Walton ’131 with Walton ’269 because Walton ’269 discloses a more efficient control channel structure that is able to accommodate different users operating at different rates to the problem identified by Walton ’131. *See* Walton ’131 at [0001]–[0015], [0050]–[0056], [0063], [0069]–[0079], [0080]–[0133]; *see* Walton ’269 at Abstract, 2:36–40. A POSITA would further be motivated to combine Walton ’131 with Walton ’944 because they share two of the same inventors.

- **Walton ’131 and Jeong ’589:** Jeong ’589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong ’589 teaches and describes “a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access (“OFDMA”) type wireless communication system . . . .” Jeong ’589 Translation at Abstract. Jeong ’589 further discloses that “[i]n IEEE 802.16ab, OFDMA wireless communication system is defined such that data can be transmitted between a base station (“BS”) and a subscriber station (“SS”) using a microwave frequency band between 2 GHz and 11 GHz.” *Id.* at 2. Jeong ’589 discloses that “the SS transmits a ranging signal to the BS using a ranging sub-channel and a ranging code arbitrarily selected in a ranging interval section.” *Id.* at 9. Walton ’131 teaches and describes “data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency.” Walton ’131 at [0003]. Walton ’131 teaches “an

exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDMA transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Jeong '589 at least because Walton '131 provides specifications of a wireless communication system that uses OFDMA transmission (such as that disclosed in Jeong '589) in order to carry out uplink and random access protocols. In addition, Walton '131 and Jeong '589 identify the common problem of improving initial ranging and channel allocation in wireless communication systems. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0103], and Table 4; *see* Jeong '589 Translation at Abstract, 2–3. A POSITA would have been motivated to combine Walton '131 with Jeong '589 because Jeong '589 provides an initial ranging interval and ranging subchannel allocation method for initial ranging of multi-user OFDMA to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0103], and Table 4; *see* Jeong '589 Translation at Abstract, 2–3.

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- **Walton ’131 and Kaiser:** Kaiser is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kaiser teaches and describes “a multiple access scheme for mobile multi-media applications. . . . referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA)” for “the uplink of a mobile radio system . . . .” Kaiser at Abstract, p.100. Kaiser further discloses “applying OFDM” to SS-MC-MA such that “data transmission can be based on OFDM-frames, where each frame consists of several OFDM-symbols.” *Id.* at pp.102–103. Kaiser discloses a transmitter and receiver using “OFDM with [a] user-specific frequency mapper.” *Id.* at p.101. Walton ’131 teaches and describes “data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency.” Walton ’131 at [0003]. Walton ’131 teaches “an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)” for uplink and downlink communication. Walton ’131 at [0048]. Walton ’131 further teaches “uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton ’131 is “to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency.” *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton ’131 with Kaiser at

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least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kaiser) in order to carry out uplink and random access protocols. In addition, Walton '131 and Kaiser identify the common problem of improving flexibility of bandwidth allocation and effective error correction in wireless communication systems. *See* Walton '131 at [0001]–[0015], [0030]–[0038], [0045], [0062], [0125]; *see* Kaiser at 1. A POSITA would have been motivated to combine Walton '131 with Kaiser because Kaiser provides a scheme with variable sub-carrier allocation and effective error protection to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0030]–[0038], [0045], [0062], [0125]; *see* Kaiser at 1.

- **Walton '131 and Benedittis '812:** Benedittis '812 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Benedittis '812 teaches and describes a "third generation (3G) cellular system of UMTS (Universal Mobile Telecommunication System)," including "a method for optimizing the random access procedures in the CDMA cellular networks," where "[t]he spreading code sequences [are] reciprocally orthogonal . . . ." Benedittis '812 at [0001]–[0002]. Benedittis '812 also discloses "MS (Mobile Stations or Mobile Units), also vehicular ones, and portable User Equipment units UE, [] radio connected with relevant TRC transceivers [] belonging to relevant base transceiver stations BTSC (Base Transceiver Station for CDMA) spread on the territory." *Id.* at [0053]–[0054]. Benedittis '812 discloses "m uplink time slots . . . coming from the mobile stations MS/UE . . . ." *Id.* at [0057]. Benedittis '812 further discloses sending "the first SYNC1 signatures sent from the mobile" followed by "a

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successive CHANNEL REQUEST message sent from the mobile on a [Random Access Channel.]" *Id.* at [0104]–[0106], and Figure 7. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Benedittis '812 at least because Walton '131 provides specifications of a wireless communication system that utilizes a first uplink signal followed by a random access protocol (such as that disclosed in Benedittis '812). In addition, Walton '131 and Benedittis '812 identify the common problem of improving efficiency and minimizing delay in accessing the network in wireless communication systems. *See* Walton '131 at [0001]–[0015], [0028]–[0035], [0050]–[0056], [0076]; *see* Benedittis '812 at [0021]–[0022]. A POSITA would have been motivated to combine Walton '131 with Benedittis '812

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because Benedittis ’812 provides an optimized random access procedure to the problem identified by Walton ’131. *See* Walton ’131 at [0001]–[0015], [0028]–[0035], [0050]–[0056], [0076]; *see* Benedittis ’812 at Abstract, [0021]–[0022].

- **Walton ’131 and Ma ’437:** Ma ’437 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma ’437 teaches and describes “physical layer structures and related access schemes for unsynchronized [wireless] communication networks,” Ma ’437 at Abstract, where “the communication signal is an OFDM signal,” *id.* at 2:25–26. Ma ’437 further discloses “a wireless communication network . . . . [that] includes base transceiver stations (BTSs),” and “[u]ser equipment (UE) [that] is adapted to communicate with any of the BTSs that are within its range[.]” Ma ’437 at 4:61–67. Walton ’131 teaches and describes “data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency.” Walton ’131 at [0003]. Walton ’131 teaches “an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)” for uplink and downlink communication. Walton ’131 at [0048]. Walton ’131 further teaches “uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton ’131 is “to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency.” *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access

control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Ma '437 at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '437) in order to carry out uplink and random access protocols. In addition, Walton '131 and Ma '437 identify the common problem of improving access to the network and base station identification in OFDM wireless communication systems. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0102]–[0133]; *see* Ma '437 at Abstract, 1:41–2:3. A POSITA would have been motivated to combine Walton '131 Eklund with Ma '437 because Ma '437 provides common and cell-specific synchronization codes, preambles, and/or pilots to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0102]–[0133]; *see* Ma '437 at Abstract, 1:41–2:3, 2:14–62.

- **Walton '131 and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 teaches and describes "[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network." Ma '546 at 1:20–22. "[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . ." *Id.* at 2:48–50. Ma '546 further describes "a Random Access Channel (RACH) for UE's new to a particular wireless network to access the system." *Id.* at 19:45–48. "A dedicated long complex PN/Golay code set is reserved for RACH of each base station," and "[t]he covering PN code for each base station is different from those of the neighboring base stations . . . ." *Id.* at

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20:50–51, 21:1–5. "The base station can broadcast this information through a DL signaling channel." *Id.* at 20:54–55. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Ma '546 at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '546) in order to carry out uplink and random access protocols. In addition, Walton '131 and Ma '546 identify the common problem of improving efficiency of multiple-access OFDM wireless communication systems. *See* Walton '131 at [0001]–[0015], [0028]–[0031], [0039], [0046], [0050]–[0056], [0070] and Table 2; *see* Ma '546 at 2:6–44. A POSITA would have been motivated to combine Walton '131 with Ma '546

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because Ma ’546 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Walton ’131. *See* Walton ’131 at [0001]–[0015], [0028]–[0031], [0039], [0046], [0050]–[0056], [0070] and Table 2; *see* Ma ’546 at Abstract, 2:48–56.

- **Walton ’131 and Ma ’429:** Ma ’429 teaches and describes “[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network.” Ma ’429 at [0003]. “[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . .” *Id.* at [0010]. Ma ’429 further describes “a Random Access Channel (RACH) for UE’s new to a particular wireless network to access the system.” *Id.* at [0205]. “A dedicated long complex PN/Golay code set is reserved for RACH of each base station,” and “[t]he covering PN code for each base station is different from those of the neighboring base stations . . . .” *Id.* at [0215], [0217]. “The base station can broadcast this information through a DL signaling channel.” *Id.* at [0215]. Walton ’131 teaches and describes “data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency.” Walton ’131 at [0003]. Walton ’131 teaches “an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)” for uplink and downlink communication. Walton ’131 at [0048]. Walton ’131 further teaches “uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton ’131 is “to achieve greater efficiency for OFDM systems . . . . [by]

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minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Ma '429 at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '429) in order to carry out uplink and random access protocols. In addition, Walton '131 and Ma '429 identify the common problem of improving efficiency of multiple-access OFDM wireless communication systems. *See* Walton '131 at [0001]–[0015], [0028]–[0031], [0039], [0046], [0050]–[0056], [0070] and Table 2; *see* Ma '429 at [0007]–[0009]. A POSITA would have been motivated to combine Walton '131 with Ma '429 because Ma '429 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0028]–[0031], [0039], [0046], [0050]–[0056], [0070] and Table 2; *see* Ma '429 at Abstract, [0010].

- **Walton '131 and Mody:** Mody teaches and describes "a wireless Orthogonal Frequency Division Multiplexing (OFDM) communication system[.]" Mody at Abstract. Mody further discloses "a system for synchronizing data transmitted across a channel." *Id.* The communication system of Mody "may be part of a . . . Wireless[MAN] system." Mody at 3:41–44. Mody further discloses communication between "a number of transmitting antennas [and] a number of receiving antennas [] used to receive the transmitted signals." Mody at 2:32–35.

Walton ’131 teaches and describes “data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency.” Walton ’131 at [0003]. Walton ’131 teaches “an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)” for uplink and downlink communication. Walton ’131 at [0048]. Walton ’131 further teaches “uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton ’131 is “to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency.” *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton ’131 with Mody at least because Walton ’131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Mody) in order to carry out uplink and random access protocols. In addition, Walton ’131 and Mody identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems. *See* Walton ’131 at [0001]–[0015], [0050]–[0056], [0086]–[0087], [0102]–[0133]; *see* Mody at Abstract, [0008]. A POSITA would have been motivated to combine Walton ’131 with Mody because Mody provides a sequence of training symbols and/or preambles and improved synchronization and channel estimation in MIMO systems

to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0086]–[0087], [0102]–[0133]; *see* Mody at Abstract, [0008]–[0012].

- **Walton '131 and Kriedte '196:** Kriedte '196 teaches and describes "a wireless communication system, such as a multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) wireless LAN system[.]" Kriedte '196 at Abstract. Kriedte '196 further discloses communication between "N_t transmit antennas and N_t receive antennas[.]" Kriedte '196 at 3:29–30. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Kriedte '196 at least because Walton '131 provides specifications of a wireless

communication system that uses OFDM transmission (such as that disclosed in Kriedte '196) in order to carry out uplink and random access protocols. In addition, Walton '131 and Kriedte '196 identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems. *See* Walton '131 at [0001]–[0015], [0068], [0102]–[0133]. Eklund at 4–5, 8–11; *see* Kriedte '196 at Abstract, 1:17–59. A POSITA would have been motivated to combine Walton '131with Kriedte '196 because Kriedte '196 provides symbol timing techniques to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0068], [0102]–[0133].; *see* Kriedte '196 at Abstract, 1:61–2:41.

- **Walton '131 and Boehnke:** Boehnke teaches and describes "wireless communication systems with high-speed mobile access, . . . wherein Orthogonal Frequency Division Multiplexing (OFDM) is applied as a multi-carrier modulation technique." Boehnke at Abstract. Boehnke further describes a system in which "mobile stations" or "mobile terminals" communicate on the uplink and downlink with an "Access Point (AP)." Boehnke at [0036]–[0038]. Boehnke teaches transmission phases of an "Uplink Phase" followed by a "Random Access Phase." *Id.* Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink

transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Boehnke at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Boehnke) in order to carry out uplink and random access protocols. In addition, Walton '131 and Boehnke identify the common problem of improving effectiveness and efficiency of OFDM wireless communication systems. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0102]–[0133]; *see* Boehnke at Abstract, [0052]–[0058]. A POSITA would have been motivated to combine Walton '131 with Boehnke because Boehnke provides a new pilot pattern and insertion of reference symbols to support channel estimation and synchronization to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0102]–[0133]; *see* Boehnke at Abstract, [0052]–[0068].

- **Walton '131 and Chheda:** Chheda teaches and describes "using . . . OFDM for broadband wireless systems." Chheda further describes "User Terminals," "Subscriber Units," and "Customer Premise Equipment" in communication with "Base Stations," "Wireless Base Stations" or "Base Transceiver Stations." Chheda

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at 22, 30, and 105. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Chheda at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Chheda) in order to carry out uplink and random access protocols. In addition, Walton '131 and Chheda identify the common problem of improving effectiveness and efficiency of wireless communication systems. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0103], [0134]–[0138]; *see* Chheda at 1–10. A POSITA would have been motivated to combine Eklund with Chheda because Chheda provides OFDM multiple-access techniques to the problem identified by Eklund. *See* Walton '131

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at [0001]–[0015], [0050]–[0056], [0103], [0134]–[0138]; *see* Chheda at 1–10, 74–95.

- **Walton '131 and HiperLAN/2 DLC Specification Part 2:** HiperLAN/2 DLC Specification Part 2 teaches and describes "the basic Radio Link Control (RLC) sublayer of HIPERLAN/2" which "is confined to . . . the physical and the data link control layer." HiperLAN/2 DLC Specification Part 2 at 9. Among other things, the "scope of HIPERLAN/2 standards" covers both the "Physical Layer" and "Medium Access Control." *Id.* at 14, Figures 1–2. HiperLAN/2 DLC Specification Part 2 further describes communication between "Mobile Terminals" and "Access Points." *Id.* at 19. For example, the "Uplink phase" is "part of the MAC frame in which data is transmitted from the mobile terminals to an access point or a central controller. *Id.* at 12. HiperLAN/2 DLC Specification Part 2 further describes various uplink channels, including a "Random Access CHannel [RACH]," and a "Random CHannel [RCH]." *Id.* HiperLAN/2 DLC Specification Part 2 uses a "normal" and "short" "OFDM symbol guard interval" in the PHY layer. *Id.* at 178. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of

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Walton ’131 is “to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency.” *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton ’131 with HiperLAN/2 DLC Specification Part 2 at least because Walton ’131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 2) in order to carry out uplink and random access protocols. In addition, Walton ’131 and HiperLAN/2 DLC Specification Part 2 identify the common problem of greater efficiency and reliability in OFDM wireless communication systems. *See* Walton ’131at [0001]–[0015], [0050]–[0056], [0063]–[0065], [0134]; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13. A POSITA would have been motivated to combine Walton ’131 with HiperLAN/2 DLC Specification Part 2 because HiperLAN/2 DLC Specification Part 2 provides radio link control layer functions, messages, and formats to the problem identified by Walton ’131. *See* Walton ’131at [0001]–[0015], [0050]–[0056], [0063]–[0065], [0134]; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13.

- **Walton ’131 and HiperLAN/2 PHY Specification:** HiperLAN/2 PHY Specification teaches and describes “the physical layer specifications for HIgh PErformance Radio Local Area Network type 2 (HIPERLAN/2),” HiperLAN/2 PHY Specification at 5–6. “The PHY layer of HIPERLAN/2 . . . provides for

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functions to map different DLC PDU trains into framing formats called PHY bursts appropriate for transmitting and receiving management and user information between an [Access Point] and a [Mobile Terminal] . . . ." *Id.* at 10. "The PHY layer of HIPERLAN/2 is based on the modulation scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* HiperLAN/2 PHY Specification further describes a "Random CHannel (RCH)" used to "carr[y] the logical channels random access channel and association channel," and that "[t]he BCH includes 2 bits which announce the guard time between random access bursts." *Id.* at 7, 33. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with HiperLAN/2 PHY Specification at least because Walton '131 provides

specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 PHY Specification) in order to carry out uplink and random access protocols. In addition, Walton '131 and HiperLAN/2 PHY Specification identify the common problem of greater efficiency and reliability in OFDM wireless communication systems. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0064]–[0073], [0080]–[0101], [0134]; *see* HiperLAN/2 PHY Specification at 6, 9. A POSITA would have been motivated to combine Walton '131 with HiperLAN/2 PHY Specification because HiperLAN/2 PHY Specification provides a multi-rate PHY layer and link adaptation scheme to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0064]–[0073], [0080]–[0101], [0134]; *see* HiperLAN/2 PHY Specification at 6, 9, 11.

- **Walton '131 and Gibson:** Gibson teaches and describes "wireless communication systems" using "[frequency division multiple access [with] signals assigned to different users [that] are clearly orthogonal . . . ." Gibson at p.17-4. Gibson discloses a "mobile station" which "initiates the procedure by transmitting a request [to the base station] on a random-access channel." *Id.* at p.17-8–17-9. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048].

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Walton ’131 further teaches “uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton ’131 is “to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency.” *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton ’131 with Gibson at least because Walton ’131 provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Gibson). In addition, Walton ’131 and Gibson identify the common problem of improving efficiency in wireless communication systems. *See* Walton ’131 at [0001]–[0015], [0046], [0048]–[0056], [0069]–[0070], [0080]–[0101], [0134]; *see* Gibson at 17-4–17-12. A POSITA would have been motivated to combine Walton ’131 with Gibson because Gibson provides channel assignment and multiple access techniques to the problem identified by Walton ’131. *See* Walton ’131 at [0001]–[0015], [0046], [0048]–[0056], [0069]–[0070], [0080]–[0101], [0134]; *see* Gibson at 17-4–17-12, and Figure 17.3.

- **Walton ’131 and Suh ’464:** Suh ’464 teaches and describes “an orthogonal frequency division multiplexing (OFDM) communication system . . . .” Suh ’464 at [0003]. “[A] wireless communication system is comprised of Node Bs and user equipments (UEs),” where “[t]he Node B’s and the UEs transmit data by the frame for a wireless communication service.” *Id.* at [0005]. Walton ’131 teaches and

describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Suh '464 at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Suh '464) in order to carry out uplink and random access protocols. In addition, Walton '131 and Suh '464 identify the common problem of improving efficiency in OFDM wireless communication systems. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0102]–[0134]; *see* Suh '464 at Abstract, [0002]–[0044]. A POSITA would have been motivated to combine Walton '131 with Suh '464 because Suh '464 provides generating a preamble sequence for low peak-to-average power ratio and improved channel estimation to the problem identified by Walton '131. *See* Walton '131 at

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[0001]–[0015], [0050]–[0056], [0102]–[0134]; *see* Suh '464 at Abstract, [0042]–[0049].

- **Walton '131 and Kanterakis:** Kanterakis teaches and describes "spread-spectrum communications," where "[t]he CMDA system has a base station (BS) and a plurality of remote stations." Kanterakis at 1:5, 27–28. Kanterakis further describes "a random-access burst structure which has a preamble followed by a data portion," where "the preamble sequence [is] spread by an orthogonal Gold code." *Id.* at 1:5–18. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Kanterakis at least because Walton '131 provides specifications of a wireless communication system that uses OFDM

transmission in order to carry out uplink and random access protocols (such as that disclosed in Kanterakis). In addition, Walton '131 and Kanterakis identify the common problem of improving efficiency and reliability in wireless communication systems. *See* Walton '131 at [0001]–[0015], [0028]–[0029], [0066], [0080]–[0101, [0102]–[0134], 10–11; Kanterakis at Abstract, 1:10–23. A POSITA would have been motivated to combine Walton '131 with Kanterakis because Kanterakis provides spread spectrum modulation to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0028]–[0029], [0066], [0080]–[0101, [0102]–[0134]; *see* Kanterakis at Abstract, 1:10–2:11.

- **Walton '131 and Frank:** Frank teaches and describes a "mobile telecommunications system" with "a method and system for processing multiple random access calls in a [CDMA] . . . system." Frank at 1:5-13. Frank further describes "[a]n uplink common physical channel (random access channel) frame structure . . . with a separate preamble and data portion," where "[t]he preamble is used by a base station to detect that a mobile station is attempting a random access request." *Id.* at Abstract. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access

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channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Walton '131 with Frank at least because Walton '131 provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Frank). In addition, Walton '131 and Frank identify the common problem of improving efficiency and effectiveness in wireless communication systems. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0063]–[0072], [0094]–[0095]; Frank at Abstract, 1:11–5:31. A POSITA would have been motivated to combine Walton '131 with Frank because Frank provides a random access channel frame structure with separate preamble and data portions to the problem identified by Walton '131. *See* Walton '131 at [0001]–[0015], [0050]–[0056], [0063]–[0072], [0094]–[0095]; *see* Frank at Abstract, 6:1–7:11.

(xiv) Engstrom in combination with the knowledge of a skilled artisan, Johnston, Walton '131, Eklund, Wahlqvist, Mantha, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton '301, Walton '944, Walton '269, Jeong '589, Kaiser, Benedittis '812, Ma '437, Ma '546, Ma '429, Mody, Kriedte '196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh '464, Kanterakis, and/or Frank.

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Engstrom with each of these

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references. A person of ordinary skill in the art would have found it obvious to combine Engstrom with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

- Johnston, Walton '131, Eklund, Wahlqvist, Mantha, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton '301, Walton '944, Walton '269, Jeong '589, Kaiser, Benedittis '812, Ma '437, Ma '546, Ma '429, Mody, Kriedte '196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh '464, Kanterakis, and/or Frank are all directed to systems and methods for a broadband wireless communication system related transmission. For example, they relate to broadband wireless communication between a mobile station and a base station using OFDM transmission and/or a related transmission scheme, and in particular to uplink and random access signal protocols. They involve communication protocols, standards, OFDM and/or related transmission methods, and access schemes that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

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- **Engstrom and Johnston**: Johnston is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" slots in the uplink. Johnston at 6. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Engstrom at 7:17-67 and Fig.8. Thus, these references were in the same field of endeavor, and describe specifications of the initial access protocol between mobile stations and base stations in an OFDM-based wireless communication system. In addition, Engstrom and Johnston identify the common problem of providing enhancements to the random access procedures and related

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resource allocation. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Johnston at 1–2. A POSITA would have been motivated to combine Engstrom with Johnston because Johnston provides further details and improvement on using the random access scheme to perform ranging functions and time delay/offset estimation, a problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; Johnston at 5–6.

- **Engstrom and Walton '131:** Walton '131 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time

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delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Engstrom at 7:17-67 and Fig.8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Walton '131 at least because Engstrom provides random access channel related specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '131) in order to improve uplink random access protocols. In addition, Engstrom and Walton '131 identify the common problem of providing greater efficiency for OFDM systems in wireless communication systems by, for example, improving random access procedures. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Walton '131 at Abstract, [0009]–[0010], [0050]-[0056], [0063], [0134]. A POSITA would have been motivated to combine Engstrom with Walton '131 because Walton '131 provides techniques to use OFDM symbols of different sizes to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Walton '131 at Abstract, [0009]–[0010], [0050]-[0056], [0063], [0134].

- **Engstrom and Eklund:** Eklund is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this

standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Engstrom teaches and describes "a random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital communication system . . . ." Engstrom at Abstract. Engstrom further describes "using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence. . . ." *Id.* at 2:51–3:8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Eklund at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Eklund) in order to carry out uplink and random access protocols. In addition, Engstrom and Eklund identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:43–48; *See* Eklund at 10–11. A POSITA would have been motivated to combine Engstrom with Eklund because Eklund provides a system level scheme

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with random access channels which could be used to solve the problem identified by Engstrom. *See* Eklund at 10–11; *see* Engstrom at 2:43–48.

- **Engstrom and Wahlqvist:** Wahlqvist is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wahlqvist teaches and describes "[the] use of orthogonal frequency division multiplex[ing] [OFDM] in a cellular system requir[ing] that the base station and the mobile station are time and frequency synchronized in order to preserve orthogonality between the subcarriers." Wahlqvist at Abstract. Wahlqvist further discloses "an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol." *Id.* at 1. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Furthermore, all three authors of Wahlqvist are inventors of Engstrom, and Wahlqvist and Engstrom focus on different aspects of the exact same system and random access protocol. It would have been obvious for a POSITA to combine Engstrom with Wahlqvist at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Wahlqvist) in order to carry out

uplink and random access protocols. In addition, Engstrom and Wahlqvist identify the same problem of improving random access protocol and have the same solution on establishing effective initial access procedures in wireless communication systems. S*ee* Engstrom at 2:43–48; *see* Wahlqvist at 1–3. A POSITA would have been motivated to combine Engstrom with Wahlqvist because Wahlqvist provides technical details of the solution provided by Engstrom from different aspects. *See* Engstrom at 2:43–48; *see* Wahlqvist at 1–3.

- **Engstrom and Mantha:** Mantha is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Mantha teaches and describes a "communication channel structure and method in a wireless communication system," where "the communication system includes a base station and a plurality of subscriber stations and the subscriber stations are given access to a variety of channels, including at least one uplink data channel." Mantha at Abstract. "The uplink data channel can operate in at least a random access mode . . . ." *Id.* "[W]ireless link employs CDMA as a multiple access technique to channelize and share link, although other multiple access techniques such as OFDM, etc. can be used." *Id.* at [0050]. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to

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allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Mantha at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Mantha) in order to carry out uplink and random access protocols. In addition, Engstrom and Mantha identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *see* Engstrom at 2:43-3:18; *see* Mantha at [0004], [0010], [0013]–[0014]. A POSITA would have been motivated to combine Engstrom with Mantha because Mantha provides a channel structure and method of monitoring the uplink channels and switching between a random access or polled mode to the problem identified by Engstrom. *See* Engstrom at 2:43-3:18, 5:3-7, 6:36-7:67; *see* Mantha at [0015]–[0040].

- **Engstrom and WiMAX 2003:** WiMAX 2003 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Defendants also incorporate by reference the citations in the WiMAX 2003 invalidity chart into the invalidity chart for Engstrom. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at

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https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with WiMAX 2003 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in WiMAX 2003) in order to carry out uplink and random access protocols. In addition, Engstrom and WiMAX 2003 identify the common problem of providing enhancements to OFDM wireless communication systems by, for example, improving physical and medium access control layers and random access protocols. *See* Engstrom at 1:1–5:13; *see*

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WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2. A POSITA would have been motivated to combine Engstrom with WiMAX 2003 because WiMAX 2003 provides enhancements to PHY and MAC layers that support difficult user environments, high bandwidth, continuous and burst traffic, and efficient spectrum use to the problem identified by Engstrom. *See See* Engstrom at 1:1–5:13; *see* WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2 and https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 18.

- **Engstrom and HiperLAN/2 DLC Specification Part 1:** HiperLAN/2 DLC Specification Part 1 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. HiperLAN/2 DLC Specification Part 1 teaches and describes a "Mobile Terminal (MT) . . . that communicates with an access point or with each other via a radio link." HiperLAN/2 DLC Specification Part 1 at 9. HiperLAN/2 DLC Specification Part 1 further discloses "Medium Access Control protocol" and "physical (PHY) layer of HIPERLAN/2 . . . ." *Id.* at 13–14. The PHY layer "is based on the modulation scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* at 14. HiperLAN/2 DLC Specification Part 1 discloses both an "uplink phase" and a "random access phase." *Id.* at 8–10. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence." Engstrom at 2:51-59. A random

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access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with HiperLAN/2 DLC Specification Part 1 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 1) in order to carry out uplink and random access protocols. In addition, Engstrom and HiperLAN/2 DLC Specification Part 1 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* HiperLAN/2 DLC Specification Part 1 at 14. A POSITA would have been motivated to combine Engstrom with HiperLAN/2 DLC Specification Part 1 because HiperLAN/2 DLC Specification Part 1 provides a multi-rate PHY layer, where the appropriate mode can be selected by a link adaptation scheme based on different interferences situations and distances among MTs and an AP, to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* HiperLAN/2 DLC Specification Part 1 at 14.

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- **Engstrom and Walton ’301:** Walton ’301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ’301 teaches and describes “a multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD.” Walton ’301 at Abstract. Walton ’301 further describes “a number of access points (APs) that support communication for a number of user terminals (UTs).” *Id.* at 3:54–63. Walton ’301 further describes an “uplink phase” that consists of “one or more [Reverse Channel] PDUs [] transmitted in a fourth segment and one more [Random Access Channel] PDUs transmitted in a fifth segment . . . .” *Id.* at Walton ’301 at 11:7–16. Engstrom teaches and describes “a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence..” Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Walton ’301 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in

Walton ’301) in order to carry out uplink and random access protocols. In addition, Engstrom and Walton ’301 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Walton ’301 at 1:35–51, 2:3. A POSITA would have been motivated to combine Engstrom with Walton ’301 because Walton ’301 provides a MIMO structure to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Walton ’301 at Abstract, 1:11–3:2.

- **Engstrom and Walton ’944:** Walton ’944 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ’944 teaches and describes “techniques for facilitating random access in wireless multiple-access communication systems,” where the system employs orthogonal frequency division multiplexing (OFDM) . . . .” Walton ’944 at Abstract, 3:34–37. Walton ’944 further describes “a number of access points (APs) that support communication for a number of user terminals (UTs).” *Id.* at 2:57–3:10. “[T]he uplink transport channels include a reverse channel (RCH) and a random access channel (RACH) . . . .” *Id.* at 3:49–4:9. Engstrom teaches and describes “a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence..” Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to

allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Walton '944 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '944) in order to carry out uplink and random access protocols. In addition, Engstrom and Walton '944 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Walton '944 at Abstract, 1:60–62. A POSITA would have been motivated to combine Engstrom with Walton '944 because Walton '944 provides a fast and slow random access channel option to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Walton '301 at Abstract, 2:1–18.

- **Engstrom and Walton '269:** Walton '269 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ' 269 teaches and describes "data communication and processing . . . for providing an efficient control channel structure in a wireless local area network (WLAN) communication system." Walton '269 at 1:9–13. "MIMO and orthogonal frequency division multiplexing (OFDM) may be employed to obtain high

throughput, combat deleterious path effects, and provide other benefits." *Id.* at 1:66–2:3. Walton '269 further discloses a system that "includes a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 3:26–28. Walton '269 discloses "uplink transport channels used by the UTs" that include a "Reverse Channel" and a "Random Access Channel." *Id.* at 9:14–15, and Figures 4 and 5. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Walton '269 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '269) in order to carry out uplink and random access protocols. In addition, Engstrom and Walton '269 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication

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systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Walton '269 at Abstract, 2:8–36. A POSITA would have been motivated to combine Engstrom with Walton '269 because Walton '269 discloses a more efficient control channel structure that is able to accommodate different users operating at different rates to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Walton '269 at Abstract, 2:36–40.

- **Engstrom and Jeong '589:** Jeong '589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system . . . ." Jeong '589 Translation at Abstract. Jeong '589 further discloses that "[i]n IEEE 802.16ab, OFDMA wireless communication system is defined such that data can be transmitted between a base station ("BS") and a subscriber station ("SS") using a microwave frequency band between 2 GHz and 11 GHz." *Id.* at 2. Jeong '589 discloses that "the SS transmits a ranging signal to the BS using a ranging sub-channel and a ranging code arbitrarily selected in a ranging interval section." *Id.* at 9. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-

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7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDMA transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Jeong '589 at least because Engstrom provides specifications of a wireless communication system that uses OFDMA transmission (such as that disclosed in Jeong '589) in order to carry out uplink and random access protocols. In addition, Engstrom and Jeong '589 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Jeong '589 Translation at Abstract, 2–3. A POSITA would have been motivated to combine Engstrom with Jeong '589 because Jeong '589 provides an initial ranging interval and ranging subchannel allocation method for initial ranging of multi-user OFDMA to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Jeong '589 Translation at Abstract, 2–3.

- **Engstrom and Kaiser:** Kaiser is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kaiser teaches and describes "a multiple access scheme for mobile multi-media applications. . . . referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA)" for "the uplink of a mobile radio system . . . ." Kaiser at Abstract, p.100. Kaiser further

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discloses "applying OFDM" to SS-MC-MA such that "data transmission can be based on OFDM-frames, where each frame consists of several OFDM-symbols." *Id.* at pp.102–103. Kaiser discloses a transmitter and receiver using "OFDM with [a] user-specific frequency mapper." *Id.* at p.101. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Kaiser at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kaiser) in order to carry out uplink and random access protocols. In addition, Engstrom and Kaiser identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Kaiser at 1. A POSITA would have been motivated to combine Engstrom with Kaiser because Kaiser provides a

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scheme with variable sub-carrier allocation and effective error protection to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Kaiser at 1.

- **Engstrom and Benedittis '812:** Benedittis '812 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Benedittis '812 teaches and describes a "third generation (3G) cellular system of UMTS (Universal Mobile Telecommunication System)," including "a method for optimizing the random access procedures in the CDMA cellular networks," where "[t]he spreading code sequences [are] reciprocally orthogonal . . . ." Benedittis '812 at [0001]–[0002]. Benedittis '812 also discloses "MS (Mobile Stations or Mobile Units), also vehicular ones, and portable User Equipment units UE, [] radio connected with relevant TRC transceivers [] belonging to relevant base transceiver stations BTSC (Base Transceiver Station for CDMA) spread on the territory." *Id.* at [0053]–[0054]. Benedittis '812 discloses "m uplink time slots . . . coming from the mobile stations MS/UE . . . ." *Id.* at [0057]. Benedittis '812 further discloses sending "the first SYNC1 signatures sent from the mobile" followed by "a successive CHANNEL REQUEST message sent from the mobile on a [Random Access Channel.]" *Id.* at [0104]–[0106], and Figure 7. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time

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delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Benedittis '812 at least because Engstrom provides specifications of a wireless communication system that utilizes a first uplink signal followed by a random access protocol (such as that disclosed in Benedittis '812). In addition, Engstrom and Benedittis '812 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Benedittis '812 at [0021]–[0022]. A POSITA would have been motivated to combine Engstrom with Benedittis '812 because Benedittis '812 provides an optimized random access procedure to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Benedittis '812 at Abstract, [0021]–[0022].

- **Engstrom and Ma '437:** Ma '437 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '437 teaches and describes "physical layer structures and related access schemes for unsynchronized [wireless] communication networks," Ma '437 at Abstract, where "the communication signal is an OFDM signal," *id.* at 2:25–26. Ma '437 further discloses "a wireless communication network . . . . [that] includes base transceiver

stations (BTSs)," and "[u]ser equipment (UE) [that] is adapted to communicate with any of the BTSs that are within its range[.]" Ma '437 at 4:61–67. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Ma '437 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '437) in order to carry out uplink and random access protocols. In addition, Engstrom and Ma '437 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Ma '437 at Abstract, 1:41–2:3. A POSITA would have been motivated to combine Engstrom with Ma '437 because Ma '437 provides common and cell-specific synchronization codes, preambles, and/or pilots to the problem identified by

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Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Ma '437 at Abstract, 1:41–2:3, 2:14–62.

- **Engstrom and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 teaches and describes "[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network." Ma '546 at 1:20–22. "[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . ." *Id.* at 2:48–50. Ma '546 further describes "a Random Access Channel (RACH) for UE's new to a particular wireless network to access the system." *Id.* at 19:45–48. "A dedicated long complex PN/Golay code set is reserved for RACH of each base station," and "[t]he covering PN code for each base station is different from those of the neighboring base stations . . . ." *Id.* at 20:50–51, 21:1–5. "The base station can broadcast this information through a DL signaling channel." *Id.* at 20:54–55. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of

wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Ma '546 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '546) in order to carry out uplink and random access protocols. In addition, Engstrom and Ma '546 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Ma '546 at 2:6–44. A POSITA would have been motivated to combine Engstrom with Ma '546 because Ma '546 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Ma '429 at Abstract, 2:48–56.

- **Engstrom and Ma '429:** Ma '429 teaches and describes "[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network." Ma '429 at [0003]. "[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . ." *Id.* at [0010]. Ma '429 further describes "a Random Access Channel (RACH) for UE's new to a particular wireless network to access the system." *Id.* at [0205]. "A dedicated long complex PN/Golay code set is reserved for RACH of each base station," and "[t]he covering PN code for each base station is different from those of the neighboring base stations . . . ." *Id.* at [0215], [0217]. "The base station can broadcast this information through a DL signaling channel." *Id.* at [0215].

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Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Ma '429 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '429) in order to carry out uplink and random access protocols. In addition, Engstrom and Ma '429 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Ma '429 at [0007]–[0009]. A POSITA would have been motivated to combine Engstrom with Ma '429 because Ma '429 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Ma '429 at Abstract, [0010].

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- **Engstrom and Mody:** Mody teaches and describes "a wireless Orthogonal Frequency Division Multiplexing (OFDM) communication system[.]" Mody at Abstract. Mody further discloses "a system for synchronizing data transmitted across a channel." *Id.* The communication system of Mody "may be part of a . . . Wireless[MAN] system." Mody at 3:41–44. Mody further discloses communication between "a number of transmitting antennas [and] a number of receiving antennas [] used to receive the transmitted signals." Mody at 2:32–35. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Mody at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Mody) in order to carry out uplink and random access protocols. In addition, Engstrom and Mody identify the common problem of

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establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Mody at Abstract, [0008]. A POSITA would have been motivated to combine Engstrom with Mody because Mody provides a sequence of training symbols and/or preambles and improved synchronization and channel estimation in MIMO systems to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Mody at Abstract, [0008]–[0012].

- **Engstrom and Kriedte '196:** Kriedte '196 teaches and describes "a wireless communication system, such as a multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) wireless LAN system[.]" Kriedte '196 at Abstract. Kriedte '196 further discloses communication between "N_t transmit antennas and N_t receive antennas[.]" Kriedte '196 at 3:29–30. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission

between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Kriedte '196 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kriedte '196) in order to carry out uplink and random access protocols. In addition, Engstrom and Kriedte '196 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Kriedte '196 at Abstract, 1:17–59. A POSITA would have been motivated to combine Engstrom with Kriedte '196 because Kriedte '196 provides symbol timing techniques to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Kriedte '196 at Abstract, 1:61–2:41.

- **Engstrom and Boehnke:** Boehnke teaches and describes "wireless communication systems with high-speed mobile access, . . . wherein Orthogonal Frequency Division Multiplexing (OFDM) is applied as a multi-carrier modulation technique." Boehnke at Abstract. Boehnke further describes a system in which "mobile stations" or "mobile terminals" communicate on the uplink and downlink with an "Access Point (AP)." Boehnke at [0036]–[0038]. Boehnke teaches transmission phases of an "Uplink Phase" followed by a "Random Access Phase." *Id.* .Engstrom teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile

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stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence..” Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Boehnke at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Boehnke) in order to carry out uplink and random access protocols. In addition, Engstrom and Boehnke identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Boehnke at Abstract, [0052]–[0058]. A POSITA would have been motivated to combine Engstrom with Boehnke because Boehnke provides a new pilot pattern and insertion of reference symbols to support channel estimation and synchronization to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Boehnke at Abstract, [0052]–[0068].

- **Engstrom and Chheda:** Chheda teaches and describes “using . . . OFDM for broadband wireless systems.” Chheda further describes “User Terminals,”

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"Subscriber Units," and "Customer Premise Equipment" in communication with "Base Stations," "Wireless Base Stations" or "Base Transceiver Stations." Chheda at 22, 30, and 105. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Chheda at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Chheda) in order to carry out uplink and random access protocols. In addition, Engstrom and Chheda identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Chheda at 1–10. A POSITA would have been motivated to combine Engstrom with Chheda because Chheda provides

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OFDM multiple-access techniques to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Chheda at 1–10, 74–95.

- **Engstrom and HiperLAN/2 DLC Specification Part 2:** HiperLAN/2 DLC Specification Part 2 teaches and describes "the basic Radio Link Control (RLC) sublayer of HIPERLAN/2" which "is confined to . . . the physical and the data link control layer." HiperLAN/2 DLC Specification Part 2 at 9. Among other things, the "scope of HIPERLAN/2 standards" covers both the "Physical Layer" and "Medium Access Control." *Id.* at 14, Figures 1–2. HiperLAN/2 DLC Specification Part 2 further describes communication between "Mobile Terminals" and "Access Points." *Id.* at 19. For example, the "Uplink phase" is "part of the MAC frame in which data is transmitted from the mobile terminals to an access point or a central controller. *Id.* at 12. HiperLAN/2 DLC Specification Part 2 further describes various uplink channels, including a "Random Access CHannel [RACH]," and a "Random CHannel [RCH]." *Id.* HiperLAN/2 DLC Specification Part 2 uses a "normal" and "short" "OFDM symbol guard interval" in the PHY layer. *Id.* at 178. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See

Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with HiperLAN/2 DLC Specification Part 2 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 2) in order to carry out uplink and random access protocols. In addition, Engstrom and HiperLAN/2 DLC Specification Part 2 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13. A POSITA would have been motivated to combine Engstrom with HiperLAN/2 DLC Specification Part 2 because HiperLAN/2 DLC Specification Part 2 provides radio link control layer functions, messages, and formats to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13.

- **Engstrom and HiperLAN/2 PHY Specification:** HiperLAN/2 PHY Specification teaches and describes "the physical layer specifications for HIgh PErformance Radio Local Area Network type 2 (HIPERLAN/2)," HiperLAN/2 PHY Specification at 5–6. "The PHY layer of HIPERLAN/2 . . . provides for functions to map different DLC PDU trains into framing formats called PHY bursts appropriate for transmitting and receiving management and user information

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between an [Access Point] and a [Mobile Terminal] . . . ." *Id.* at 10. "The PHY layer of HIPERLAN/2 is based on the modulation scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* HiperLAN/2 PHY Specification further describes a "Random CHannel (RCH)" used to "carr[y] the logical channels random access channel and association channel," and that "[t]he BCH includes 2 bits which announce the guard time between random access bursts." *Id.* at 7, 33. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with HiperLAN/2 PHY Specification at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 PHY Specification) in order to carry out uplink and random access protocols. In addition, Engstrom and HiperLAN/2 PHY Specification identify the common problem of

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establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* HiperLAN/2 PHY Specification at 6, 9. A POSITA would have been motivated to combine Engstrom with HiperLAN/2 PHY Specification because HiperLAN/2 PHY Specification provides a multi-rate PHY layer and link adaptation scheme to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* HiperLAN/2 PHY Specification at 6, 9, 11.

- **Engstrom and Gibson:** Gibson teaches and describes "wireless communication systems" using "[frequency division multiple access [with] signals assigned to different users [that] are clearly orthogonal . . . ." Gibson at p.17-4. Gibson discloses a "mobile station" which "initiates the procedure by transmitting a request [to the base station] on a random-access channel." *Id.* at p.17-8–17-9. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base

stations. It would have been obvious for a POSITA to combine Engstrom with Gibson at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Gibson). In addition, Engstrom and Gibson identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Gibson at 17-4–17-12. A POSITA would have been motivated to combine Engstrom with Gibson because Gibson provides channel assignment and multiple access techniques to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Gibson at 17-4–17-12, and Figure 17.3.

- **Engstrom and Suh '464:** Suh '464 teaches and describes "an orthogonal frequency division multiplexing (OFDM) communication system . . . ." Suh '464 at [0003]. "[A] wireless communication system is comprised of Node Bs and user equipments (UEs)," where "[t]he Node B's and the UEs transmit data by the frame for a wireless communication service." *Id.* at [0005]. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for

the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Suh '464 at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Suh '464) in order to carry out uplink and random access protocols. In addition, Engstrom and Suh '464 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; *see* Suh '464 at Abstract, [0002]–[0044]. A POSITA would have been motivated to combine Engstrom with Suh '464 because Suh '464 provides generating a preamble sequence for low peak-to-average power ration and improved channel estimation to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Suh '464 at Abstract, [0042]–[0049].

- **Engstrom and Kanterakis:** Kanterakis teaches and describes "spread-spectrum communications," where "[t]he CMDA system has a base station (BS) and a plurality of remote stations." Kanterakis at 1:5, 27–28. Kanterakis further describes "a random-access burst structure which has a preamble followed by a data portion," where "the preamble sequence [is] spread by an orthogonal Gold code." *Id.* at 1:5–18. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile

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stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence..” Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Kanterakis at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Kanterakis). In addition, Engstrom and Kanterakis identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; Kanterakis at Abstract, 1:10–23. A POSITA would have been motivated to combine Engstrom with Kanterakis because Kanterakis provides spread spectrum modulation to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Kanterakis at Abstract, 1:10–2:11.

- **Engstrom and Frank:** Frank teaches and describes a “mobile telecommunications system” with “a method and system for processing multiple random access calls in a [CDMA] . . . system.” Frank at 1:5-13. Frank further describes “[a]n uplink

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common physical channel (random access channel) frame structure . . . with a separate preamble and data portion," where "[t]he preamble is used by a base station to detect that a mobile station is attempting a random access request." *Id.* at Abstract. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51-59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36-7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17-67 and Fig. 8. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Engstrom with Frank at least because Engstrom provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Frank). In addition, Engstrom and Frank identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Engstrom at 2:51-3:18, 5:3-7, 6:36-7:67; Frank at Abstract, 1:11–5:31. A POSITA would have been motivated to combine Engstrom with Frank because Frank provides a random

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access channel frame structure with separate preamble and data portions to the problem identified by Engstrom. *See* Engstrom at 1:64-67, 6:58-7:4, 7:50-67, 12:40-50; *see* Frank at Abstract, 6:1–7:11.

(xv) Wahlqvist in combination with the knowledge of a skilled artisan, Johnston, Walton '131, Eklund, Engstrom, Mantha, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton '301, Walton '944, Walton '269, Jeong '589, Kaiser, Benedittis '812, Ma '437, Ma '546, Ma '429, Mody, Kriedte '196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh '464, Kanterakis, and/or Frank.

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Wahlqvist with each of these references. A person of ordinary skill in the art would have found it obvious to combine Wahlqvist with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

- Johnston, Walton '131, Eklund, Engstrom, Mantha, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton '301, Walton '944, Walton '269, Jeong '589, Kaiser, Benedittis '812, Ma '437, Ma '546, Ma '429, Mody, Kriedte '196, Boehnke,

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Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh '464, Kanterakis, and/or Frank are all directed to systems and methods for a broadband wireless communication system related transmission. For example, they relate to broadband wireless communication between a mobile station and a base station using OFDM transmission and/or a related transmission scheme, and in particular to uplink and random access signal protocols. They involve communication protocols, standards, OFDM and/or related transmission methods, and access schemes that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Wahlqvist and Johnston**: Johnston is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Johnston teaches and describes "key technical elements defined under the 802.16a [WiMAX] specification," including the "specification, . . . physical layer requirements, and . . . the frame and media access control structures" of a WiMAX system. Johnston at 1. "The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS)." Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, "the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . ." Johnston at 3. Johnston further discloses "initial ranging" slots in the uplink. Johnston at 6. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an

OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1-2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of the initial access protocol between mobile stations and base stations in an OFDM-based wireless communication system. It would have been obvious for a POSITA to combine Wahlqvist with Johhston at least because Wahlqvist provides random access channel related specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Johnston) in order to improve uplink random access protocols. In addition, Wahlqvist and Johnston identify the common problem of providing enhancements to the random access procedures and related resource allocation. *See* Wahlqvist at 1–3; *see* Johnston at 1–2. A POSITA would have been motivated to combine Wahlqvist with Johnston because Johnston provides further details and improvement on using the random access scheme to perform ranging functions and time delay/offset estimation, a problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Johnston at 5–6.

- **Wahlqvist and Walton '131:** Walton '131 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal frequency division multiplexing (OFDM) communication systems and techniques

for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1-2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Walton '131 at least because Wahlqvist provides random access channel related specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '131) in order to improve uplink random access protocols. In addition,

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Wahlqvist and Walton ’131 identify the common problem of providing greater efficiency for OFDM systems in wireless communication systems by, for example, improving random access procedures. *See* Wahlqvist at 1–3; *see* Walton ’131 at Abstract, [0009]–[0010], [0050]-[0056], [0063], [0134]. A POSITA would have been motivated to combine Wahlqvist with Walton ’131 because Walton ’131 provides techniques to use OFDM symbols of different sizes to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Walton ’131 at Abstract, [0009]–[0010], [0050]–[0056], [0063], [0134].

- **Wahlqvist and Eklund:** Eklund is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Eklund teaches and describes the “IEEE Standard 802.16, with its WirelessMAN air interface,” and overviews “the technical medium access control and physical layer features” of this standard. Eklund at Abstract. “WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform.” Eklund at 3, 5. WirelessMAN also “provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS).” Eklund at 3. Eklund further discloses “initial access” opportunities that are followed by “requests for bandwidth in either random access slots or dedicated transmission opportunities.” Eklund at 8–9, and Figure 2. Wahlqvist teaches and describes “a new scheme for initial time synchronization” and “a random access protocol based on the proposed scheme” which “will have good performance in a mobile radio environment” in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate

transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig.5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Eklund at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Eklund) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Eklund identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *See* Eklund at 10–11. A POSITA would have been motivated to combine Wahlqvist with Eklund because Eklund provides a system level scheme with random access channels which could be used to solve the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Eklund at 10–11.

- **Wahlqvist and Engstrom:** Engstrom is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51–

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59. A random access signal could establish an initial access and find time delay/offset using ranging techniques. *See* Engstrom at 6:36–7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17–67 and Fig. 8. Wahlqvist teaches and describes "[the] use of orthogonal frequency division multiplex[ing] [OFDM] in a cellular system requir[ing] that the base station and the mobile station are time and frequency synchronized in order to preserve orthogonality between the subcarriers." Wahlqvist at Abstract. Wahlqvist further discloses "an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol." *Id.* at 1. Furthermore, all three authors of Wahlqvist are inventors of Engstrom, and Wahlqvist and Engstrom focus on different aspects of the exact same system and the random access protocol. It would have been obvious for a POSITA to combine Wahlqvist with Engstrom at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Engstrom) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Engstrom identify the same problem of improving random access protocol and have the same solution on establishing effective initial access procedures in wireless communication systems. *See* Wahlqvist at 1–3; *see* Engstrom at 2:43–48. A POSITA would have been motivated to combine Wahlqvist with Engstrom because Engstrom provides technical details of the solution provided by Wahlqvist from different aspects. *See* Wahlqvist at 1–3; *see* Engstrom at 2:43–48.

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- **Wahlqvist and Mantha:** Mantha is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Mantha teaches and describes a "communication channel structure and method in a wireless communication system," where "the communication system includes a base station and a plurality of subscriber stations and the subscriber stations are given access to a variety of channels, including at least one uplink data channel." Mantha at Abstract. "The uplink data channel can operate in at least a random access mode . . . ." *Id.* "[W]ireless link employs CDMA as a multiple access technique to channelize and share link, although other multiple access techniques such as OFDM, etc. can be used." *Id.* at [0050]. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Mantha at least because Wahlqvist provides specifications of a wireless communication system that

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uses OFDM transmission (such as that disclosed in Mantha) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Mantha identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *see* Wahlqvist at 1–3; *see* Mantha at [0004], [0010], [0013]–[0014]. A POSITA would have been motivated to combine Wahlqvist with Mantha because Mantha provides a channel structure and method of monitoring the uplink channels and switching between a random access or polled mode to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Mantha at [0015]–[0040].

- **Wahlqvist and WiMAX 2003:** WiMAX 2003 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Defendants also incorporate by reference the citations in the WiMAX 2003 invalidity chart into the invalidity chart for Wahlqvist. WiMAX 2003 teaches and describes that "the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system

requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with WiMAX 2003 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in WiMAX 2003) in order to carry out uplink and random access protocols. In addition, Wahlqvist and WiMAX 2003 identify the common problem of providing enhancements to OFDM wireless communication systems by, for example, improving physical and medium access control layers, initial time sychhronization, and random access protocols. *See* Wahlqvist at 1–4; *see* WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2. A POSITA would have been motivated to combine Wahlqvist with WiMAX 2003 because WiMAX 2003 provides enhancements to PHY and MAC layers that support difficult user environments, high bandwidth, continuous and burst traffic, and efficient spectrum use to the problem identified by Wahlqvist. *See* Wahlqvist at 1–4; *see* WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2 and https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 18.

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- **Wahlqvist and HiperLAN/2 DLC Specification Part 1:** HiperLAN/2 DLC Specification Part 1 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. HiperLAN/2 DLC Specification Part 1 teaches and describes a "Mobile Terminal (MT) . . . that communicates with an access point or with each other via a radio link." HiperLAN/2 DLC Specification Part 1 at 9. HiperLAN/2 DLC Specification Part 1 further discloses "Medium Access Control protocol" and "physical (PHY) layer of HIPERLAN/2 . . . ." *Id.* at 13–14. The PHY layer "is based on the modulation scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* at 14. HiperLAN/2 DLC Specification Part 1 discloses both an "uplink phase" and a "random access phase." *Id.* at 8–10. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with HiperLAN/2

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DLC Specification Part 1 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 1) in order to carry out uplink and random access protocols. In addition, Wahlqvist and HiperLAN/2 DLC Specification Part 1 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* HiperLAN/2 DLC Specification Part 1 at 14. A POSITA would have been motivated to combine Wahlqvist with HiperLAN/2 DLC Specification Part 1 because HiperLAN/2 DLC Specification Part 1 provides a multi-rate PHY layer, where the appropriate mode can be selected by a link adaptation scheme based on different interferences situations and distances among MTs and an AP, to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* HiperLAN/2 DLC Specification Part 1 at 14.

- **Wahlqvist and Walton '301:** Walton '301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '301 teaches and describes "a multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. Walton '301 further describes "a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 3:54–63. Walton '301 further describes an "uplink phase" that consists of "one or more [Reverse Channel] PDUs [] transmitted in a fourth segment and one more [Random Access Channel] PDUs transmitted in a fifth segment . . . ." *Id.* at Walton '301 at 11:7–16. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a

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random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Walton '301 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '301) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Walton '301 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Walton '301 at 1:35–51, 2:3. A POSITA would have been motivated to combine Wahlqvist with Walton '301 because Walton '301 provides a MIMO structure to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Walton '301 at Abstract, 1:11–3:2.

- **Wahlqvist and Walton '944:** Walton '944 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '944 teaches and describes "techniques for facilitating random access in wireless

multiple-access communication systems," where the system employs orthogonal frequency division multiplexing (OFDM) . . . ." Walton '944 at Abstract, 3:34–37. Walton '944 further describes "a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 2:57–3:10. "[T]he uplink transport channels include a reverse channel (RCH) and a random access channel (RACH) . . . ." *Id.* at 3:49–4:9. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Walton '944 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '944) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Walton '944 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless

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communication systems. *See* Wahlqvist at 1–3; *see* Walton '944 at Abstract, 1:60–62. A POSITA would have been motivated to combine Wahlqvist with Walton '944 because Walton '944 provides a fast and slow random access channel option to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Walton '301 at Abstract, 2:1–18.

- **Wahlqvist and Walton '269:** Walton '269 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ' 269 teaches and describes "data communication and processing . . . for providing an efficient control channel structure in a wireless local area network (WLAN) communication system." Walton '269 at 1:9–13. "MIMO and orthogonal frequency division multiplexing (OFDM) may be employed to obtain high throughput, combat deleterious path effects, and provide other benefits." *Id.* at 1:66–2:3. Walton '269 further discloses a system that "includes a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 3:26–28. Walton '269 discloses "uplink transport channels used by the UTs" that include a "Reverse Channel" and a "Random Access Channel." *Id.* at 9:14–15, and Figures 4 and 5. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM

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resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Walton '269 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '269) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Walton '269 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Walton '269 at Abstract, 2:8–36. A POSITA would have been motivated to combine Wahlqvist with Walton '269 because Walton '269 discloses a more efficient control channel structure that is able to accommodate different users operating at different rates to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Walton '269 at Abstract, 2:36–40.

- **Wahlqvist and Jeong '589:** Jeong '589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system . . . ." Jeong '589 Translation at Abstract. Jeong '589 further discloses that "[i]n IEEE 802.16ab, OFDMA wireless communication system is defined such that data can be

transmitted between a base station ("BS") and a subscriber station ("SS") using a microwave frequency band between 2 GHz and 11 GHz." *Id.* at 2. Jeong '589 discloses that "the SS transmits a ranging signal to the BS using a ranging sub-channel and a ranging code arbitrarily selected in a ranging interval section." *Id.* at 9. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDMA transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Jeong '589 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDMA transmission (such as that disclosed in Jeong '589) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Jeong '589 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Jeong '589 Translation at Abstract, 2–3. A POSITA would have been motivated to combine Wahlqvist with

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Jeong ’589 because Jeong ’589 provides an initial ranging interval and ranging subchannel allocation method for initial ranging of multi-user OFDMA to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Jeong ’589 Translation at Abstract, 2–3.

- **Wahlqvist and Kaiser:** Kaiser is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kaiser teaches and describes “a multiple access scheme for mobile multi-media applications. . . . referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA)” for “the uplink of a mobile radio system . . . .” Kaiser at Abstract, p.100. Kaiser further discloses “applying OFDM” to SS-MC-MA such that “data transmission can be based on OFDM-frames, where each frame consists of several OFDM-symbols.” *Id.* at pp.102–103. Kaiser discloses a transmitter and receiver using “OFDM with [a] user-specific frequency mapper.” *Id.* at p.101. Wahlqvist teaches and describes “a new scheme for initial time synchronization” and “a random access protocol based on the proposed scheme” which “will have good performance in a mobile radio environment” in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access

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control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Kaiser at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kaiser) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Kaiser identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Kaiser at 1. A POSITA would have been motivated to combine Wahlqvist with Kaiser because Kaiser provides a scheme with variable sub-carrier allocation and effective error protection to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Kaiser at 1.

- **Wahlqvist and Benedittis '812:** Benedittis '812 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Benedittis '812 teaches and describes a "third generation (3G) cellular system of UMTS (Universal Mobile Telecommunication System)," including "a method for optimizing the random access procedures in the CDMA cellular networks," where "[t]he spreading code sequences [are] reciprocally orthogonal . . . ." Benedittis '812 at [0001]–[0002]. Benedittis '812 also discloses "MS (Mobile Stations or Mobile Units), also vehicular ones, and portable User Equipment units UE, [] radio connected with relevant TRC transceivers [] belonging to relevant base transceiver stations BTSC (Base Transceiver Station for CDMA) spread on the territory." *Id.* at [0053]–[0054]. Benedittis '812 discloses "m uplink time slots . . . coming from the mobile stations MS/UE . . . ." *Id.* at [0057]. Benedittis '812 further discloses

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sending "the first SYNC1 signatures sent from the mobile" followed by "a successive CHANNEL REQUEST message sent from the mobile on a [Random Access Channel.]" *Id.* at [0104]–[0106], and Figure 7. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Benedittis '812 at least because Wahlqvist provides specifications of a wireless communication system that utilizes a first uplink signal followed by a random access protocol (such as that disclosed in Benedittis '812). In addition, Wahlqvist and Benedittis '812 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Benedittis '812 at [0021]–[0022]. A POSITA would have been motivated to combine Wahlqvist with Benedittis '812 because Benedittis '812 provides an

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optimized random access procedure to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Benedittis '812 at Abstract, [0021]–[0022].

- **Wahlqvist and Ma '437:** Ma '437 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '437 teaches and describes "physical layer structures and related access schemes for unsynchronized [wireless] communication networks," Ma '437 at Abstract, where "the communication signal is an OFDM signal," *id.* at 2:25–26. Ma '437 further discloses "a wireless communication network . . . . [that] includes base transceiver stations (BTSs)," and "[u]ser equipment (UE) [that] is adapted to communicate with any of the BTSs that are within its range[.]" Ma '437 at 4:61–67. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Ma '437 at least because Wahlqvist provides specifications of a wireless

communication system that uses OFDM transmission (such as that disclosed in Ma '437) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Ma '437 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Ma '437 at Abstract, 1:41–2:3. A POSITA would have been motivated to combine Wahlqvist with Ma '437 because Ma '437 provides common and cell-specific synchronization codes, preambles, and/or pilots to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Ma '437 at Abstract, 1:41–2:3, 2:14–62.

- **Wahlqvist and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 teaches and describes "[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network." Ma '546 at 1:20–22. "[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . ." *Id.* at 2:48–50. Ma '546 further describes "a Random Access Channel (RACH) for UE's new to a particular wireless network to access the system." *Id.* at 19:45–48. "A dedicated long complex PN/Golay code set is reserved for RACH of each base station," and "[t]he covering PN code for each base station is different from those of the neighboring base stations . . . ." *Id.* at 20:50–51, 21:1–5. "The base station can broadcast this information through a DL signaling channel." *Id.* at 20:54–55. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio

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environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Ma '546 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '546) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Ma '546 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Ma '546 at 2:6–44. A POSITA would have been motivated to combine Wahlqvist with Ma '546 because Ma '546 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Ma '546 at Abstract, 2:48–56.

- **Wahlqvist and Ma '429:** Ma '429 teaches and describes "[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network." Ma '429 at [0003]. "[T]he invention

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provides a wireless terminal for communicating over a shared OFDM band . . . ." *Id.* at [0010]. Ma '429 further describes "a Random Access Channel (RACH) for UE's new to a particular wireless network to access the system." *Id.* at [0205]. "A dedicated long complex PN/Golay code set is reserved for RACH of each base station," and "[t]he covering PN code for each base station is different from those of the neighboring base stations . . . ." *Id.* at [0215], [0217]. "The base station can broadcast this information through a DL signaling channel." *Id.* at [0215]. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Ma '429 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '429) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Ma '429 identify the common problem of establishing effective

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access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Ma '429 at [0007]–[0009]. A POSITA would have been motivated to combine Wahlqvist with Ma '429 because Ma '429 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Ma '429 at Abstract, [0010].

- **Wahlqvist and Mody:** Mody teaches and describes "a wireless Orthogonal Frequency Division Multiplexing (OFDM) communication system[.]" Mody at Abstract. Mody further discloses "a system for synchronizing data transmitted across a channel." *Id.* The communication system of Mody "may be part of a . . . Wireless[MAN] system." Mody at 3:41–44. Mody further discloses communication between "a number of transmitting antennas [and] a number of receiving antennas [] used to receive the transmitted signals." Mody at 2:32–35. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and

medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Mody at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Mody) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Mody identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Mody at Abstract, [0008]. A POSITA would have been motivated to combine Wahlqvist with Mody because Mody provides a sequence of training symbols and/or preambles and improved synchronization and channel estimation in MIMO systems to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Mody at Abstract, [0008]–[0012].

- **Wahlqvist and Kriedte '196:** Kriedte '196 teaches and describes "a wireless communication system, such as a multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) wireless LAN system[.]" Kriedte '196 at Abstract. Kriedte '196 further discloses communication between "N_t transmit antennas and N_t receive antennas[.]" Kriedte '196 at 3:29–30. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist

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further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Kriedte '196 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kriedte '196) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Kriedte '196 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Kriedte '196 at Abstract, 1:17–59. A POSITA would have been motivated to combine Wahlqvist with Kriedte '196 because Kriedte '196 provides symbol timing techniques to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Kriedte '196 at Abstract, 1:61–2:41.

- **Wahlqvist and Boehnke:** Boehnke teaches and describes "wireless communication systems with high-speed mobile access, . . . wherein Orthogonal Frequency Division Multiplexing (OFDM) is applied as a multi-carrier modulation technique." Boehnke at Abstract. Boehnke further describes a system in which "mobile stations" or "mobile terminals" communicate on the uplink and downlink with an "Access Point (AP)." Boehnke at [0036]–[0038]. Boehnke teaches transmission phases of an "Uplink Phase" followed by a "Random Access Phase."

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Id. .Wahlqvist teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Boehnke at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Boehnke) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Boehnke identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Boehnke at Abstract, [0052]–[0058]. A POSITA would have been motivated to combine Wahlqvist with Boehnke because Boehnke provides a new pilot pattern and insertion of reference

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symbols to support channel estimation and synchronization to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Boehnke at Abstract, [0052]–[0068].

- **Wahlqvist and Chheda:** Chheda teaches and describes "using . . . OFDM for broadband wireless systems." Chheda further describes "User Terminals," "Subscriber Units," and "Customer Premise Equipment" in communication with "Base Stations," "Wireless Base Stations" or "Base Transceiver Stations." Chheda at 22, 30, and 105. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Chheda at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Chheda) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Chheda identify the common problem of

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establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Chheda at 1–10. A POSITA would have been motivated to combine Wahlqvist with Chheda because Chheda provides OFDM multiple-access techniques to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Chheda at 1–10, 74–95.

- **Wahlqvist and HiperLAN/2 DLC Specification Part 2:** HiperLAN/2 DLC Specification Part 2 teaches and describes "the basic Radio Link Control (RLC) sublayer of HIPERLAN/2" which "is confined to . . . the physical and the data link control layer." HiperLAN/2 DLC Specification Part 2 at 9. Among other things, the "scope of HIPERLAN/2 standards" covers both the "Physical Layer" and "Medium Access Control." *Id.* at 14, Figures 1–2. HiperLAN/2 DLC Specification Part 2 further describes communication between "Mobile Terminals" and "Access Points." *Id.* at 19. For example, the "Uplink phase" is "part of the MAC frame in which data is transmitted from the mobile terminals to an access point or a central controller. *Id.* at 12. HiperLAN/2 DLC Specification Part 2 further describes various uplink channels, including a "Random Access CHannel [RACH]," and a "Random CHannel [RCH]." *Id.* HiperLAN/2 DLC Specification Part 2 uses a "normal" and "short" "OFDM symbol guard interval" in the PHY layer. *Id.* at 178. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system

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requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with HiperLAN/2 DLC Specification Part 2 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 2) in order to carry out uplink and random access protocols. In addition, Wahlqvist and HiperLAN/2 DLC Specification Part 2 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13. A POSITA would have been motivated to combine Wahlqvist with HiperLAN/2 DLC Specification Part 2 because HiperLAN/2 DLC Specification Part 2 provides radio link control layer functions, messages, and formats to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13.

- **Wahlqvist and HiperLAN/2 PHY Specification:** HiperLAN/2 PHY Specification teaches and describes "the physical layer specifications for HIgh PErformance Radio Local Area Network type 2 (HIPERLAN/2)," HiperLAN/2

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PHY Specification at 5–6. "The PHY layer of HIPERLAN/2 . . . provides for functions to map different DLC PDU trains into framing formats called PHY bursts appropriate for transmitting and receiving management and user information between an [Access Point] and a [Mobile Terminal] . . . ." *Id.* at 10. "The PHY layer of HIPERLAN/2 is based on the modulation scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* HiperLAN/2 PHY Specification further describes a "Random CHannel (RCH)" used to "carr[y] the logical channels random access channel and association channel," and that "[t]he BCH includes 2 bits which announce the guard time between random access bursts." *Id.* at 7, 33. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with HiperLAN/2 PHY Specification at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission

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(such as that disclosed in HiperLAN/2 PHY Specification) in order to carry out uplink and random access protocols. In addition, Wahlqvist and HiperLAN/2 PHY Specification identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* HiperLAN/2 PHY Specification at 6, 9. A POSITA would have been motivated to combine Wahlqvist with HiperLAN/2 PHY Specification because HiperLAN/2 PHY Specification provides a multi-rate PHY layer and link adaptation scheme to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* HiperLAN/2 PHY Specification at 6, 9, 11.

- **Wahlqvist and Gibson:** Gibson teaches and describes "wireless communication systems" using "[frequency division multiple access [with] signals assigned to different users [that] are clearly orthogonal . . . ." Gibson at p.17-4. Gibson discloses a "mobile station" which "initiates the procedure by transmitting a request [to the base station] on a random-access channel." *Id.* at p.17-8–17-9. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2

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and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Gibson at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Gibson). In addition, Wahlqvist and Gibson identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Gibson at 17-4–17-12. A POSITA would have been motivated to combine Wahlqvist with Gibson because Gibson provides channel assignment and multiple access techniques to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Gibson at 17-4–17-12, and Figure 17.3.

- **Wahlqvist and Suh '464:** Suh '464 teaches and describes "an orthogonal frequency division multiplexing (OFDM) communication system . . . ." Suh '464 at [0003]. "[A] wireless communication system is comprised of Node Bs and user equipments (UEs)," where "[t]he Node B's and the UEs transmit data by the frame for a wireless communication service." *Id.* at [0005]. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and

frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Suh '464 at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Suh '464) in order to carry out uplink and random access protocols. In addition, Wahlqvist and Suh '464 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; *see* Suh '464 at Abstract, [0002]–[0044]. A POSITA would have been motivated to combine Wahlqvist with Suh '464 because Suh '464 provides generating a preamble sequence for low peak-to-average power ration and improved channel estimation to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Suh '464 at Abstract, [0042]–[0049].

- **Wahlqvist and Kanterakis:** Kanterakis teaches and describes "spread-spectrum communications," where "[t]he CMDA system has a base station (BS) and a plurality of remote stations." Kanterakis at 1:5, 27–28. Kanterakis further describes "a random-access burst structure which has a preamble followed by a data portion," where "the preamble sequence [is] spread by an orthogonal Gold code."

Id. at 1:5–18. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Kanterakis at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Kanterakis). In addition, Wahlqvist and Kanterakis identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; Kanterakis at Abstract, 1:10–23. A POSITA would have been motivated to combine Wahlqvist with Kanterakis because Kanterakis provides spread spectrum modulation to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Kanterakis at Abstract, 1:10–2:11.

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- **Wahlqvist and Frank:** Frank teaches and describes a "mobile telecommunications system" with "a method and system for processing multiple random access calls in a [CDMA] . . . system." Frank at 1:5–13. Frank further describes "[a]n uplink common physical channel (random access channel) frame structure . . . with a separate preamble and data portion," where "[t]he preamble is used by a base station to detect that a mobile station is attempting a random access request." *Id.* at Abstract. Wahlqvist teaches and describes "a new scheme for initial time synchronization" and "a random access protocol based on the proposed scheme" which "will have good performance in a mobile radio environment" in an OFDM cellular system, Wahlqvist at Abstract. A random access signal in an OFDM-based cellular system requires time and frequency synchronization and estimate transmission delay using a random access sequence and protocol. *See* Wahlqvist at Abstract, 1–2. Wahlqvist further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. *See* Wahlqvist at 2 and Fig. 5. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Wahlqvist with Frank at least because Wahlqvist provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Frank). In addition, Wahlqvist and Frank identify the common problem of establishing effective access initialization procedures and/or random access

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channel allocation in wireless communication systems. *See* Wahlqvist at 1–3; Frank at Abstract, 1:11–5:31. A POSITA would have been motivated to combine Wahlqvist with Frank because Frank provides a random access channel frame structure with separate preamble and data portions to the problem identified by Wahlqvist. *See* Wahlqvist at 1–3; *see* Frank at Abstract, 6:1–7:11.

(xvi) Mantha in combination with the knowledge of a skilled artisan, Johnston, Walton '131, Eklund, Engstrom, Wahlqvist, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton '301, Walton '944, Walton '269, Jeong '589, Kaiser, Benedittis '812, Ma '437, Ma '546, Ma '429, Mody, Kriedte '196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh '464, Kanterakis, and/or Frank.

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Mantha with each of these references. A person of ordinary skill in the art would have found it obvious to combine Mantha with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '908 patent was filed. Specifically:

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- Johnston, Walton ’131, Eklund, Engstrom, Wahlqvist, WiMAX 2003, HiperLAN/2 DLC Specification Part 1, Walton ’301, Walton ’944, Walton ’269, Jeong ’589, Kaiser, Benedittis ’812, Ma ’437, Ma ’546, Ma ’429, Mody, Kriedte ’196, Boehnke, Chheda, HiperLAN/2 DLC Specification Part 2, HiperLAN/2 PHY Specification, Gibson, Suh ’464, Kanterakis, and/or Frank are all directed to systems and methods for a broadband wireless communication system related transmission. For example, they relate to broadband wireless communication between a mobile station and a base station using OFDM transmission and/or a related transmission scheme, and in particular to uplink and random access signal protocols. They involve communication protocols, standards, OFDM and/or related transmission methods, and access schemes that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Mantha and Johnston**: Johnston is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Johnston teaches and describes “key technical elements defined under the 802.16a [WiMAX] specification,” including the “specification, . . . physical layer requirements, and . . . the frame and media access control structures” of a WiMAX system. Johnston at 1. “The core components of a WiMAX system are the subscriber station (SS) . . . and the base station (BS).” Johnston at 1. For the WirelessMetropolitan Area Network (WirelessMAN) OFDM system specified in 802.16, “the OFDM signaling format was selected in preference to competing formats such as single-carrier (SC) and CDMA . . . .” Johnston at 3. Johnston further discloses “initial ranging” slots

in the uplink. Johnston at 6. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of the initial access protocol between mobile stations and base stations in an OFDM-based wireless communication system. It would have been obvious for a POSITA to combine Mantha with Johnston at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Johnston) in order to carry out uplink and random access protocols. In addition, Mantha and Johnston identify the common problem of providing enhancements to the random access procedures. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Johnston at 1–2. A POSITA would have been motivated to combine Mantha with Johnston because Johnston provides further details and improvement on using the random access scheme to perform ranging functions and time delay/offset estimation, a problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; Johnston at 5–6.

- **Mantha and Walton '131:** Walton '131 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '131 teaches and describes "data communication, and more specifically . . . orthogonal

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frequency division multiplexing (OFDM) communication systems and techniques for providing OFDM symbol sizes to increase wireless efficiency." Walton '131 at [0003]. Walton '131 teaches "an exemplary MIMI-OFDM system with a number of access points (APs) that support communication for a number of user terminals (UTs)" for uplink and downlink communication. Walton '131 at [0048]. Walton '131 further teaches "uplink transport channels [that] include a reverse channel (RCH) and a random access channel (RACH). One goal of Walton '131 is "to achieve greater efficiency for OFDM systems . . . . [by] minimizing cyclic prefix overhead and maximizing packing efficiency." *Id.* at [0012]. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Walton '131 at least because Mantha provides random access channel related specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '131) in order to improve uplink random access protocols. In addition, Mantha and Walton '131 identify the common problem of providing greater

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efficiency for OFDM systems in wireless communication systems by, for example, improving random access procedures. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Walton '131 at Abstract, [0009]–[0010], [0050]–[0056], [0063], [0134]. A POSITA would have been motivated to combine Mantha with Walton '131 because Walton '131 provides techniques to use OFDM symbols of different sizes to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Walton '131 at Abstract, [0009]–[0010], [0050]–[0056], [0063], [0134].

- **Mantha and Eklund:** Eklund is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Eklund teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and overviews "the technical medium access control and physical layer features" of this standard. Eklund at Abstract. "WirelessMAN OFDM [] uses orthogonal frequency-division multiplexing with a 256-point transform." Eklund at 3, 5. WirelessMAN also "provides network access [to SSes] through exterior antennas communicating with central radio base stations (BS)." Eklund at 3. Eklund further discloses "initial access" opportunities that are followed by "requests for bandwidth in either random access slots or dedicated transmission opportunities." Eklund at 8–9, and Figure 2. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–

[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Eklund at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Eklund) in order to carry out uplink and random access protocols. In addition, Mantha and Eklund identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *See* Eklund at 10–11. A POSITA would have been motivated to combine Mantha with Eklund because Eklund provides a system level scheme with random access channels which could be used to solve the problem identified by Mantha. *See* Eklund at 10–11; *see* Mantha at 1–3 and [0040], [0064], [0085]–[0089] and [0094]–[0095].

- **Mantha and Engstrom:** Engstrom is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Engstrom teaches and describes "a random access protocol for use in a multi-access digital radio communications system having a plurality of mobile stations and a plurality of base stations and using OFDM for an uplink between a mobile station and base station in which a mobile station transmits a random access sequence.." Engstrom at 2:51–59. A random access signal could establish an initial access and find time

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delay/offset using ranging techniques. *See* Engstrom at 6:36–7:4. Engstrom further discloses how to allocate OFDM resource (i.e. sub-carriers), including dedicated sub-carriers, for the initial random access channel. See Engstrom at 7:17–67 and Fig. 8. Mantha teaches and describes "[the] use of orthogonal frequency division multiplex[ing] [OFDM] in a cellular system requir[ing] that the base station and the mobile station are time and frequency synchronized in order to preserve orthogonality between the subcarriers." Mantha at Abstract. Mantha further discloses "an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol." *Id.* at 1. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Engstrom at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Engstrom) in order to carry out uplink and random access protocols. In addition, Mantha and Engstrom identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *see* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Engstrom at 2:43–48. A POSITA would have been motivated to combine Mantha with Engstrom because Engstrom provides a random access protocol in which a random access sequence can be cyclically repeated to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Engstrom at 2:43–48.

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- **Mantha and Wahlqvist:** Wahlqvist is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wahlqvist teaches and describes "[the] use of orthogonal frequency division multiplex[ing] [OFDM] in a cellular system requir[ing] that the base station and the mobile station are time and frequency synchronized in order to preserve orthogonality between the subcarriers." Wahlqvist at Abstract. Wahlqvist further discloses "an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol." *Id.* at 1. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Wahlqvist at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Wahlqvist) in order to carry out uplink and random access protocols. In addition, Mantha and Wahlqvist identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *see* Mantha at [0040],

[0064], [0085]–[0089] and [0094]–[0095]; *see* Wahlqvist at 1–4. A POSITA would have been motivated to combine Mantha with Wahlqvist because Wahlqvist provides an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Wahlqvist at 1–4.

- **Mantha and WiMAX 2003:** WiMAX 2003 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Defendants also incorporate by reference the citations in the WiMAX 2003 invalidity chart into the invalidity chart for Mantha. WiMAX 2003 teaches and describes that " the SS (i.e. the mobile terminal) transmits an UL signal (i.e., and OFDM signal) to the base station." WiMAX 2003 at https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 2. WiMAX 2003 further describes an uplink subfram with a "contention slot for initial ranging," followed by a "contention slot for [bandwidth] requests. WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page 183. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and

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base stations. It would have been obvious for a POSITA to combine Mantha with WiMAX 2003 at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in WiMAX 2003) in order to carry out uplink and random access protocols. In addition, Mantha and WiMAX 2003 identify the common problem of providing enhancements to OFDM wireless communication systems by, for example, improving physical and medium access control layers, including uplink and random access protocols. *See* Mantha at [0001]–[0040]; *see* WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2. A POSITA would have been motivated to combine Mantha with WiMAX 2003 because WiMAX 2003 provides enhancements to PHY and MAC layers that support difficult user environments, high bandwidth, continuous and burst traffic, and efficient spectrum use to the problem identified by Mantha. *See* Mantha at [0001]–[0040]; WiMAX 2003 at https://sci-hub.se/10.1109/IEEESTD.2003.94247, Page iii, 2 and https://www.ieee802.org/16/docs/03/S80216-03_14.pdf, Slide 18.

- **Mantha and HiperLAN/2 DLC Specification Part 1:** HiperLAN/2 DLC Specification Part 1 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. HiperLAN/2 DLC Specification Part 1 teaches and describes a "Mobile Terminal (MT) . . . that communicates with an access point or with each other via a radio link." HiperLAN/2 DLC Specification Part 1 at 9. HiperLAN/2 DLC Specification Part 1 further discloses "Medium Access Control protocol" and "physical (PHY) layer of HIPERLAN/2 . . . ." *Id.* at 13–14. The PHY layer "is based on the modulation

scheme Orthogonal Frequency Division Multiplexing (OFDM)." *Id.* at 14. HiperLAN/2 DLC Specification Part 1 discloses both an "uplink phase" and a "random access phase." *Id.* at 8–10. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with HiperLAN/2 DLC Specification Part 1 at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 1) in order to carry out uplink and random access protocols. In addition, Mantha and HiperLAN/2 DLC Specification Part 1 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* HiperLAN/2 DLC Specification Part 1 at 14. A POSITA would have been motivated to combine Mantha with HiperLAN/2 DLC Specification Part 1 because HiperLAN/2 DLC Specification Part 1 provides a multi-rate PHY layer, where the appropriate mode

can be selected by a link adaptation scheme based on different interferences situations and distances among MTs and an AP, to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* HiperLAN/2 DLC Specification Part 1 at 14.

- **Mantha and Walton '301:** Walton '301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '301 teaches and describes "a multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. Walton '301 further describes "a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 3:54–63. Walton '301 further describes an "uplink phase" that consists of "one or more [Reverse Channel] PDUs [] transmitted in a fourth segment and one more [Random Access Channel] PDUs transmitted in a fifth segment . . . ." *Id.* at Walton '301 at 11:7–16. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Walton '301 at

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least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '301) in order to carry out uplink and random access protocols. In addition, Mantha and Walton '301 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Walton '301 at 1:35–51, 2:3. A POSITA would have been motivated to combine Mantha with Walton '301 because Walton '301 provides a MIMO structure to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Walton '301 at Abstract, 1:11–3:2.

- **Mantha and Walton '944:** Walton '944 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '944 teaches and describes "techniques for facilitating random access in wireless multiple-access communication systems," where the system employs orthogonal frequency division multiplexing (OFDM) . . . ." Walton '944 at Abstract, 3:34–37. Walton '944 further describes "a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 2:57–3:10. "[T]he uplink transport channels include a reverse channel (RCH) and a random access channel (RACH) . . . ." *Id.* at 3:49–4:9. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040],

[0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Walton '944 at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '944) in order to carry out uplink and random access protocols. In addition, Mantha and Walton '944 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Walton '944 at Abstract, 1:60–62. A POSITA would have been motivated to combine Mantha with Walton '944 because Walton '944 provides a fast and slow random access channel option to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Walton '301 at Abstract, 2:1–18.

- **Mantha and Walton '269:** Walton '269 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ' 269 teaches and describes "data communication and processing . . . for providing an efficient control channel structure in a wireless local area network (WLAN) communication system." Walton '269 at 1:9–13. "MIMO and orthogonal frequency division multiplexing (OFDM) may be employed to obtain high throughput, combat deleterious path effects, and provide other benefits." *Id.* at

1:66–2:3. Walton '269 further discloses a system that "includes a number of access points (APs) that support communication for a number of user terminals (UTs)." *Id.* at 3:26–28. Walton '269 discloses "uplink transport channels used by the UTs" that include a "Reverse Channel" and a "Random Access Channel." *Id.* at 9:14–15, and Figures 4 and 5. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Walton '269 at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Walton '269) in order to carry out uplink and random access protocols. In addition, Mantha and Walton '269 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Walton '269 at Abstract, 2:8–36. A POSITA would have been motivated to combine Mantha with Walton '269 because Walton '269 discloses a more efficient control channel

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structure that is able to accommodate different users operating at different rates to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Walton '269 at Abstract, 2:36–40.

- **Mantha and Jeong '589:** Jeong '589 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Jeong '589 teaches and describes "a method for ranging interval and ranging sub-channel allocation for initial ranging in a multi-user orthogonal frequency division multiple access ("OFDMA") type wireless communication system . . . ." Jeong '589 Translation at Abstract. Jeong '589 further discloses that "[i]n IEEE 802.16ab, OFDMA wireless communication system is defined such that data can be transmitted between a base station ("BS") and a subscriber station ("SS") using a microwave frequency band between 2 GHz and 11 GHz." *Id.* at 2. Jeong '589 discloses that "the SS transmits a ranging signal to the BS using a ranging sub-channel and a ranging code arbitrarily selected in a ranging interval section." *Id.* at 9. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDMA transmission between mobile stations and base stations. It

would have been obvious for a POSITA to combine Mantha with Jeong '589 at least because Mantha provides specifications of a wireless communication system that uses OFDMA transmission (such as that disclosed in Jeong '589) in order to carry out uplink and random access protocols. In addition, Mantha and Jeong '589 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Jeong '589 Translation at Abstract, 2–3. A POSITA would have been motivated to combine Mantha with Jeong '589 because Jeong '589 provides an initial ranging interval and ranging subchannel allocation method for initial ranging of multi-user OFDMA to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Jeong '589 Translation at Abstract, 2–3.

- **Mantha and Kaiser:** Kaiser is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kaiser teaches and describes "a multiple access scheme for mobile multi-media applications. . . . referred to as spread-spectrum multi-carrier multiple-access (SS-MC-MA)" for "the uplink of a mobile radio system . . . ." Kaiser at Abstract, p.100. Kaiser further discloses "applying OFDM" to SS-MC-MA such that "data transmission can be based on OFDM-frames, where each frame consists of several OFDM-symbols." *Id.* at pp.102–103. Kaiser discloses a transmitter and receiver using "OFDM with [a] user-specific frequency mapper." *Id.* at p.101. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access

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mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Kaiser at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kaiser) in order to carry out uplink and random access protocols. In addition, Mantha and Kaiser identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Kaiser at 1. A POSITA would have been motivated to combine Mantha with Kaiser because Kaiser provides a scheme with variable sub-carrier allocation and effective error protection to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Kaiser at 1.

- **Mantha and Benedittis '812:** Benedittis '812 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Benedittis '812 teaches and describes a "third generation (3G) cellular system of UMTS (Universal Mobile Telecommunication System)," including "a method for optimizing the random access procedures in the CDMA cellular networks," where

"[t]he spreading code sequences [are] reciprocally orthogonal . . . ." Benedittis '812 at [0001]–[0002]. Benedittis '812 also discloses "MS (Mobile Stations or Mobile Units), also vehicular ones, and portable User Equipment units UE, [] radio connected with relevant TRC transceivers [] belonging to relevant base transceiver stations BTSC (Base Transceiver Station for CDMA) spread on the territory." *Id.* at [0053]–[0054]. Benedittis '812 discloses "m uplink time slots . . . coming from the mobile stations MS/UE . . . ." *Id.* at [0057]. Benedittis '812 further discloses sending "the first SYNC1 signatures sent from the mobile" followed by "a successive CHANNEL REQUEST message sent from the mobile on a [Random Access Channel.]" *Id.* at [0104]–[0106], and Figure 7. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Benedittis '812 at least because Mantha provides specifications of a wireless communication system that utilizes a first uplink signal followed by a random access protocol (such as that disclosed in Benedittis '812). In addition, Mantha and Benedittis '812 identify the common

problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Benedittis '812 at [0021]–[0022]. A POSITA would have been motivated to combine Mantha with Benedittis '812 because Benedittis '812 provides an optimized random access procedure to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Benedittis '812 at Abstract, [0021]–[0022].

- **Mantha and Ma '437:** Ma '437 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '437 teaches and describes "physical layer structures and related access schemes for unsynchronized [wireless] communication networks," Ma '437 at Abstract, where "the communication signal is an OFDM signal," *id.* at 2:25–26. Ma '437 further discloses "a wireless communication network . . . . [that] includes base transceiver stations (BTSs)," and "[u]ser equipment (UE) [that] is adapted to communicate with any of the BTSs that are within its range[.]" Ma '437 at 4:61–67. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and

medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Ma '437 at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '437) in order to carry out uplink and random access protocols. In addition, Mantha and Ma '437 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Ma '437 at Abstract, 1:41–2:3. A POSITA would have been motivated to combine Mantha with Ma '437 because Ma '437 provides common and cell-specific synchronization codes, preambles, and/or pilots to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Ma '437 at Abstract, 1:41–2:3, 2:14–62.

- **Mantha and Ma '546:** Ma '546 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '546 teaches and describes "[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network." Ma '546 at 1:20–22. "[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . ." *Id.* at 2:48–50. Ma '546 further describes "a Random Access Channel (RACH) for UE's new to a particular wireless network to access the system." *Id.* at 19:45–48. "A dedicated long complex PN/Golay code set is reserved for RACH of each base station," and "[t]he covering PN code for each base station is different from those of the neighboring base stations . . . ." *Id.* at

20:50–51, 21:1–5. "The base station can broadcast this information through a DL signaling channel." *Id.* at 20:54–55. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Ma '546 at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma '546) in order to carry out uplink and random access protocols. In addition, Mantha and Ma '546 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Ma '546 at 2:6–44. A POSITA would have been motivated to combine Mantha with Ma '546 because Ma '546 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Ma '546 at Abstract, 2:48–56.

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- **Mantha and Ma ’429:** Ma ’429 teaches and describes “[a] wireless network [that] includes access points (e.g. base stations) through which User Equipment (UE) may access the wireless network.” Ma ’429 at [0003]. “[T]he invention provides a wireless terminal for communicating over a shared OFDM band . . . .” *Id.* at [0010]. Ma ’429 further describes “a Random Access Channel (RACH) for UE’s new to a particular wireless network to access the system.” *Id.* at [0205]. “A dedicated long complex PN/Golay code set is reserved for RACH of each base station,” and “[t]he covering PN code for each base station is different from those of the neighboring base stations . . . .” *Id.* at [0215], [0217]. “The base station can broadcast this information through a DL signaling channel.” *Id.* at [0215]. Mantha teaches and describes a “novel communication channel structure and method in a wireless communication system” in which an “uplink data channel can operate in at least a random access mode and a polled access mode”, Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Ma ’429 at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Ma ’429) in order to carry out uplink and random access protocols. In addition, Mantha and Ma ’429 identify the

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common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Ma '429 at [0007]–[0009]. A POSITA would have been motivated to combine Mantha with Ma '429 because Ma '429 provides an uplink protocol with low-rate mode and burst mode OFDM transmission to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Ma '429 at Abstract, [0010].

- **Mantha and Mody:** Mody teaches and describes "a wireless Orthogonal Frequency Division Multiplexing (OFDM) communication system[.]" Mody at Abstract. Mody further discloses "a system for synchronizing data transmitted across a channel." *Id.* The communication system of Mody "may be part of a . . . Wireless[MAN] system." Mody at 3:41–44. Mody further discloses communication between "a number of transmitting antennas [and] a number of receiving antennas [] used to receive the transmitted signals." Mody at 2:32–35. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and

base stations. It would have been obvious for a POSITA to combine Mantha with Mody at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Mody) in order to carry out uplink and random access protocols. In addition, Mantha and Mody identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Mody at Abstract, [0008]. A POSITA would have been motivated to combine Mantha with Mody because Mody provides a sequence of training symbols and/or preambles and improved synchronization and channel estimation in MIMO systems to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Mody at Abstract, [0008]–[0012].

- **Mantha and Kriedte '196:** Kriedte '196 teaches and describes "a wireless communication system, such as a multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) wireless LAN system[.]" Kriedte '196 at Abstract. Kriedte '196 further discloses communication between "N_t transmit antennas and N_t receive antennas[.]" Kriedte '196 at 3:29–30. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050].

Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Kriedte '196 at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Kriedte '196) in order to carry out uplink and random access protocols. In addition, Mantha and Kriedte '196 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Kriedte '196 at Abstract, 1:17–59. A POSITA would have been motivated to combine Mantha with Kriedte '196 because Kriedte '196 provides symbol timing techniques to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Kriedte '196 at Abstract, 1:61–2:41.

- **Mantha and Boehnke:** Boehnke teaches and describes "wireless communication systems with high-speed mobile access, . . . wherein Orthogonal Frequency Division Multiplexing (OFDM) is applied as a multi-carrier modulation technique." Boehnke at Abstract. Boehnke further describes a system in which "mobile stations" or "mobile terminals" communicate on the uplink and downlink with an "Access Point (AP)." Boehnke at [0036]–[0038]. Boehnke teaches transmission phases of an "Uplink Phase" followed by a "Random Access Phase." *Id.* .Mantha teaches and describes the "IEEE Standard 802.16, with its WirelessMAN air interface," and

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overviews "the technical medium access control and physical layer features" of this standard. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Boehnke at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Boehnke) in order to carry out uplink and random access protocols. In addition, Mantha and Boehnke identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Boehnke at Abstract, [0052]–[0058]. A POSITA would have been motivated to combine Mantha with Boehnke because Boehnke provides a new pilot pattern and insertion of reference symbols to support channel estimation and synchronization to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Boehnke at Abstract, [0052]–[0068].

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- **Mantha and Chheda:** Chheda teaches and describes "using . . . OFDM for broadband wireless systems." Chheda further describes "User Terminals," "Subscriber Units," and "Customer Premise Equipment" in communication with "Base Stations," "Wireless Base Stations" or "Base Transceiver Stations." Chheda at 22, 30, and 105. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Chheda at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Chheda) in order to carry out uplink and random access protocols. In addition, Mantha and Chheda identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Chheda at 1–10. A POSITA would have been motivated to combine Mantha with Chheda because Chheda provides OFDM multiple-access techniques to the problem identified by Mantha. *See*

Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Chheda at 1–10, 74–95.

- **Mantha and HiperLAN/2 DLC Specification Part 2:** HiperLAN/2 DLC Specification Part 2 teaches and describes "the basic Radio Link Control (RLC) sublayer of HIPERLAN/2" which "is confined to . . . the physical and the data link control layer." HiperLAN/2 DLC Specification Part 2 at 9. Among other things, the "scope of HIPERLAN/2 standards" covers both the "Physical Layer" and "Medium Access Control." *Id.* at 14, Figures 1–2. HiperLAN/2 DLC Specification Part 2 further describes communication between "Mobile Terminals" and "Access Points." *Id.* at 19. For example, the "Uplink phase" is "part of the MAC frame in which data is transmitted from the mobile terminals to an access point or a central controller. *Id.* at 12. HiperLAN/2 DLC Specification Part 2 further describes various uplink channels, including a "Random Access CHannel [RACH]," and a "Random CHannel [RCH]." *Id.* HiperLAN/2 DLC Specification Part 2 uses a "normal" and "short" "OFDM symbol guard interval" in the PHY layer. *Id.* at 178. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and

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medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with HiperLAN/2 DLC Specification Part 2 at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 DLC Specification Part 2) in order to carry out uplink and random access protocols. In addition, Mantha and HiperLAN/2 DLC Specification Part 2 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13. A POSITA would have been motivated to combine Mantha with HiperLAN/2 DLC Specification Part 2 because HiperLAN/2 DLC Specification Part 2 provides radio link control layer functions, messages, and formats to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* HiperLAN/2 DLC Specification Part 2 at 9, 13.

- **Mantha and HiperLAN/2 PHY Specification:** HiperLAN/2 PHY Specification teaches and describes "the physical layer specifications for HIgh PErformance Radio Local Area Network type 2 (HIPERLAN/2)," HiperLAN/2 PHY Specification at 5–6. "The PHY layer of HIPERLAN/2 . . . provides for functions to map different DLC PDU trains into framing formats called PHY bursts appropriate for transmitting and receiving management and user information between an [Access Point] and a [Mobile Terminal] . . . ." *Id.* at 10. "The PHY layer of HIPERLAN/2 is based on the modulation scheme Orthogonal Frequency

Division Multiplexing (OFDM)." *Id.* HiperLAN/2 PHY Specification further describes a "Random CHannel (RCH)" used to "carr[y] the logical channels random access channel and association channel," and that "[t]he BCH includes 2 bits which announce the guard time between random access bursts." *Id.* at 7, 33. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using OFDM transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with HiperLAN/2 PHY Specification at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in HiperLAN/2 PHY Specification) in order to carry out uplink and random access protocols. In addition, Mantha and HiperLAN/2 PHY Specification identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* HiperLAN/2 PHY Specification at 6, 9. A POSITA would have been motivated to combine Mantha with HiperLAN/2 PHY Specification because HiperLAN/2 PHY

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Specification provides a multi-rate PHY layer and link adaptation scheme to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* HiperLAN/2 PHY Specification at 6, 9, 11.

- **Mantha and Gibson:** Gibson teaches and describes "wireless communication systems" using "[frequency division multiple access [with] signals assigned to different users [that] are clearly orthogonal . . . ." Gibson at p.17-4. Gibson discloses a "mobile station" which "initiates the procedure by transmitting a request [to the base station] on a random-access channel." *Id.* at p.17-8–17-9. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Gibson at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Gibson). In addition, Mantha and Gibson identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless

communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Gibson at 17-4–17-12. A POSITA would have been motivated to combine Mantha with Gibson because Gibson provides channel assignment and multiple access techniques to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Gibson at 17-4–17-12, and Figure 17.3.

- **Mantha and Suh '464:** Suh '464 teaches and describes "an orthogonal frequency division multiplexing (OFDM) communication system . . . ." Suh '464 at [0003]. "[A] wireless communication system is comprised of Node Bs and user equipments (UEs)," where "[t]he Node B's and the UEs transmit data by the frame for a wireless communication service." *Id.* at [0005]. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Suh '464 at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission (such as that disclosed in Suh '464) in order to carry out uplink and

random access protocols. In addition, Mantha and Suh '464 identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Suh '464 at Abstract, [0002]–[0044]. A POSITA would have been motivated to combine Mantha with Suh '464 because Suh '464 provides generating a preamble sequence for low peak-to-average power ration and improved channel estimation to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Suh '464 at Abstract, [0042]–[0049].

- **Mantha and Kanterakis:** Kanterakis teaches and describes "spread-spectrum communications," where "[t]he CMDA system has a base station (BS) and a plurality of remote stations." Kanterakis at 1:5, 27–28. Kanterakis further describes "a random-access burst structure which has a preamble followed by a data portion," where "the preamble sequence [is] spread by an orthogonal Gold code." *Id.* at 1:5–18. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission

between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Kanterakis at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Kanterakis). In addition, Mantha and Kanterakis identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; Kanterakis at Abstract, 1:10–23. A POSITA would have been motivated to combine Mantha with Kanterakis because Kanterakis provides spread spectrum modulation to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Kanterakis at Abstract, 1:10–2:11.

- **Mantha and Frank:** Frank teaches and describes a "mobile telecommunications system" with "a method and system for processing multiple random access calls in a [CDMA] . . . system." Frank at 1:5–13. Frank further describes "[a]n uplink common physical channel (random access channel) frame structure . . . with a separate preamble and data portion," where "[t]he preamble is used by a base station to detect that a mobile station is attempting a random access request." *Id.* at Abstract. Mantha teaches and describes a "novel communication channel structure and method in a wireless communication system" in which an "uplink data channel can operate in at least a random access mode and a polled access mode", Mantha at Abstract. Mantha further discloses how to establish the initial access during the random access mode. *See* Mantha at [0040], [0064], [0085]–

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[0089] and [0094]–[0095], and the method could be implemented in an OFDM system. *See* Mantha at [0050]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems, including the physical layer and medium access control, using transmission between mobile stations and base stations. It would have been obvious for a POSITA to combine Mantha with Frank at least because Mantha provides specifications of a wireless communication system that uses OFDM transmission in order to carry out uplink and random access protocols (such as that disclosed in Frank). In addition, Mantha and Frank identify the common problem of establishing effective access initialization procedures and/or random access channel allocation in wireless communication systems. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; Frank at Abstract, 1:11–5:31. A POSITA would have been motivated to combine Mantha with Frank because Frank provides a random access channel frame structure with separate preamble and data portions to the problem identified by Mantha. *See* Mantha at [0040], [0064], [0085]–[0089] and [0094]–[0095]; *see* Frank at Abstract, 6:1–7:11.

c. The ’941 Patent

A person of ordinary skill in the art would have been motivated to combine or modify each piece of prior art identified in Sections III.B-E in such a way as to render the asserted claims of the ’941 patent invalid. For example, Defendants identify at least the following grounds (and similar permutations based on the listed references) that render the asserted claims of the ’941 patent invalid under 35 U.S.C. § 103:

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(i) Classon ’996 in combination with the knowledge of a skilled artisan, Walton ’040, Walton ’110, Wallace ’467, Walton ’269, Heath, Catreux, Jalali, Wu ’434, Li ’781, Li ’017, Li ’748, and/or Shattil ’043

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Classon ’996 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Classon ’996 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’941 patent was filed. Specifically:

- Classon ’996 in combination with the knowledge of a skilled artisan, Walton ’040, Walton ’110, Wallace ’467, Walton ’269, Heath, Catreux, Jalali, Wu ’434, Li ’781, Li ’017, Li ’748, and/or Shattil ’043 are all directed to systems and methods for transmitting information in a wireless packet system. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic transmissions, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA, MIMO), and modulation schemes, that were common and easily

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understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Classon '996 and Wallace '467**: Wallace '467 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wallace '467 teaches and describes that "the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system." Wallace '467 at 1:20-22. Wallace '467 discloses that "[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units" and "[i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit." *Id.* at Abstract. According to Wallace '467, "pilot symbols are generated and transmitted on a subset of the disjoint sub-channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be further minimized through compression techniques and resource allocation techniques." *Id.* Wallace '467 further discloses "[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly" and "[a]s delay of the measurement and reporting process increases,

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the utility of the channel response information decreases." *Id.* at 2:13-20. According to Wallace '467, "[a] present need exists for efficient techniques that will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and "pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. Classon '996 teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these

problems, Classon ’996 teaches “a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain” where “[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained.” *Id.* at 3:50-55. Classon further discloses “In addition to the frequency dimension characteristics of the channel in a multicarrier system, spatial dimension channel characteristics may also be of interest when both the transmitter and receiver are equipped with a plurality of antennas. A multi-antenna setting allows simultaneous transmission of different data streams from the plurality of antennas in the same frequency band, thus increasing the spectral efficiency significantly. The spatial channel characteristics include knowledge of all the spatial channels between each transmit antenna and each receive antenna. In the case of a multicarrier system, each spatial channel comprises multiple subcarriers. Since the channel is now characterized in both frequency and spatial dimensions, as well as in a time dimension (rate of channel variation), this characterizes the wireless system as a multi-dimensional system. Spatial dimension channel characteristics may also be of interest when only the transmitter is equipped with a plurality of antennas. In this case, the spatial channel characteristics can be used to adapt a space-time coding scheme, a transmit diversity scheme, or a handoff scheme.” *Id.* at 6:1-20. According to Classon ’996, “[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time,” which “allows the system to support both robust

communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques and channel state information. It would have been obvious for a POSITA to combine Classon '996 with Wallace '467 at least because Classon '996 provides a method to facilitate adaptive transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Wallace '467's) in order to optimize data throughput and improve communications and performance in a system capable of supporting more users.

- **Classon '996 and Walton '040:** Walton '040 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the

operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Classon '996 teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these

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problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques and channel state information. It would have been obvious for a POSITA to combine Classon '996 with Walton '040 at least because Classon '996 provides a method to facilitate adaptive transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Walton '040) in order to optimize data throughput and improve communications and performance in a system capable of supporting more users.

- **Classon '996 and Walton '110**: Walton '110 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '110 is directed "to techniques for allocating resources in multiple-input multiple-output communication systems that utilize orthogonal frequency division multiplexing (i.e., MIMO-OFDM systems)." Walton '110 at 1:7-11. Walton '110

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teaches and describes "[t]echniques to schedule terminals for data transmission on the downlink and/or uplink in a MIMO-OFDM system based on the spatial and/or frequency "signatures" of the terminals." Walton '110 at Abstract. In Walton '110, "[a] scheduler forms one or more sets of terminals for possible (downlink or uplink) data transmission for each of a number of frequency bands" and "[o]ne or more sub-hypotheses may further be formed for each hypothesis, with each sub-hypothesis corresponding to (1) specific assignments of transmit antennas to the terminal(s) in the hypothesis (for the downlink) or (2) a specific order for processing the uplink data transmissions from the terminal(s) (for the uplink). *Id.* Walton '110 discloses "[a] wideband MIMO system typically experiences frequency selective fading, which is characterized by different amounts of attenuation across the system bandwidth" and "[t]his frequency selective fading causes inter-symbol interference (ISI), which is a phenomenon whereby each symbol in a received signal acts as distortion to subsequent symbols in the received signal," which the "distortion degrades performance by impacting the ability to correctly detect the received symbols." *Id*. at 1:36-45. According to Walton '110, "[t]here is therefore a need in the art for techniques to allocate resources in a MIMO-OFDM system to provide high system performance." *Id.* at 2:14-16. To address these problems, Walton '110 describes "[t]echniques are provided herein to schedule terminals for data transmission on the downlink and/or uplink based on the spatial and/or frequency "signatures" of the terminals" in which "[v]arious scheduling schemes are provided herein to select a "proper" set of one or more terminals for data transmission on each frequency band and to assign the available

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transmission channels to the selected terminals such that system goals (e.g., high throughput, fairness, and so on) are achieved." *Id.* 2:20-32. Classon '996 teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which

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"allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments, including optimizing throughput, using improved adaptive transmission techniques. It would have been obvious for a POSITA to combine Classon '996 with Walton '110 at least because Classon '996 provides a method to facilitate adaptive transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Walton '110's) in order to optimize data throughput and improve communications and performance in a system capable of supporting more users.

- **Classon '996 and 802.16a-2003:** 802.16a discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna

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systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.* at 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* Classon '996 teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of

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the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques and channel state information. It would have been obvious for a POSITA to combine Classon '996 with 802.16a-2003 at least because Classon '996 provides a method to facilitate adaptive transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like 802.16a-2003) in order to optimize data throughput and improve communications and performance in a system capable of supporting more users.

- **Classon '996 and Li '017:** Li '017 is directed to "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '017 at [0002]. Li '017 explains that "[i]n one embodiment, each subscriber measures the SINR of each subcarrier cluster and reports these SINR measurements to their base station through an access channel. The SINR value may comprise the average of the SINR values of each of the subcarriers in the cluster." *Id*. at [0045]. Li '017 discloses that "there are two categories of clusters: coherence clusters, containing multiple subcarriers close to each other and diversity clusters, containing multiple subcarriers with at least some of the subcarriers spread far apart over the spectrum. The closeness of the multiple subcarriers in coherence clusters is preferably within the channel coherence bandwidth, i.e. the bandwidth within

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which the channel response remains roughly the same, which is typically within 100 kHz for many cellular systems. On the other hand, the spread of subcarriers in diversity clusters is preferably larger than the channel coherence bandwidth, typically within 100 kHz for many cellular systems. Of course, the larger the spread, the better the diversity. Therefore, a general goal in such cases is to maximize the spread." *Id.* at [0111]. Classon '996 teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55.

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According to Classon ’996, “[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time,” which “allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions.” *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques and channel state information. It would have been obvious for a POSITA to combine Classon ’996 with Li ’017 at least because Classon ’996 provides a method to facilitate adaptive transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Li ’017) in order to optimize data throughput and improve communications and performance in a system capable of supporting more users.

- **Classon ’996 and Li ’781:** Li ’781 is directed to “[a] method and apparatus for subcarrier selection for systems.” Li ’781 at Abstract. Li ’781 discloses “the system employs orthogonal frequency division multiple access (OFDMA). . . . In one embodiment, a method for subcarrier selection comprises each of multiple subscribers measuring channel and interference information for subcarriers based on pilot symbols received from a base station, at least one of subscribers selecting a set of candidate subcarriers, providing feedback information on the set of candidate subcarriers to the base station, and the one subscriber receiving an indication of subcarriers of the set of subcarriers selected by the base station for use

by the one subscriber." *Id.* Li '781 teaches and describes "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '781 at [0001]. According to Li '781, "[o]ne approach to subcarrier allocation for OFDMA is a joint optimization operation, not only requiring the activity and channel knowledge of all the subscribers in all the cells, but also requiring frequent rescheduling every time an existing subscriber is dropped off the network or a new subscriber is added onto the network." *Id.* at [0006]. However, this approach "is often impractical in real wireless system, mainly due to the bandwidth cost for updating the subscriber information and the computation cost for the joint optimization." *Id.* Li '781 also describes that with an "aggressive frequency reuse plan, e.g., the same spectrum is used for multiple neighboring cells, the problem of intercell interference arises." *Id.* at [0005]. "At the receiver, the subscriber first distinguishes the two sequences using the signal processing methods which are well known in the art, e.g., the correlation methods, and then estimates the channel and interference level." *Id.* at [0090]. Thus, Li '781 teaches "[a] distributed, reduced-complexity approach for subcarrier allocation." *Id.* at [0023]. Classon '996 teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission

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source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques. It would have been obvious for a POSITA to combine Classon '996 with Li '781 at least because Classon '996 provides a method to facilitate adaptive transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems

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like Li ’781) in order to optimize data throughput and improve communications and performance in a system capable of supporting more users.

- **Classon ’996 and Shattil ’043:** Shattil ’043 is directed to “multi-carrier communications, and in particular, to Carrier Interferometry.” Shattil ’043 at 1: 17-18. Shattil ’043 discloses “[t]echniques for reducing peak-to-average power in multicarrier transmitters employ peak cancellation with subcarriers that are impaired by existing channel conditions” and that “[t]he use of Carrier Interferometry (CI) coding further improves the effectiveness of peak reduction.” *Id.* at Abstract. “CI coding can also be impressed onto pulse sequences in the time domain, which enhances spectral selection and facilitates peak-power control.” *Id*. According to Shattil ’043, “the problem of interference suppression is more difficult and also more critical for the uplink, since it typically represents the capacity bottleneck compared to the downlink. Accordingly, various aspects of the invention are directed toward mitigating interference in CI systems.” *Id.* at 5:58-63. Classon ’996 teaches and describes an adaptive transmission method where “[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness.” Classon at Abstract. Classon ’996 explains that “[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target.” *Id.* at 2:34-38. Classon ’996 discloses that “[a] need therefore exists for a way to improve upon overall system data throughput for

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a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques. It would have been obvious for a POSITA to combine Classon '996 with Shattil '043at least because Classon '996 provides a method to facilitate adaptive transmissions in a multicarrier system (which can be applied to other multi-carrier systems like Shattil '043) in order to optimize data throughput and improve communications and performance in a system capable of supporting more users.

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- **Classon ’996 and Walton ’269:** Walton ’269 is an “invention relates generally to data communication and processing, and more specifically to a method and apparatus for providing an efficient control channel structure in a wireless local area network (WLAN) communication system.” Walton ’269 at 1:9-13. Walton teaches “a method is provided in which a control channel used for transmitting control information is partitioned into a plurality of subchannels each of which is operated at a specific data rate” and “[f]or each of one or more user terminals, one of the subchannels is selected based on one or more selection criteria for transmitting control information from an access point to the respective user terminal.” *Id*. at Abstract. In Walton ’269 “[c]ontrol information is transmitted from the access point to a user terminal on a particular subchannel selected for the respective user terminal” and “[a]t the user terminal, one or more subchannels are decoded to obtain control information designated for the user terminal.” *Id.* Classon ’996 teaches and describes an adaptive transmission method where “[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness.” Classon at Abstract. Classon ’996 explains that “[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target.” *Id.* at 2:34-38. Classon ’996 discloses that “[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency

division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques and control information. It would have been obvious for a POSITA to combine Classon '996 with Walton '269 at least because Classon '996 provides a method to facilitate adaptive transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Walton '269) in order to optimize data throughput and improve communications and performance in a system capable of supporting more users.

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- **Classon ’996 and Li ’748:** Li ’748 discloses “it is advantageous in an OFDMA system to adaptively allocate the subcarriers to subscribers so that each subscriber enjoys a high channel gain.” Li ’748 at 1:48-50. For example, “[t]he coding/modulation rate can be adaptively changed according to the channel conditions observed at the receiver after the initial cluster allocation and rate selection.” *Id*. at 7:26-28. Classon ’996 teaches and describes an adaptive transmission method where “[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness.” Classon at Abstract. Classon ’996 explains that “[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target.” *Id.* at 2:34-38. Classon ’996 discloses that “[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system” and “any such improvement should not present a significant or undue loading requirement upon the system itself” or “unduly delay the transmission of data in favor of overall improvement throughput.” *Id.* at 2:62-3:4. To address these problems, Classon ’996 teaches “a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain” where “[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained.” *Id.* at 3:50-55.

According to Classon ’996, “[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time,” which “allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions.” *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques and control information. It would have been obvious for a POSITA to combine Li ’748 with Classon ’996 at least because both are directed to adaptive transmission of wireless communication signals.

- **Classon ’996 and Heath:** Heath is directed to a wireless communication system that supports wireless transmissions with and without spatial multiplexing in which “[a] wireless communications adapts its mode of operation between spatial multiplexing and non-spatial multiplexing in response to transmission-specific variables. Heath at Abstract. Heath teaches and describes that “the base transceiver stations and subscriber units communicate information related to the operation mode over a control channel.” Heath at 8:48-50. Heath discloses “FIG. 1 depicts a multiple access wireless communications system that includes base transceiver stations (BTSs) 102 and 104 and subscriber units (SUs) 106, 108, and 110. The base transceiver stations include spatially separated antennas 114 and spatial multiplexing logic 118. The base transceiver stations also include mode determination logic 122 that enables the system to adapt its mode of operation

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between spatial multiplexing and non-spatial multiplexing in response to transmission-specific variables." *Id*. at 5:7-15. Heath further explains "[t]he mode determination logic is the focus of the invention and is described in more detail below. Subscriber unit 106 does not support spatial multiplexing, does not include spatial multiplexing logic, and includes one or more antennas. Subscriber units that do not support spatial multiplexing may or may not include mode determination logic. In the embodiment of FIG. 1, the subscriber unit 106 includes mode determination logic 140 that notifies the base transceiver stations 102 and 104 that the subscriber unit does not support spatial multiplexing." *Id.* at 5:15-20. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques and control information. It would have been obvious for a POSITA to combine Classon '996 with Heath at least because Classon '996 provides a method to facilitate adaptive transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Heath) in order to optimize data throughput and improve communications and performance in a system capable of supporting more users.

- **Classon '996 and Catreux:** Catreux teaches and describes "wireless communications between a base station and multiple users." Catreux at 1:12-13. The "communication over the wireless channel uses one of several possible channelization modes" including OFDM. *Id*. at 5:17-39. "An embodiment of the transmit unit 200 of FIG. 2 includes a mode selection block 250. The mode selection block generates a first mode selection based upon a first quality parameter

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fed back from the receiver unit." *Id*. at 8:61-64. "The transmit unit 200 receives feedback from receive unit 300 via a feedback extractor 260." *Id*. at 9:13-15. "A subsequent transmission mode is selected based upon the predetermined channel database, the error factor and a subsequent channel characterization." *Id*. at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques and control information. It would have been obvious for a POSITA to combine Catreux with Classon '996 at least because both are directed to adaptive transmission of wireless communication signals.

- **Classon '996 and Jalali '454**: Jalali '454 teaches and describes "[t]ransmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services." Jalali '454 at Abstract. "For example, the communications system may include a central system (i.e., similar to a base station in the IS-95 CDMA system) having a number of antennas that transmit data to, and receive data from, a number of remote systems (i.e., subscriber units, similar to remote stations in the CDMA system), some of which may include one antenna and others of which may include multiple antennas." *Id*. at 6:30-37. "In one implementation, each packet includes packet type identifier indicative of a change in the circuit to be used to transmit the next packet, a circuit identifier indicative of a particular circuit to be used to transmit the next packet, and a data field for the payload." *Id*. at 3:37-42. "An indication to use a new circuit can be sent in a field of the packet transmitted on the current circuit or can be sent via a control

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channel." *Id*. at 3:59-61. "When the transmitter unit is provided with information indicative of the conditions (i.e., the 'state') of the communications links, additional processing can be performed at the transmitter unit to further improve performance and increase efficiency." *Id*. at 10:47-52. Classon '996 teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways

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to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques and control information. It would have been obvious for a POSITA to combine Jalali '454 with Classon '996 at least because both are directed to adaptive transmission of wireless communication signals.

- **Classon '996 and Wu '434**: Wu '434 teaches and describes "[a]n adaptable orthogonal frequency-division multiplexing system (OFDM) that uses a multiple input multiple output (MIMO) to having OFDM signals transmitted either in accordance with time diversity to reducing signal fading or in accordance with spatial diversity to increase the data rate." Wu '434 at Abstract. "Information data is fed into adaptive coding modulation, the modulation is multiplexed and fed into adaptive space/time diversity encoding and assignment. A receiver feedback to provide feedback signals to the adaptive coding of modulation, multiplexer and adaptive space/time diversity is also provided." *Id*. at 4:62-67. "The feedback signal is received at the transmitter side and interpreted by a controller at the transmitter side." *Id*. at 5:34-36. "[T]he feedback signal [is] indicative of a determination for a sub-carrier of the plurality of sub-carriers as to whether time diversity or spatial diversity should be used for subsequent transmission on the sub-

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carrier." *Id*. at Claim 9. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved adaptive transmission techniques and control information. It would have been obvious for a POSITA to combine Wu '434 with Classon '996 at least because both are directed to adaptive transmission of wireless communication signals.

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(ii) Wallace ’467 in combination with the knowledge of a skilled artisan, Classon ’996, Walton ’040, Walton ’110, Li ’781, Li ’017, Walton ’269, 802.16a-2003, and /or Shattil ’043

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Wallace ’467 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Wallace ’467 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’941 patent was filed. Specifically:

- Wallace ’467 in combination with the knowledge of a skilled artisan, Classon ’996, Walton ’040, Walton ’110, Li ’781, Li ’017, Walton ’269, 802.16a-2003, and /or Shattil ’043 are all directed to systems and methods for transmitting information in a wireless packet system. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic transmissions, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA, MIMO), and modulation schemes, that were common and easily understood and were also well adapted to

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integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Wallace '467 and Classon '996**: Classon '996 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Classon '996 teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. Classon further discloses "In addition to the frequency dimension characteristics of the channel in a multicarrier system,

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spatial dimension channel characteristics may also be of interest when both the transmitter and receiver are equipped with a plurality of antennas. A multi-antenna setting allows simultaneous transmission of different data streams from the plurality of antennas in the same frequency band, thus increasing the spectral efficiency significantly. The spatial channel characteristics include knowledge of all the spatial channels between each transmit antenna and each receive antenna. In the case of a multicarrier system, each spatial channel comprises multiple subcarriers. Since the channel is now characterized in both frequency and spatial dimensions, as well as in a time dimension (rate of channel variation), this characterizes the wireless system as a multi-dimensional system. Spatial dimension channel characteristics may also be of interest when only the transmitter is equipped with a plurality of antennas. In this case, the spatial channel characteristics can be used to adapt a space-time coding scheme, a transmit diversity scheme, or a handoff scheme." *Id.* at 6:1-20. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Wallace '467 teaches and describes that "the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system." Wallace '467 at 1:20-22. Wallace '467 discloses that "[c]hannel state information (CSI) can be used by a communications

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system to precondition transmissions between transmitter units and receiver units" and " [i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit." *Id.* at Abstract. According to Wallace '467, "pilot symbols are generated and transmitted on a subset of the disjoint sub-channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be further minimized through compression techniques and resource allocation techniques." *Id.* Wallace '467 further discloses "[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly" and "[a]s delay of the measurement and reporting process increases, the utility of the channel response information decreases." *Id.* at 2:13-20. According to Wallace '467, "[a] present need exists for efficient techniques that will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and "pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying

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the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various pilot symbols. It would have been obvious for a POSITA to combine Wallace '467 with Classon '996 at least because Wallace '467 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Classon '996) using channel state information in order to improve communications and performance in a system capable of supporting more users.

- **Wallace '467 and Walton '040:** Walton '040 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the

operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Wallace '467 teaches and describes that "the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system." Wallace '467 at 1:20-22. Wallace '467 discloses that "[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units" and "[i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit." *Id.* at Abstract. According to Wallace '467, "pilot symbols are generated and transmitted on a subset of the disjoint sub-channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be further minimized through compression techniques and resource

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allocation techniques." *Id.* Wallace '467 further discloses "[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly" and "[a]s delay of the measurement and reporting process increases, the utility of the channel response information decreases." *Id.* at 2:13-20. According to Wallace '467, "[a] present need exists for efficient techniques that will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and "pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various pilot symbols. It would have been obvious for a POSITA to combine Wallace '467 with Walton '040 at least because Wallace '467 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Walton '040) using channel state information in order to improve communications and performance in a system capable of supporting more users. It would have also been obvious for a POSITA to combine

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Walton ’040 with Wallace ’467 at least because both are directed to using CSI to increase efficiency of the communication system. Moreover, the named inventors, Walton and Wallace, worked at Qualcomm and both are named inventors on Wallace ’467.

- **Wallace ’467 and Walton ’110**: Wallace ’467 teaches and describes that “the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system.” Wallace ’467 at 1:20-22. Wallace ’467 discloses that “[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units” and “[i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit.” *Id.* at Abstract. According to Wallace ’467, “pilot symbols are generated and transmitted on a subset of the disjoint sub-channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be further minimized through compression techniques and resource allocation techniques.” *Id.* Wallace ’467 further discloses “[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly” and “[a]s delay of the measurement and

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reporting process increases, the utility of the channel response information decreases." *Id.* at 2:13-20. According to Wallace '467, "[a] present need exists for efficient techniques that will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and "pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various pilot symbols. It would have been obvious for a POSITA to combine Wallace '467 with Walton '110 at least because Wallace '467 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Walton '040) using channel state information in order to improve communications and performance in a system capable of supporting more users. It would have also been obvious for a POSITA to combine Walton '040 with Wallace '467 at least because both are directed to using CSI to increase efficiency of the communication system. Moreover, the named inventors, Walton and Wallace, worked at Qualcomm and both are named inventors on Wallace '467.

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- **Wallace ’467 and 802.16a-2003:** 802.16a discloses an OFDM communication system having at least one base station serving multiple mobile stations (“subscriber stations”/“subscribers”/“SS”). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers “forming one subchannel may, but need not be adjacent.” 802.16a-2003 at 180. 802.16a’s communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is “transmitted at the beginning of each frame” in the downlink and “contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages.” *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.*, 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* Wallace ’467 teaches and describes that “the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system.” Wallace ’467 at 1:20-22. Wallace ’467 discloses that “[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units” and “ [i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit.” *Id.* at Abstract. According to Wallace ’467, “pilot symbols are generated and transmitted on a subset of the disjoint sub-

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channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be further minimized through compression techniques and resource allocation techniques." *Id.* Wallace '467 further discloses "[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly" and "[a]s delay of the measurement and reporting process increases, the utility of the channel response information decreases." *Id.* at 2:13-20. According to Wallace '467, "[a] present need exists for efficient techniques that will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and "pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various

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pilot symbols. It would have been obvious for a POSITA to combine Wallace '467 with 802.16a-2003 at least because Wallace '467 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like 802.16a-2003) using channel state information in order to improve communications and performance in a system capable of supporting more users.

- **Wallace '467 and Li '017:** Li '017 is directed to "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '017 at [0002]. Li '017 explains that "[i]n one embodiment, each subscriber measures the SINR of each subcarrier cluster and reports these SINR measurements to their base station through an access channel. The SINR value may comprise the average of the SINR values of each of the subcarriers in the cluster." *Id*. at [0045]. Li '017 discloses that "there are two categories of clusters: coherence clusters, containing multiple subcarriers close to each other and diversity clusters, containing multiple subcarriers with at least some of the subcarriers spread far apart over the spectrum. The closeness of the multiple subcarriers in coherence clusters is preferably within the channel coherence bandwidth, i.e. the bandwidth within which the channel response remains roughly the same, which is typically within 100 kHz for many cellular systems. On the other hand, the spread of subcarriers in diversity clusters is preferably larger than the channel coherence bandwidth, typically within 100 kHz for many cellular systems. Of course, the larger the spread, the better the diversity. Therefore, a general goal in such cases is to maximize the spread." *Id.* at [0111]. Thus, these references were in the same field

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of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Wallace '467 with Li '017 at least because Wallace '467 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other OFDM systems like Li '017) using channel state information in order to improve communications and performance in a system capable of supporting more users.

- **Wallace '467 and Li '781:** Li '781 is directed to "[a] method and apparatus for subcarrier selection for systems." Li '781 at Abstract. Li '781 discloses "the system employs orthogonal frequency division multiple access (OFDMA). . . . In one embodiment, a method for subcarrier selection comprises each of multiple subscribers measuring channel and interference information for subcarriers based on pilot symbols received from a base station, at least one of subscribers selecting a set of candidate subcarriers, providing feedback information on the set of candidate subcarriers to the base station, and the one subscriber receiving an indication of subcarriers of the set of subcarriers selected by the base station for use by the one subscriber." *Id.* Li '781 teaches and describes "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '781 at [0001]. According to Li '781, "[o]ne approach to subcarrier allocation for OFDMA is a joint optimization operation, not only requiring the activity and channel knowledge of all the subscribers in all the cells, but also requiring frequent rescheduling every time an existing subscribers is dropped off the network or a new subscribers is added onto the network." *Id.* at [0006].

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However, this approach "is often impractical in real wireless system, mainly due to the bandwidth cost for updating the subscriber information and the computation cost for the joint optimization." *Id.* "At the receiver, the subscriber first distinguishes the two sequences using the signal processing methods which are well known in the art, e.g., the correlation methods, and then estimates the channel and interference level." *Id.* at [0090]. Li '781 also describes that with an "aggressive frequency reuse plan, e.g., the same spectrum is used for multiple neighboring cells, the problem of intercell interference arises." *Id.* at [0005]. Thus, Li '781 teaches "[a] distributed, reduced-complexity approach for subcarrier allocation." *Id.* at [0023]. Wallace '467 teaches and describes that "the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system." Wallace '467 at 1:20-22. Wallace '467 discloses that "[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units" and " [i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit." *Id.* at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Wallace '467 with Li '781 at least because Wallace '467 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other OFDM systems like Li '781) using channel state information in order to improve communications and performance in a system capable of supporting more users.

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- **Wallace ’467 and Shattil ’043:** Shattil ’043 is directed to “multi-carrier communications, and in particular, to Carrier Interferometry.” Shattil ’043 at 1: 17-18. Shattil ’043 discloses “[t]echniques for reducing peak-to-average power in multicarrier transmitters employ peak cancellation with subcarriers that are impaired by existing channel conditions” and that “[t]he use of Carrier Interferometry (CI) coding further improves the effectiveness of peak reduction.” *Id.* at Abstract. “CI coding can also be impressed onto pulse sequences in the time domain, which enhances spectral selection and facilitates peak-power control.” *Id*. According to Shattil ’043, “the problem of interference suppression is more difficult and also more critical for the uplink, since it typically represents the capacity bottleneck compared to the downlink. Accordingly, various aspects of the invention are directed toward mitigating interference in CI systems.” *Id.* at 5:58-63. Wallace ’467 teaches and describes that “the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system.” Wallace ’467 at 1:20-22. Wallace ’467 discloses that “[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units” and “ [i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit.” *Id.* at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Wallace ’467 with Li ’781 at least because Wallace ’467 provides a method to facilitate improved

data transmissions in a multicarrier system (which can be applied to other OFDM systems like Li '781) using channel state information in order to improve communications and performance in a system capable of supporting more users.

- **Wallace '467 and Walton '269:** Walton '269 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '269 discloses using "channel state information (CSI)" to provide feedback information "for the processing of the downlink transmission." Walton '269 at 8:13-43. This results in "a more efficient control channel structure that is able to accommodate different users that may operate at different data rates." *Id*. at 2:37-40. Wallace '467 teaches and describes that "the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system." Wallace '467 at 1:20-22. Wallace '467 discloses that "[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units" and "[i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit." *Id.* at Abstract. According to Wallace '467, "pilot symbols are generated and transmitted on a subset of the disjoint sub-channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be further minimized through compression techniques and

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resource allocation techniques." *Id.* Wallace '467 further discloses "[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly" and "[a]s delay of the measurement and reporting process increases, the utility of the channel response information decreases." *Id.* at 2:13-20. According to Wallace '467, "[a] present need exists for efficient techniques that will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and "pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various pilot symbols. It would have been obvious for a POSITA to combine Wallace '467 with Walton '040 at least because Wallace '467 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Walton '040) using channel state information in order to improve communications and performance in a system capable of supporting more users. It would have been

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obvious for a POSITA to combine Walton '269 with Wallace '467 at least because both are directed to using CSI to increase efficiency of the communication system. Moreover, the named inventors, Walton and Wallace, worked at Qualcomm and both are named inventors on Wallace '467. Additionally, Wallace '467 is listed in the "References Cited" section of Walton '269.

(iii) Walton '040 in combination with the knowledge of a skilled artisan, Classon '996, Heath, Wallace '467, Li '781, Li '017, Walton '269, 802.16a-2003, and /or Shattil '043

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Walton '040 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Walton '040 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '941 patent was filed. Specifically:

- Walton '040 in combination with the knowledge of a skilled artisan, Classon '996, Wallace '467, Li '781, Li '017, Walton '269, Heath, 802.16a-2003, and /or Shattil '043 are all directed to systems and methods for transmitting information in a

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wireless packet system. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic transmissions, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA), Multiple-Input Multiple-Output (MIMO) technology, and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Walton '040 and Classon '996**: Classon '996 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Classon '996 teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a

method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Classon further discloses "In addition to the frequency dimension characteristics of the channel in a multicarrier system, spatial dimension channel characteristics may also be of interest when both the transmitter and receiver are equipped with a plurality of antennas. A multi-antenna setting allows simultaneous transmission of different data streams from the plurality of antennas in the same frequency band, thus increasing the spectral efficiency significantly. The spatial channel characteristics include knowledge of all the spatial channels between each transmit antenna and each receive antenna. In the case of a multicarrier system, each spatial channel comprises multiple subcarriers. Since the channel is now characterized in both frequency and spatial dimensions, as well as in a time dimension (rate of channel variation), this characterizes the wireless system as a multi-dimensional system. Spatial dimension channel characteristics may also be of interest when only the transmitter is equipped with a plurality of antennas. In this case, the spatial channel characteristics can be used to adapt a space-time coding

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scheme, a transmit diversity scheme, or a handoff scheme." *Id.* at 6:1-20. Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-

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carrier communications environments using improved adaptive transmission techniques and channel state information. It would have been obvious for a POSITA to combine Classon '996 with Walton '040 at least because Classon '996 provides a method to facilitate adaptive transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Walton '040) in order to optimize data throughput and improve communications and performance in a system capable of supporting more users.

- **Walton '040 and Wallace '467:** Wallace '467 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wallace '467 teaches and describes that "the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system." Wallace '467 at 1:20-22. Wallace '467 discloses that "[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units" and " [i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit." *Id.* at Abstract. According to Wallace '467, "pilot symbols are generated and transmitted on a subset of the disjoint sub-channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be further minimized through compression techniques and resource

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allocation techniques." *Id.* Wallace '467 further discloses "[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly" and "[a]s delay of the measurement and reporting process increases, the utility of the channel response information decreases." *Id.* at 2:13-20. According to Wallace '467, "[a] present need exists for efficient techniques that will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and "pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. Wallace '467 further discloses "[o]ne type of higher performance wireless communications system is a Multiple Input/Multiple Output (MIMO) system that employs multiple transmit antennas to transmit over a propagation channel to multiple receive antennas. As in lower performance systems, the propagation channel in a MIMO system is subject to the deleterious effects of multipath, as well as interference from adjacent antennas." *Id.* at 1:59-66. Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively

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process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various pilot symbols. It would have been obvious for a POSITA to combine Walton '040 with Wallace '467 at least because Walton '040 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other

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multi-carrier OFDM systems like Wallace '467) in order to improve communications and performance in a system capable of supporting more users. It would have also been obvious for a POSITA to combine Walton '040 with Wallace '467 at least because both are directed to using CSI to increase efficiency of the communication system. Moreover, the named inventors, Walton and Wallace, worked at Qualcomm and both are named inventors on Wallace '467.

- **Walton '040 and Heath**: Heath is directed to a wireless communication system that supports wireless transmissions with and without spatial multiplexing in which "[a] wireless communication adapts its mode of operation between spatial multiplexing and non-spatial multiplexing in response to transmission-specific variables. Heath at Abstract. Heath teaches and describes that "the base transceiver stations and subscriber units communicate information related to the operation mode over a control channel." Heath at 8:48-50. Heath discloses "FIG. 1 depicts a multiple access wireless communications system that includes base transceiver stations (BTSs) 102 and 104 and subscriber units (SUs) 106, 108, and 110. The base transceiver stations include spatially separated antennas 114 and spatial multiplexing logic 118. The base transceiver stations also include mode determination logic 122 that enables the system to adapt its mode of operation between spatial multiplexing and non-spatial multiplexing in response to transmission-specific variables." *Id*. at 5:7-15. Heath further explains "[t]he mode determination logic is the focus of the invention and is described in more detail below. Subscriber unit 106 does not support spatial multiplexing, does not include spatial multiplexing logic, and includes one or more antennas. Subscriber units that

do not support spatial multiplexing may or may not include mode determination logic. In the embodiment of FIG. 1, the subscriber unit 106 includes mode determination logic 140 that notifies the base transceiver stations 102 and 104 that the subscriber unit does not support spatial multiplexing." *Id.* at 5:15-20. Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial

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dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various pilot symbols. It would have been obvious for a POSITA to combine Walton '040 with Heath at least because Walton '040 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Heath) in order to improve communications and performance in a system capable of supporting more users.

- **Walton '040 and 802.16a-2003:** 802.16a discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.*, 186, 180. Each subchannel is a collection

of subcarriers that may or may not be adjacent in the frequency domain. *Id.* Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-

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carrier communications environments using channel state information and various pilot symbols. It would have been obvious for a POSITA to combine Walton '040 with 802.16a-2003 at least because Walton '040 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like 802.16a-2003) in order to improve communications and performance in a system capable of supporting more users.

- **Walton '040 and Li '017:** Li '017 is directed to "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '017 at [0002]. Li '017 explains that "[i]n one embodiment, each subscriber measures the SINR of each subcarrier cluster and reports these SINR measurements to their base station through an access channel. The SINR value may comprise the average of the SINR values of each of the subcarriers in the cluster." *Id*. at [0045]. Li '017 discloses that "there are two categories of clusters: coherence clusters, containing multiple subcarriers close to each other and diversity clusters, containing multiple subcarriers with at least some of the subcarriers spread far apart over the spectrum. The closeness of the multiple subcarriers in coherence clusters is preferably within the channel coherence bandwidth, i.e. the bandwidth within which the channel response remains roughly the same, which is typically within 100 kHz for many cellular systems. On the other hand, the spread of subcarriers in diversity clusters is preferably larger than the channel coherence bandwidth, typically within 100 kHz for many cellular systems. Of course, the larger the spread, the better the diversity. Therefore, a general goal in such cases is to maximize the spread." *Id.* at [0111]. Li '017 further discloses "[t]he techniques

disclosed herein are described using OFDMA (clusters) as an example. However, they are not limited to OFDMA-based systems. The techniques apply to multi-carrier systems in general, where, for example, a carrier can be a cluster in OFDMA, a spreading code in CDMA, an antenna beam in SDMA (space-division multiple access), etc. In one embodiment, subcarrier allocation is performed in each cell separately. Within each cell, the allocation for individual subscribers (e.g., mobiles) is also made progressively as each new subscriber is added to the system as opposed to joint allocation for subscribers within each cell in which allocation decisions are made taking into account all subscribers in a cell for each allocation." *Id.* at [0025]. Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that

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"[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Both Walton '040 and Li '017 are directed to the same field endeavor (directed to a multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM) with mobile stations that can move about.). While Walton '040 describes transmitting OFDM symbols on any number of subcarriers to different terminals, Walton040 does not explicitly describe how to assign or group subcarriers for use in the MIMO system utilizing OFDM. A POSITA would have therefore looked to the prior art, such as Li '017, for determining how to assign or group subcarriers and how to inform a mobile station of the subcarriers it should use to receive information. For example, as previously explained, Li '017 describes selecting between diversity clusters ("distributed subcarriers") and coherence clusters ("localized subcarriers") and how each configuration provides different advantages. Li '017 at [0111], [0113]-[0114], [0118]. Diversity clusters provide interference diversity gain—"[t]herefore, it is advantageous to assign diversity clusters to subscribers that are close (e.g., within the coherent bandwidth) to the cell boundaries and are more subject to inter-cell interference." *Id.* at [0113], [0118]. However, for "static subscribers, such as in fixed wireless access, the channels change very little over time. Selective cluster

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allocation using the coherence clusters achieves good performance." *Id.* Figure 11 illustrates selecting diversity or coherence clusters "depending on subscribers mobility." *Id.* at [0120]. To select the appropriate cluster type, "each subscriber measures the SINR of each subcarrier cluster and reports these SINR measurements to their base station through an access channel." *Id.* at [0045]. Upon receiving that feedback, the BS "selects one or more clusters for the subscriber among the candidates" and "notifies the subscriber about the cluster allocation through a downlink common control channel." *Id.* at [0047]-[0048]. In view of these advatanges, a POSITA would have been motivated to modify Walton '040 based on the teachings of Li '017 so as to incorporate Li '017's "process for intelligent selection between diversity clusters and coherence clusters depending on subscribers mobility" and informing the subscriber of the selected subchannel configuration via the existing control channel. *Id.* at [0120]. Flexibly selecting between different subchannel configurations as described in Li '017 would have allowed for the implementation of their respective advantages in Walton '040

- **Walton '040 and Li '781:** Li '781 is directed to "[a] method and apparatus for subcarrier selection for systems." Li '781 at Abstract. Li '781 discloses "the system employs orthogonal frequency division multiple access (OFDMA). . . . In one embodiment, a method for subcarrier selection comprises each of multiple subscribers measuring channel and interference information for subcarriers based on pilot symbols received from a base station, at least one of subscribers selecting a set of candidate subcarriers, providing feedback information on the set of candidate subcarriers to the base station, and the one subscriber receiving an

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indication of subcarriers of the set of subcarriers selected by the base station for use by the one subscriber." *Id.* Li '781 teaches and describes "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '781 at [0001]. According to Li '781, "[o]ne approach to subcarrier allocation for OFDMA is a joint optimization operation, not only requiring the activity and channel knowledge of all the subscribers in all the cells, but also requiring frequent rescheduling every time an existing subscribers is dropped off the network or a new subscribers is added onto the network." *Id.* at [0006]. However, this approach "is often impractical in real wireless system, mainly due to the bandwidth cost for updating the subscriber information and the computation cost for the joint optimization." *Id.* "At the receiver, the subscriber first distinguishes the two sequences using the signal processing methods which are well known in the art, e.g., the correlation methods, and then estimates the channel and interference level." *Id.* at [0090]. Li '781 also describes that with an "aggressive frequency reuse plan, e.g., the same spectrum is used for multiple neighboring cells, the problem of intercell interference arises." *Id.* at [0005]. Thus, Li '781 teaches "[a] distributed, reduced-complexity approach for subcarrier allocation." *Id.* at [0023]. Li '781 further discloses "[t]he techniques disclosed herein are described using OFDMA (clusters) as an example. However, they are not limited to OFDMA-based systems. The techniques apply to multi-carrier systems in general, where, for example, a carrier can be a cluster in OFDMA, a spreading code in CDMA, an antenna beam in SDMA (space-division multiple access), etc." Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available

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resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various pilot symbols. It would have been obvious for a POSITA to combine Walton '040 with Li '781 at least

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because Walton ’040 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Li ’781) using channel state information in order to improve communications and performance in a system capable of supporting more users.

- **Walton ’040 and Shattil ’043:** Shattil ’043 is directed to “multi-carrier communications, and in particular, to Carrier Interferometry.” Shattil ’043 at 1: 17-18. Shattil ’043 discloses “[t]echniques for reducing peak-to-average power in multicarrier transmitters employ peak cancellation with subcarriers that are impaired by existing channel conditions” and that “[t]he use of Carrier Interferometry (CI) coding further improves the effectiveness of peak reduction.” *Id.* at Abstract. “CI coding can also be impressed onto pulse sequences in the time domain, which enhances spectral selection and facilitates peak-power control.” *Id*. According to Shattil ’043, “the problem of interference suppression is more difficult and also more critical for the uplink, since it typically represents the capacity bottleneck compared to the downlink. Accordingly, various aspects of the invention are directed toward mitigating interference in CI systems.” *Id.* at 5:58-63. Shattil ’043 further discloses “In a MIMO configuration, subcarriers may be identified with respect to unique space-frequency combinations. Thus, certain sub-space channels identified as unsuitable for data communications may be allocated for PAPR-reduction transmissions. Similarly, unallocated subchannels and/or allocated (but unused) subchannels may be identified for PAPR-reduction transmissions. In some cases, subchannels in a network (such as a MIMO, MISO, or SIMO network) may be allocated specifically for PAPR-reduction transmissions.”

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Id. at 18:38-46. Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state

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information and various pilot symbols. It would have been obvious for a POSITA to combine Walton '040 with Shattil '043 at least because Walton '040 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other OFDM systems like Shattil '043) using channel state information in order to improve communications and performance in a system capable of supporting more users.

(iv) Walton '110 in combination with the knowledge of a skilled artisan, Classon '996, Wallace '467, Li '781, Li '017, Walton '269, 802.16a-2003, and/or Shattil '043

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Walton '110 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Walton '110 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '941 patent was filed. Specifically:

- Walton '110 in combination with the knowledge of a skilled artisan, Classon '996, Wallace '467, Li '781, Li '017, Walton '269, 802.16a-2003, and/or Shattil '043 are all directed to systems and methods for transmitting information in a wireless

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packet system. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic transmissions, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM, OFDMA, MIMO), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Walton '110 and Classon '996**: Classon '996 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Classon '996 teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a

method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at 4:49-59. Walton '110 is directed "to techniques for allocating resources in multiple-input multiple-output communication systems that utilize orthogonal frequency division multiplexing (i.e., MIMO-OFDM systems)." Walton '110 at 1:7-11. Walton '110 teaches and describes "[t]echniques to schedule terminals for data transmission on the downlink and/or uplink in a MIMO-OFDM system based on the spatial and/or frequency "signatures" of the terminals." Walton '110 at Abstract. In Walton '110, "[a] scheduler forms one or more sets of terminals for possible (downlink or uplink) data transmission for each of a number of frequency bands" and "[o]ne or more sub-hypotheses may further be formed for each hypothesis, with each sub-hypothesis corresponding to (1) specific assignments of transmit antennas to the terminal(s) in the hypothesis (for the downlink) or (2) a specific order for processing the uplink data transmissions from the terminal(s) (for the uplink). *Id.* Walton '110 discloses "[a] wideband MIMO system typically experiences frequency selective fading, which is characterized by different amounts

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of attenuation across the system bandwidth" and "[t]his frequency selective fading causes inter-symbol interference (ISI), which is a phenomenon whereby each symbol in a received signal acts as distortion to subsequent symbols in the received signal," which the "distortion degrades performance by impacting the ability to correctly detect the received symbols." *Id*. at 1:36-45. According to Walton '110, "[t]here is therefore a need in the art for techniques to allocate resources in a MIMO-OFDM system to provide high system performance." *Id.* at 2:14-16. To address these problems, Walton '110 describes "[t]echniques are provided herein to schedule terminals for data transmission on the downlink and/or uplink based on the spatial and/or frequency "signatures" of the terminals" in which "[v]arious scheduling schemes are provided herein to select a "proper" set of one or more terminals for data transmission on each frequency band and to assign the available transmission channels to the selected terminals such that system goals (e.g., high throughput, fairness, and so on) are achieved." *Id.* 2:20-32. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions and resource allocation in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '110 with Classon '996 at least because Walton '110 provides methods to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Classon '996) using various signatures from the terminal in order to improve communications and performance in a system capable of supporting more users.

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- **Walton ’110 and Wallace ’467:** Wallace ’467 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wallace ’467 teaches and describes that “the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system.” Wallace ’467 at 1:20-22. Wallace ’467 discloses that “[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units” and “[i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit.” *Id.* at Abstract. According to Wallace ’467, “pilot symbols are generated and transmitted on a subset of the disjoint sub-channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be further minimized through compression techniques and resource allocation techniques.” *Id.* Wallace ’467 further discloses “[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly” and “[a]s delay of the measurement and reporting process increases, the utility of the channel response information decreases.” *Id.* at 2:13-20. According to Wallace ’467, “[a] present need exists for efficient techniques that

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will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and " pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. Walton '110 is directed "to techniques for allocating resources in multiple-input multiple-output communication systems that utilize orthogonal frequency division multiplexing (i.e., MIMO-OFDM systems)." Walton '110 at 1:7-11. Walton '110 teaches and describes "[t]echniques to schedule terminals for data transmission on the downlink and/or uplink in a MIMO-OFDM system based on the spatial and/or frequency "signatures" of the terminals" Walton '110 at Abstract. In Walton '110, "[a] scheduler forms one or more sets of terminals for possible (downlink or uplink) data transmission for each of a number of frequency bands" and "[o]ne or more sub-hypotheses may further be formed for each hypothesis, with each sub-hypothesis corresponding to (1) specific assignments of transmit antennas to the terminal(s) in the hypothesis (for the downlink) or (2) a specific order for processing the uplink data transmissions from the terminal(s) (for the uplink). *Id.* Walton '110 discloses "[a] wideband MIMO system typically experiences frequency selective fading, which is characterized by different amounts of attenuation across the system bandwidth" and "[t]his frequency selective fading causes inter-symbol interference (ISI), which is a

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phenomenon whereby each symbol in a received signal acts as distortion to subsequent symbols in the received signal," which the "distortion degrades performance by impacting the ability to correctly detect the received symbols." *Id*. at 1:36-45. According to Walton '110, "[t]here is therefore a need in the art for techniques to allocate resources in a MIMO-OFDM system to provide high system performance." *Id.* at 2:14-16. To address these problems, Walton '110 describes "[t]echniques are provided herein to schedule terminals for data transmission on the downlink and/or uplink based on the spatial and/or frequency "signatures" of the terminals" in which "[v]arious scheduling schemes are provided herein to select a "proper" set of one or more terminals for data transmission on each frequency band and to assign the available transmission channels to the selected terminals such that system goals (e.g., high throughput, fairness, and so on) are achieved." *Id.* 2:20-32. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions and resource allocation in multi-carrier communications environments using various signatures. It would have been obvious for a POSITA to combine Walton '110 with Wallace '467 at least because Walton '110 provides methods to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Wallace '467) using various signatures from the terminal in order to improve communications and performance in a system capable of supporting more users. It would have also been obvious for a POSITA to combine Walton '110 with Wallace '467 at least because both are directed to using frequency information and/or CSI to increase efficiency of the communication system. Moreover, the

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named inventors, Walton and Wallace, worked at Qualcomm and both are named inventors on Wallace '467.

- **Walton '110 and 802.16a-2003:** 802.16a discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.*, 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* Walton '110 is directed "to techniques for allocating resources in multiple-input multiple-output communication systems that utilize orthogonal frequency division multiplexing (i.e., MIMO-OFDM systems)." Walton '110 at 1:7-11. Walton '110 teaches and describes "[t]echniques to schedule terminals for data transmission on the downlink and/or uplink in a MIMO-OFDM system based on the spatial and/or frequency "signatures" of the terminals" Walton '110 at Abstract. In Walton '110,

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"[a] scheduler forms one or more sets of terminals for possible (downlink or uplink) data transmission for each of a number of frequency bands" and "[o]ne or more sub-hypotheses may further be formed for each hypothesis, with each sub-hypothesis corresponding to (1) specific assignments of transmit antennas to the terminal(s) in the hypothesis (for the downlink) or (2) a specific order for processing the uplink data transmissions from the terminal(s) (for the uplink). *Id.* Walton '110 discloses "[a] wideband MIMO system typically experiences frequency selective fading, which is characterized by different amounts of attenuation across the system bandwidth" and "[t]his frequency selective fading causes inter-symbol interference (ISI), which is a phenomenon whereby each symbol in a received signal acts as distortion to subsequent symbols in the received signal," which the "distortion degrades performance by impacting the ability to correctly detect the received symbols." *Id*. at 1:36-45. According to Walton '110, "[t]here is therefore a need in the art for techniques to allocate resources in a MIMO-OFDM system to provide high system performance." *Id.* at 2:14-16. To address these problems, Walton '110 describes "[t]echniques are provided herein to schedule terminals for data transmission on the downlink and/or uplink based on the spatial and/or frequency "signatures" of the terminals" in which "[v]arious scheduling schemes are provided herein to select a "proper" set of one or more terminals for data transmission on each frequency band and to assign the available transmission channels to the selected terminals such that system goals (e.g., high throughput, fairness, and so on) are achieved." *Id.* 2:20-32. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of

improving data transmissions and resource allocation in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '110 with 802.16a-2003 at least because Walton '110 provides methods to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like 802.16a-2003) using various signatures from the terminal in order to improve communications and performance in a system capable of supporting more users. It would have also been obvious for a POSITA to combine Walton '110 with 802.16a-2003 at least because both are directed to using frequency information and/or CSI to increase efficiency of the communication system.

- **Walton '110 and Li '017:** Li '017 is directed to "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '017 at [0002]. Li '017 explains that "[i]n one embodiment, each subscriber measures the SINR of each subcarrier cluster and reports these SINR measurements to their base station through an access channel. The SINR value may comprise the average of the SINR values of each of the subcarriers in the cluster." *Id*. at [0045]. Li '017 discloses that "there are two categories of clusters: coherence clusters, containing multiple subcarriers close to each other and diversity clusters, containing multiple subcarriers with at least some of the subcarriers spread far apart over the spectrum. The closeness of the multiple subcarriers in coherence clusters is preferably within the channel coherence bandwidth, i.e. the bandwidth within which the channel response remains roughly the same, which is typically within 100 kHz for many cellular systems. On the other hand, the spread of subcarriers in

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diversity clusters is preferably larger than the channel coherence bandwidth, typically within 100 kHz for many cellular systems. Of course, the larger the spread, the better the diversity. Therefore, a general goal in such cases is to maximize the spread." *Id.* at [0111]. Walton '110 is directed "to techniques for allocating resources in multiple-input multiple-output communication systems that utilize orthogonal frequency division multiplexing (i.e., MIMO-OFDM systems)." Walton '110 at 1:7-11. Walton '110 teaches and describes "[t]echniques to schedule terminals for data transmission on the downlink and/or uplink in a MIMO-OFDM system based on the spatial and/or frequency "signatures" of the terminals" Walton '110 at Abstract. In Walton '110, "[a] scheduler forms one or more sets of terminals for possible (downlink or uplink) data transmission for each of a number of frequency bands" and "[o]ne or more sub-hypotheses may further be formed for each hypothesis, with each sub-hypothesis corresponding to (1) specific assignments of transmit antennas to the terminal(s) in the hypothesis (for the downlink) or (2) a specific order for processing the uplink data transmissions from the terminal(s) (for the uplink). *Id.* Walton '110 discloses "[a] wideband MIMO system typically experiences frequency selective fading, which is characterized by different amounts of attenuation across the system bandwidth" and "[t]his frequency selective fading causes inter-symbol interference (ISI), which is a phenomenon whereby each symbol in a received signal acts as distortion to subsequent symbols in the received signal," which the "distortion degrades performance by impacting the ability to correctly detect the received symbols." *Id.* at 1:36-45. According to Walton '110, "[t]here is therefore a need in the art for

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techniques to allocate resources in a MIMO-OFDM system to provide high system performance." *Id.* at 2:14-16. To address these problems, Walton '110 describes "[t]echniques are provided herein to schedule terminals for data transmission on the downlink and/or uplink based on the spatial and/or frequency "signatures" of the terminals" in which "[v]arious scheduling schemes are provided herein to select a "proper" set of one or more terminals for data transmission on each frequency band and to assign the available transmission channels to the selected terminals such that system goals (e.g., high throughput, fairness, and so on) are achieved." *Id.* 2:20-32. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions and resource allocation in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '110 with Li '017 at least because Walton '110 provides methods to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Li '017) in order to improve communications and performance in a system capable of supporting more users.

- **Walton '110 and Li '781:** Li '781 is directed to "[a] method and apparatus for subcarrier selection for systems." Li '781 at Abstract. Li '781 discloses "the system employs orthogonal frequency division multiple access (OFDMA). . . . In one embodiment, a method for subcarrier selection comprises each of multiple subscribers measuring channel and interference information for subcarriers based on pilot symbols received from a base station, at least one of subscribers selecting a set of candidate subcarriers, providing feedback information on the set of

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candidate subcarriers to the base station, and the one subscriber receiving an indication of subcarriers of the set of subcarriers selected by the base station for use by the one subscriber." *Id.* Li '781 teaches and describes "multi-cell, multi-subscriber wireless systems using orthogonal frequency division multiplexing (OFDM)." Li '781 at [0001]. According to Li '781, "[o]ne approach to subcarrier allocation for OFDMA is a joint optimization operation, not only requiring the activity and channel knowledge of all the subscribers in all the cells, but also requiring frequent rescheduling every time an existing subscribers is dropped off the network or a new subscribers is added onto the network." *Id.* at [0006]. However, this approach "is often impractical in real wireless system, mainly due to the bandwidth cost for updating the subscriber information and the computation cost for the joint optimization." *Id.* "At the receiver, the subscriber first distinguishes the two sequences using the signal processing methods which are well known in the art, e.g., the correlation methods, and then estimates the channel and interference level." *Id.* at [0090]. Li '781 also describes that with an "aggressive frequency reuse plan, e.g., the same spectrum is used for multiple neighboring cells, the problem of intercell interference arises." *Id.* at [0005]. Thus, Li '781 teaches "[a] distributed, reduced-complexity approach for subcarrier allocation." *Id.* at [0023]. Walton '110 is directed "to techniques for allocating resources in multiple-input multiple-output communication systems that utilize orthogonal frequency division multiplexing (i.e., MIMO-OFDM systems)." Walton '110 at 1:7-11. Walton '110 teaches and describes "[t]echniques to schedule terminals for data transmission on the downlink and/or uplink in a MIMO-OFDM system based on

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the spatial and/or frequency 'signatures' of the terminals." Walton '110 at Abstract. In Walton '110, "[a] scheduler forms one or more sets of terminals for possible (downlink or uplink) data transmission for each of a number of frequency bands" and "[o]ne or more sub-hypotheses may further be formed for each hypothesis, with each sub-hypothesis corresponding to (1) specific assignments of transmit antennas to the terminal(s) in the hypothesis (for the downlink) or (2) a specific order for processing the uplink data transmissions from the terminal(s) (for the uplink). *Id.* Walton '110 discloses "[a] wideband MIMO system typically experiences frequency selective fading, which is characterized by different amounts of attenuation across the system bandwidth" and "[t]his frequency selective fading causes inter-symbol interference (ISI), which is a phenomenon whereby each symbol in a received signal acts as distortion to subsequent symbols in the received signal," which the "distortion degrades performance by impacting the ability to correctly detect the received symbols." *Id*. at 1:36-45. According to Walton '110, "[t]here is therefore a need in the art for techniques to allocate resources in a MIMO-OFDM system to provide high system performance." *Id.* at 2:14-16. To address these problems, Walton '110 describes "[t]echniques are provided herein to schedule terminals for data transmission on the downlink and/or uplink based on the spatial and/or frequency 'signatures' of the terminals" in which "[v]arious scheduling schemes are provided herein to select a "proper" set of one or more terminals for data transmission on each frequency band and to assign the available transmission channels to the selected terminals such that system goals (e.g., high throughput, fairness, and so on) are achieved." *Id.* 2:20-32. Thus, these references

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were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions and resource allocation in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '110 with Li '781 at least because Walton '110 provides methods to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Li '781) in order to improve communications and performance in a system capable of supporting more users.

- **Walton '110 and Shattil '043:** Shattil '043 is directed to "multi-carrier communications, and in particular, to Carrier Interferometry." Shattil '043 at 1: 17-18. Shattil '043 discloses "[t]echniques for reducing peak-to-average power in multicarrier transmitters employ peak cancellation with subcarriers that are impaired by existing channel conditions" and that "[t]he use of Carrier Interferometry (CI) coding further improves the effectiveness of peak reduction." *Id.* at Abstract. "CI coding can also be impressed onto pulse sequences in the time domain, which enhances spectral selection and facilitates peak-power control." *Id*. According to Shattil '043, "the problem of interference suppression is more difficult and also more critical for the uplink, since it typically represents the capacity bottleneck compared to the downlink. Accordingly, various aspects of the invention are directed toward mitigating interference in CI systems." *Id.* at 5:58-63. Walton '110 is directed "to techniques for allocating resources in multiple-input multiple-output communication systems that utilize orthogonal frequency division multiplexing (i.e., MIMO-OFDM systems)." Walton '110 at 1:7-11. Walton '110 teaches and describes "[t]echniques to schedule terminals for data

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transmission on the downlink and/or uplink in a MIMO-OFDM system based on the spatial and/or frequency "signatures" of the terminals" Walton '110 at Abstract. In Walton '110, "[a] scheduler forms one or more sets of terminals for possible (downlink or uplink) data transmission for each of a number of frequency bands" and "[o]ne or more sub-hypotheses may further be formed for each hypothesis, with each sub-hypothesis corresponding to (1) specific assignments of transmit antennas to the terminal(s) in the hypothesis (for the downlink) or (2) a specific order for processing the uplink data transmissions from the terminal(s) (for the uplink). *Id.* Walton '110 discloses "[a] wideband MIMO system typically experiences frequency selective fading, which is characterized by different amounts of attenuation across the system bandwidth" and "[t]his frequency selective fading causes inter-symbol interference (ISI), which is a phenomenon whereby each symbol in a received signal acts as distortion to subsequent symbols in the received signal," which the "distortion degrades performance by impacting the ability to correctly detect the received symbols." *Id*. at 1:36-45. According to Walton '110, "[t]here is therefore a need in the art for techniques to allocate resources in a MIMO-OFDM system to provide high system performance." *Id.* at 2:14-16. To address these problems, Walton '110 describes "[t]echniques are provided herein to schedule terminals for data transmission on the downlink and/or uplink based on the spatial and/or frequency "signatures" of the terminals" in which "[v]arious scheduling schemes are provided herein to select a "proper" set of one or more terminals for data transmission on each frequency band and to assign the available transmission channels to the selected terminals such that system goals (e.g., high

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throughput, fairness, and so on) are achieved." *Id.* 2:20-32. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions and resource allocation in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '110 with Shattil '043 at least because Walton '110 provides methods to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier systems like Shattil '043) in order to improve communications and performance in a system capable of supporting more users.

(v) 802.16a-2003 in combination with the knowledge of a skilled artisan, 802.16a-2001, Heath, Walton '040, Walton '110, Wallace '467, Catreux, Jalali '454, and/or Wu '434

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine 802.16a-2003 with each of these references. A person of ordinary skill in the art would have found it obvious to combine 802.16a-2003 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the 802.16a-2003 patent was filed. Specifically:

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- 802.16a-2003, 802.16a-2001, Heath, Walton ’040, Walton ’110, Wallace ’467, Catreux, Jalali ’454, and Wu ’434 are all directed to systems and methods for adaptive transmission of wireless communication signals. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **802.16a-2003 and 802.16a-2001**: 802.16a-2003 explains that it “amends IEEE Std 802.16-2001 by enhancing the medium access control layer and providing additional physical layer specifications in support of broadband wireless access at frequencies from 2-11 GHz.” 802.16a-2003, cover, iii (“This amendment expands the scope of IEEE Std 802.16-2001 by extending the WirelessMAN air interface to address operational frequencies from 2-11 GHz.”). 802.16a-2003 also contains specific editing instructions that “define how to merge the material contained herein into the existing base standard (IEEE Std 802.l6TM-2001) to form the comprehensive standard.” 802.16a-2003, 1. Thus, 802.16a-2003 directly references and builds upon 802.16a-2001. These references were in the same field of endeavor, and were directed to the same standard which improved data transmissions in multi-carrier communications environments. Therefore, it would have been obvious for a POSITA to combine 802.16a-2003 with 802.16a-2001 at least because 802.16a-2003 directly references and incorporates 802.16a-2001. It would have been obvious for a POSITA to consider 802.16a-2003 and 802.16-2001 as a single document/standard.

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- **802.16a-2003 and Heath**: Heath is directed to a wireless communication system that supports wireless transmissions with and without spatial multiplexing in which "[a] wireless communication adapts its mode of operation between spatial multiplexing and non-spatial multiplexing in response to transmission-specific variables. Heath at Abstract. Heath teaches and describes that "the base transceiver stations and subscriber units communicate information related to the operation mode over a control channel." Heath at 8:48-50. Heath discloses "FIG. 1 depicts a multiple access wireless communications system that includes base transceiver stations (BTSs) 102 and 104 and subscriber units (SUs) 106, 108, and 110. The base transceiver stations include spatially separated antennas 114 and spatial multiplexing logic 118. The base transceiver stations also include mode determination logic 122 that enables the system to adapt its mode of operation between spatial multiplexing and non-spatial multiplexing in response to transmission-specific variables." *Id.* at 5:7-16. Heath also describes the importance of selecting the appropriate antenna scheme depending on transmission conditions. Heath states that "[a]lthough diversity communication may reduce the effects of multipath fading, diversity does not enable the increased bit rates that are enabled by spatial multiplexing." *Id.*, 8:18-21. However, using "multiple spatially separated antennas at the base transceiver stations and the subscriber units to multiplex transmissions" "increase[s] the bit rates between the base transceiver stations and the subscriber units." *Id.*, 1:46-51, 1:55-65. In view of the importance of selecting the appropriate antenna scheme depending on transmission conditions, Heath's base station utilizes mode determination logic to determine whether to use a

transmit diversity (non-spatial multiplexing) or MIMO (spatial multiplexing) scheme based on transmission characteristics 450. *Id.*, 9:60-10:1. 802.16a-2003 also describes an OFDM communication system that utilizes multiple antennas. 802.16a-2003 at 66-68, 179, 203-205. 802.16a's BS can communicate with SSs with the multiple antennas using different antenna schemes, including transmit diversity (STC) and AAS. *Id.* at 66-68, 203-205. 802.16a-2003 and Heath thus both disclose a BS having multiple antennas that can operate in a transmit diversity scheme or MIMO scheme, and inform the mobile station of the selected scheme via a control channel. Similarly, 802.16a-2003's communication system is configured to adapt its transmission parameters based on the capabilities of the base station and subscribers as well as the state of the channel. 802.16a-2003, 4 ("adaptive modulation: A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles,"), 83 ("The downlink burst profile is determined by the BS according to the quality of the signal that is received by each SS."). 802.16a-2003 discloses that AAS uses "channel state information in the PHY at both downlink and uplink." 802.16a-2003, 67; *see also id.*, 203, 220-221. This channel state information is used "in adjusting the direction of the adaptive array." *Id.*, 42-44. In this manner, 802.16a-2003's describes the use of different antenna schemes. 802.16a-2003, however, does not explicitly disclose details of how to select the appropriate antenna scheme. Therefore, a POSITA would have been motivated to look at the prior art, e.g. Heath, for techniques for selecting the appropriate antenna scheme. As previously explained, Heath provides such

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techniques and describes determining a particular transmission mode and conveying the selected transmission mode to the mobile station via a control channel. Heath at 11:67-12:38, 14:55-63, 2:58-61, 3:60-62, Fig. 8. A POSITA would have therefore been motivated to modify 802.16a-2003 so as to incorporate Heath's mode determination logic. Heath and 802.16a-2003 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine 802.16a-2003 with Heath at least because of the ability to increase the bit rate between a base transceiver station and a single SS, based on the teachings of Heath. *Id.*, 1:55-65. Such a modification would have also incorporated Heath's teaching of informing the SS of the switch to single-user MIMO via the existing FCH using DL-Map so that the SS may properly receive and decode the data. *Id.*, 2:58-61, 3:60-62. Combining 802.16a-2003 and Heath would have improved data transmissions in a multicarrier system leading to improved communications and performance in a system capable of supporting more users.

- **802.16a-2003 and Walton '040**: 802.16a-2003 discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as

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the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.*, 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the

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transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various pilot symbols. It would have been obvious for a POSITA to combine Walton '040 with 802.16a-2003 at least because Walton '040 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like 802.16a-2003) in order to improve communications and performance in a system capable of supporting more users.

- **802.16a-2003 and Walton '110**: 802.16a discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and

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may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.*, 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* Walton '110 is directed "to techniques for allocating resources in multiple-input multiple-output communication systems that utilize orthogonal frequency division multiplexing (i.e., MIMO-OFDM systems)." Walton '110 at 1:7-11. Walton '110 teaches and describes "[t]echniques to schedule terminals for data transmission on the downlink and/or uplink in a MIMO-OFDM system based on the spatial and/or frequency "signatures" of the terminals" Walton '110 at Abstract. In Walton '110, "[a] scheduler forms one or more sets of terminals for possible (downlink or uplink) data transmission for each of a number of frequency bands" and "[o]ne or more sub-hypotheses may further be formed for each hypothesis, with each sub-hypothesis corresponding to (1) specific assignments of transmit antennas to the terminal(s) in the hypothesis (for the downlink) or (2) a specific order for processing the uplink data transmissions from the terminal(s) (for the uplink). *Id.* Walton '110 discloses "[a] wideband MIMO system typically experiences frequency selective fading, which is characterized by different amounts of attenuation across the system bandwidth" and "[t]his frequency selective fading causes inter-symbol interference (ISI), which is a phenomenon whereby each symbol in a received signal acts as distortion to subsequent symbols in the received

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signal," which the "distortion degrades performance by impacting the ability to correctly detect the received symbols." *Id*. at 1:36-45. According to Walton '110, "[t]here is therefore a need in the art for techniques to allocate resources in a MIMO-OFDM system to provide high system performance." *Id.* at 2:14-16. To address these problems, Walton '110 describes "[t]echniques are provided herein to schedule terminals for data transmission on the downlink and/or uplink based on the spatial and/or frequency "signatures" of the terminals" in which "[v]arious scheduling schemes are provided herein to select a "proper" set of one or more terminals for data transmission on each frequency band and to assign the available transmission channels to the selected terminals such that system goals (e.g., high throughput, fairness, and so on) are achieved." *Id.* 2:20-32. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions and resource allocation in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '110 with 802.16a-2003 at least because Walton '110 provides methods to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like 802.16a-2003) using various signatures from the terminal in order to improve communications and performance in a system capable of supporting more users. It would have also been obvious for a POSITA to combine Walton '110 with 802.16a-2003 at least because both are directed to using frequency information and/or CSI to increase efficiency of the communication system.

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- **802.16a-2003 and Wallace '467**: 802.16a discloses an OFDM communication system having at least one base station serving multiple mobile stations ("subscriber stations"/"subscribers"/"SS"). 802.16a-2003 at Chapter 8.5. 802.16a-2003 discloses subchannel configurations with distributed or localized subcarriers and explains that subcarriers "forming one subchannel may, but need not be adjacent." 802.16a-2003 at 180. 802.16a's communication system adapts its transmission parameters based on the capabilities of the BS and SSs, as well as the channel state. *Id.* at 4, 83. Specifically, a frame control header (FCH) is "transmitted at the beginning of each frame" in the downlink and "contains the DL-MAP message and may additionally include the UL-MAP, DCD or UCD messages." *Id.* at 184. BSs and SSs communicate using different antenna schemes with multiple antennas, including transmit diversity (space time coding (STC)) and adaptive antenna systems (AAS). *Id*. at 66-68, 203-205. Downlink transmission is performed on subchannels of the OFDMA symbol. *Id.*, 186, 180. Each subchannel is a collection of subcarriers that may or may not be adjacent in the frequency domain. *Id.* Wallace '467 teaches and describes that "the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system." Wallace '467 at 1:20-22. Wallace '467 discloses that "[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units" and " [i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit." *Id.* at Abstract. According to Wallace '467, "pilot symbols are generated and transmitted on a subset of the disjoint sub-

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channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be further minimized through compression techniques and resource allocation techniques." *Id.* Wallace '467 further discloses "[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly" and "[a]s delay of the measurement and reporting process increases, the utility of the channel response information decreases." *Id.* at 2:13-20. According to Wallace '467, "[a] present need exists for efficient techniques that will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and "pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various

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pilot symbols. It would have been obvious for a POSITA to combine Wallace '467 with 802.16a-2003 at least because Wallace '467 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like 802.16a-2003) using channel state information in order to improve communications and performance in a system capable of supporting more users.

- **802.16a-2003 and Catreux**: Catreux teaches and describes "wireless communications between a base station and multiple users." Catreux at 1:12-13. The "communication over the wireless channel uses one of several possible channelization modes" including OFDM. *Id*. at 5:17-39. "An embodiment of the transmit unit 200 of FIG. 2 includes a mode selection block 250. The mode selection block generates a first mode selection based upon a first quality parameter fed back from the receiver unit." *Id*. at 8:61-64. "The transmit unit 200 receives feedback from receive unit 300 via a feedback extractor 260." *Id*. at 9:13-15. "A subsequent transmission mode is selected based upon the predetermined channel database, the error factor and a subsequent channel characterization." *Id*. at Abstract. Similarly, 802.16a-2003's communication system is configured to adapt its transmission parameters based on the capabilities of the base station and subscribers as well as the state of the channel. 802.16a-2003, 4 ("adaptive modulation: A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles,"), 83 ("The downlink burst profile is determined by the BS according to the quality of the signal that is received by each

SS."). 802.16a-2003 discloses that AAS uses "channel state information in the PHY at both downlink and uplink." 802.16a-2003, 67; *see also id.*, 203, 220-221. This channel state information is used "in adjusting the direction of the adaptive array." *Id.*, 42-44. It would have been obvious for a POSITA to combine 802.16a-2003 with Catreux at least because both are directed to OFDM communication systems that include receiver units providing feedback information to a base station, and the base station using that information for a subsequent transmission to the receiver unit.

- **802.16a-2003 and Jalali '454**: Jalali '454 teaches and describes "[t]ransmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services." Jalali '454 at Abstract. "For example, the communications system may include a central system (i.e., similar to a base station in the IS-95 CDMA system) having a number of antennas that transmit data to, and receive data from, a number of remote systems (i.e., subscriber units, similar to remote stations in the CDMA system), some of which may include one antenna and others of which may include multiple antennas." *Id*. at 6:30-37. "In one implementation, each packet includes packet type identifier indicative of a change in the circuit to be used to transmit the next packet, a circuit identifier indicative of a particular circuit to be used to transmit the next packet, and a data field for the payload." *Id*. at 3:37-42. "An indication to use a new circuit can be sent in a field of the packet transmitted on the current circuit or can be sent via a control channel." *Id*. at 3:59-61. "When the transmitter unit is provided with information indicative of the conditions (i.e., the 'state') of the communications links, additional

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processing can be performed at the transmitter unit to further improve performance and increase efficiency." *Id*. at 10:47-52. Similarly, 802.16a-2003's communication system is configured to adapt its transmission parameters based on the capabilities of the base station and subscribers as well as the state of the channel. 802.16a-2003, 4 ("adaptive modulation: A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles,"), 83 ("The downlink burst profile is determined by the BS according to the quality of the signal that is received by each SS."). 802.16a-2003 discloses that AAS uses "channel state information in the PHY at both downlink and uplink." 802.16a-2003, 67; *see also id.*, 203, 220-221. This channel state information is used "in adjusting the direction of the adaptive array." *Id.*, 42-44. It would have been obvious for a POSITA to combine 802.16a-2003 with Jalali '454 at least because both are directed to OFDM communication systems that include receiver units feeding channel state information to a transmitter, e.g., a base station, and the transmitter using that information to send transmission parameters for a subsequent transmission to the receiver unit.

- **802.16a-2003 and Wu '434**: Wu '434 teaches and describes "[a]n adaptable orthogonal frequency-division multiplexing system (OFDM) that uses a multiple input multiple output (MIMO) to having OFDM signals transmitted either in accordance with time diversity to reducing signal fading or in accordance with spatial diversity to increase the data rate." Wu '434 at Abstract. "Information data is fed into adaptive coding modulation, the modulation is multiplexed and fed into

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adaptive space/time diversity encoding and assignment. A receiver feedback to provide feedback signals to the adaptive coding of modulation, multiplexer and adaptive space/time diversity is also provided." *Id*. at 4:62-67. "The feedback signal is received at the transmitter side and interpreted by a controller at the transmitter side." *Id*. at 5:34-36. "[T]he feedback signal [is] indicative of a determination for a sub-carrier of the plurality of sub-carriers as to whether time diversity or spatial diversity should be used for subsequent transmission on the sub-carrier." *Id*. at Claim 9. Similarly, 802.16a-2003's communication system is configured to adapt its transmission parameters based on the capabilities of the base station and subscribers as well as the state of the channel. 802.16a-2003, 4 ("adaptive modulation: A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles,"), 83 ("The downlink burst profile is determined by the BS according to the quality of the signal that is received by each SS."). 802.16a-2003 discloses that AAS uses "channel state information in the PHY at both downlink and uplink." 802.16a-2003, 67; *see also id.*, 203, 220-221. This channel state information is used "in adjusting the direction of the adaptive array." *Id.*, 42-44. It would have been obvious for a POSITA to combine 802.16a-2003 with Wu '434 at least because both are directed to OFDM communication systems that include receiver units providing feedback information to a transmitter, e.g., a base station, and the transmitter using that information for a subsequent transmission to the receiver unit.

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(vi) Li ’445 in combination with the knowledge of a skilled artisan, 802.16a-2003, Heath, Catreux, Walton ’040, Walton ’110, Wallace ’467, Jalali ’454, and/or Wu ’434

As further explained below, the asserted claims of the ’941 patent are invalid based on obvious-type double patenting in view of Li ’445. The asserted claims are invalid in view of Li ’445 either alone or in combination with 802.16a-2003, Heath, Catreux, Walton ’040, Walton ’110, Wallace ’467, Jalali ’454, and/or Wu ’434. For the combination of references, in addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Li ’445 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Li ’445 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the Walton ’269 patent was filed. Specifically:

- Li ’455, 802.16a-2003, Heath, Catreux, Walton ’040, Walton ’110, Wallace ’467, Jalali ’454, and/or Wu ’434 are all directed to systems and methods for adaptive transmission of wireless communication signals. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to

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integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Li '445 and 802.16a-2003**: 802.16a-2003's communication system is configured to adapt its transmission parameters based on the capabilities of the base station and subscribers as well as the state of the channel. 802.16a-2003, 4 ("adaptive modulation: A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles,"), 83 ("The downlink burst profile is determined by the BS according to the quality of the signal that is received by each SS."). 802.16a-2003 discloses that AAS uses "channel state information in the PHY at both downlink and uplink." 802.16a-2003, 67; *see also id.*, 203, 220-221. This channel state information is used "in adjusting the direction of the adaptive array." *Id.*, 42-44. Similarly, Li '445's communication system adapts its transmission parameters based on the conditions of the channel between a base station and a subscrier system. *See* Li '445 at 5:33-6:32 (describing subscriber systems measuring channel conditions and feeding back this information to a base station). Li '445 explains that transmission parameters "can be adaptively changed according to the channel conditions observed at the receiver after the initial cluster allocation and rate selection." *Id.* at 7:38-40. The base station can then "intelligently select" how to allocate clusters of subcarriers. *Id.* at 11:22-36, 15:41-16:48. It would have been obvious for a POSITA to combine 802.16a-2003 with Li '445 at least because both are directed to OFDM communication systems that include receiver units providing feedback information to a transmitter, e.g., a base

station, and the transmitter using that information for a subsequent transmission to the receiver unit. The combined system would improve communications and performance in a system capable of supporting more users using different antenna and subcarrier communication schemes.

- **Li '445 and Heath**: Heath is directed to a wireless communication system that supports wireless transmissions with and without spatial multiplexing in which "[a] wireless communications adapts its mode of operation between spatial multiplexing and non-spatial multiplexing in response to transmission-specific variables." Heath at Abstract. Heath teaches and describes that "the base transceiver stations and subscriber units communicate information related to the operation mode over a control channel." Heath at 8:48-50. Heath discloses "FIG. 1 depicts a multiple access wireless communications system that includes base transceiver stations (BTSs) 102 and 104 and subscriber units (SUs) 106, 108, and 110. The base transceiver stations include spatially separated antennas 114 and spatial multiplexing logic 118. The base transceiver stations also include mode determination logic 122 that enables the system to adapt its mode of operation between spatial multiplexing and non-spatial multiplexing in response to transmission-specific variables." *Id*. at 5:7-16. Similarly, Li '445's communication system adapts its transmission parameters based on the conditions of the channel between a base station and a subscrier system. *See* Li '445 at 5:33-6:32 (describing subscriber systems measuring channel conditions and feeding back this information to a base station). Li '445 explains that transmission parameters "can be adaptively changed according to the channel conditions observed at the receiver after the initial

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cluster allocation and rate selection." *Id.* at 7:38-40. The base station can then "intelligently select" how to allocate clusters of subcarriers. *Id.* at 11:22-36, 15:41-16:48. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information. It would have been obvious for a POSITA to combine Li '445 with Heath at least because Heath provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Li '445) in order to improve communications and performance in a system capable of supporting more users.

- **Li '445 and Catreux**: Catreux teaches and describes "wireless communications between a base station and multiple users." Catreux at 1:12-13. The "communication over the wireless channel uses one of several possible channelization modes" including OFDM. *Id*. at 5:17-39. "An embodiment of the transmit unit 200 of FIG. 2 includes a mode selection block 250. The mode selection block generates a first mode selection based upon a first quality parameter fed back from the receiver unit." *Id*. at 8:61-64. "The transmit unit 200 receives feedback from receive unit 300 via a feedback extractor 260." *Id*. at 9:13-15. "A subsequent transmission mode is selected based upon the predetermined channel database, the error factor and a subsequent channel characterization." *Id*. at Abstract. Similarly, Li '445's communication system adapts its transmission parameters based on the conditions of the channel between a base station and a subscrier system. *See* Li '445 at 5:33-6:32 (describing subscriber systems

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measuring channel conditions and feeding back this information to a base station). Li '445 explains that transmission parameters "can be adaptively changed according to the channel conditions observed at the receiver after the initial cluster allocation and rate selection." *Id.* at 7:38-40. The base station can then "intelligently select" how to allocate clusters of subcarriers. *Id.* at 11:22-36, 15:41-16:48. It would have been obvious for a POSITA to combine Li '445 with Catreux at least because both are directed to OFDM communication systems that include receiver units providing feedback information to a base station, and the base station using that information for a subsequent transmission to the receiver unit.

- **Li '445 and Walton '040**: Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at

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Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various pilot symbols. Similarly, Li '445's communication system adapts its transmission parameters based on the conditions of the channel between a base station and a subscrier system. *See* Li '445 at 5:33-6:32 (describing subscriber systems measuring channel conditions and feeding back this information to a base station). Li '445 explains that transmission parameters "can be adaptively changed according to the channel conditions observed at the receiver after the initial cluster allocation and rate selection." *Id.* at 7:38-40. The base station can then "intelligently select" how to allocate clusters of subcarriers. *Id.* at 11:22-36, 15:41-16:48. Thus, it would have been obvious for a POSITA to combine Walton '040 with Li '445 at least because Walton '040 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Li '445) in order to improve communications and performance in a system capable of supporting more users.

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- **Li '445 and Walton '110:** Walton '110 teaches and describes "[t]echniques to schedule terminals for data transmission on the downlink and/or uplink in a MIMO-OFDM system based on the spatial and/or frequency 'signatures' of the terminals." Walton '110 at Abstract. In Walton '110, "[a] scheduler forms one or more sets of terminals for possible (downlink or uplink) data transmission for each of a number of frequency bands" and "[o]ne or more sub-hypotheses may further be formed for each hypothesis, with each sub-hypothesis corresponding to (1) specific assignments of transmit antennas to the terminal(s) in the hypothesis (for the downlink) or (2) a specific order for processing the uplink data transmissions from the terminal(s) (for the uplink). *Id.* Walton '110 discloses "[a] wideband MIMO system typically experiences frequency selective fading, which is characterized by different amounts of attenuation across the system bandwidth" and "[t]his frequency selective fading causes inter-symbol interference (ISI), which is a phenomenon whereby each symbol in a received signal acts as distortion to subsequent symbols in the received signal," which the "distortion degrades performance by impacting the ability to correctly detect the received symbols." *Id.* at 1:36-45. According to Walton '110, "[t]here is therefore a need in the art for techniques to allocate resources in a MIMO-OFDM system to provide high system performance." *Id.* at 2:14-16. To address these problems, Walton '110 describes "[t]echniques are provided herein to schedule terminals for data transmission on the downlink and/or uplink based on the spatial and/or frequency 'signatures' of the terminals" in which "[v]arious scheduling schemes are provided herein to select a "proper" set of one or more terminals for data transmission on each frequency band

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and to assign the available transmission channels to the selected terminals such that system goals (e.g., high throughput, fairness, and so on) are achieved." *Id.* 2:20-32. Similarly, Li '445's communication system adapts its transmission parameters based on the conditions of the channel between a base station and a subscrier system. *See* Li '445 at 5:33-6:32 (describing subscriber systems measuring channel conditions and feeding back this information to a base station). Li '445 explains that transmission parameters "can be adaptively changed according to the channel conditions observed at the receiver after the initial cluster allocation and rate selection." *Id.* at 7:38-40. The base station can then "intelligently select" how to allocate clusters of subcarriers. *Id.* at 11:22-36, 15:41-16:48. Thus, Walton '011 and Li '445 were in the same field of endeavor, and shared the same fundamental goal of improving data throughput and resource allocation in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '110 with Li '445 at least because Walton '110 provides methods to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Li '445) in order to improve communications and performance in a system capable of supporting more users.

- **Li '445 and Wallace '467**: Wallace '467 teaches and describes that "the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system." Wallace '467 at 1:20-22. Wallace '467 discloses that "[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units" and " [i]n one aspect of the invention, disjoint sub-channel sets

are assigned to transmit antennas located at a transmitter unit." *Id.* at Abstract. According to Wallace '467, "pilot symbols are generated and transmitted on a subset of the disjoint sub-channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be further minimized through compression techniques and resource allocation techniques." *Id.* Wallace '467 further discloses "[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly" and "[a]s delay of the measurement and reporting process increases, the utility of the channel response information decreases." *Id.* at 2:13-20. According to Wallace '467, "[a] present need exists for efficient techniques that will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and "pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. Similarly, Li '445's communication system adapts its

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transmission parameters based on the conditions of the channel between a base station and a subscrier system. *See* Li '445 at 5:33-6:32 (describing subscriber systems measuring channel conditions and feeding back this information to a base station). Li '445 explains that transmission parameters "can be adaptively changed according to the channel conditions observed at the receiver after the initial cluster allocation and rate selection." *Id.* at 7:38-40. The base station can then "intelligently select" how to allocate clusters of subcarriers. *Id.* at 11:22-36, 15:41-16:48. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information. It would have been obvious for a POSITA to combine Wallace '467 with Li '445 at least because Wallace '467 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Li '445) using channel state information in order to improve communications and performance in a system capable of supporting more users.

- **Li '445 and Jalali '454**: Jalali '454 teaches and describes "[t]ransmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services." Jalali '454 at Abstract. "For example, the communications system may include a central system (i.e., similar to a base station in the IS-95 CDMA system) having a number of antennas that transmit data to, and receive data from, a number of remote systems (i.e., subscriber units, similar to remote stations in the CDMA system), some of which may include one antenna and others of which may include multiple antennas." *Id*. at 6:30-37. "In one

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implementation, each packet includes packet type identifier indicative of a change in the circuit to be used to transmit the next packet, a circuit identifier indicative of a particular circuit to be used to transmit the next packet, and a data field for the payload." *Id*. at 3:37-42. "An indication to use a new circuit can be sent in a field of the packet transmitted on the current circuit or can be sent via a control channel." *Id*. at 3:59-61. "When the transmitter unit is provided with information indicative of the conditions (i.e., the 'state') of the communications links, additional processing can be performed at the transmitter unit to further improve performance and increase efficiency." *Id*. at 10:47-52. Similarly, Li '445's communication system adapts its transmission parameters based on the conditions of the channel between a base station and a subscrier system. *See* Li '445 at 5:33-6:32 (describing subscriber systems measuring channel conditions and feeding back this information to a base station). Li '445 explains that transmission parameters "can be adaptively changed according to the channel conditions observed at the receiver after the initial cluster allocation and rate selection." *Id.* at 7:38-40. The base station can then "intelligently select" how to allocate clusters of subcarriers. *Id.* at 11:22-36, 15:41-16:48. Thus, it would have been obvious for a POSITA to combine Li '445 with Jalali '454 at least because both are directed to OFDM communication systems that include receiver units feeding channel state information to a transmitter, e.g., a base station, and the transmitter using that information to send transmission parameters for a subsequent transmission to the receiver unit.

- **Li '445 and Wu '434**: Wu '434 teaches and describes "[a]n adaptable orthogonal frequency-division multiplexing system (OFDM) that uses a multiple input

multiple output (MIMO) to having OFDM signals transmitted either in accordance with time diversity to reducing signal fading or in accordance with spatial diversity to increase the data rate." Wu '434 at Abstract. "Information data is fed into adaptive coding modulation, the modulation is multiplexed and fed into adaptive space/time diversity encoding and assignment. A receiver feedback to provide feedback signals to the adaptive coding of modulation, multiplexer and adaptive space/time diversity is also provided." *Id*. at 4:62-67. "The feedback signal is received at the transmitter side and interpreted by a controller at the transmitter side." *Id*. at 5:34-36. "[T]he feedback signal [is] indicative of a determination for a sub-carrier of the plurality of sub-carriers as to whether time diversity or spatial diversity should be used for subsequent transmission on the sub-carrier." *Id*. at Claim 9. Similarly, Li '445's communication system adapts its transmission parameters based on the conditions of the channel between a base station and a subscrier system. *See* Li '445 at 5:33-6:32 (describing subscriber systems measuring channel conditions and feeding back this information to a base station). Li '445 explains that transmission parameters "can be adaptively changed according to the channel conditions observed at the receiver after the initial cluster allocation and rate selection." *Id.* at 7:38-40. The base station can then "intelligently select" how to allocate clusters of subcarriers. *Id.* at 11:22-36, 15:41-16:48. Thus, it would have been obvious for a POSITA to combine Li '445 with Wu '434 at least because both are directed to OFDM communication systems that include receiver units providing feedback information to a transmitter, e.g., a base

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station, and the transmitter using that information for a subsequent transmission to the receiver unit.

(vii) Walton ’269 in combination with the knowledge of a skilled artisan, 802.16a-2003, and/or Shattil ’043

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Walton ’269 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Walton ’269 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the Walton ’269 patent was filed. Specifically:

- Walton ’269, 802.16a-2003, and Shattil ’043 are all directed to systems and methods for adaptive transmission of wireless communication signals. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Walton ’269 and 802.16a-2003**: 802.16a-2003 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference.

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802.16a-2003 teaches and describes a link adaption method for an OFDM communication system that includes transmitting a control message to a mobile station containing specific transmission parameters indicating an antenna transmission scheme and subchannel configuration. 802.16a-2003 at 186-205. Similarly, Walton '269 discloses using "channel state information (CSI)" to provide feedback information "for the processing of the downlink transmission." Walton '269 at 8:13-43. This results in "a more efficient control channel structure that is able to accommodate different users that may operate at different data rates." *Id*. at 2:37-40. It would have been obvious for a POSITA to combine Walton '269 with 802.16a-2003 at least because doing so provides an improved means of resource allocation in a communication system.

- **Walton '269 and Shattil '043**: Shattil '043 teaches and describes spreading "data over predetermined subcarriers (e.g., selected by frequency and number of subcarriers)" that "is typically performed relative to channel conditions on each carrier or on an aggregate of carriers." Shattil '043 at 6:28-34. "Each user's subcarriers may be distributed contiguously or non-contiguously" and "may be spaced equally and/or non-equally." *Id*. at 21:15-18. Walton '269 also describes allocating downlink resources based on "the channel conditions." Walton '269 at 2:4-7. A POSITA would have understood that channel conditions impact how to efficiently distribute a user's subcarriers. It would have been obvious for a POSITA to combine Walton '269 with Shattil '043 at least because doing so provides an improved means of resource allocation in a communication system.

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(viii) Li ’748 in combination with the knowledge of a skilled artisan, Classon ’996, Wallace ’467, Jalali ’454, Wu ’434, Heath, Catreux, Walton ’040, and/or Walton ’110

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Li ’748 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Li ’748 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the Li ’748 patent was filed. Specifically:

- Li ’748, Classon ’996, Wallace ’467, Jalali ’454, Wu ’434, Heath, Catreux, Walton ’040, and Walton ’110 are all directed to systems and methods for adaptive transmission of wireless communication signals. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Li ’748 and Classon ’996:** Classon ’996 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Classon ’996

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teaches and describes an adaptive transmission method where "[d]ifferent modulation and coding schemes, along with responsive frequency and time diversity resource allocations, are adaptively selected as a function of this level of trustworthiness." Classon at Abstract. Classon '996 explains that "[a]daptive modulation and coding schemes (where different modulation and/or coding schemes are selected to accommodate different situations) are also known and utilized to at least attempt to optimize data throughput as between a transmission source and a transmission target." *Id.* at 2:34-38. Classon '996 discloses that "[a] need therefore exists for a way to improve upon overall system data throughput for a multicarrier communications systems such as a wireless orthogonal frequency division multiplexed communications system" and "any such improvement should not present a significant or undue loading requirement upon the system itself" or "unduly delay the transmission of data in favor of overall improvement throughput." *Id.* at 2:62-3:4. To address these problems, Classon '996 teaches "a method to facilitate adaptive transmissions in a multicarrier, multidimensional domain" where "[u]pon receiving data to be transmitted to at least one transmission target, a transmission source determines whether trustworthy channel quality data can likely be obtained." *Id.* at 3:50-55. According to Classon '996, "[w]hen configured in accordance with the present invention, a multicarrier communications system can respond in significant ways to adapt to varying conditions that impact the ability of the system to ascertain channel quality at any particular moment in time," which "allows the system to support both robust communications in a harsh environment as well as improved data throughput in improved conditions." *Id*. at

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4:49-59. Similarly, Li '748 discloses "it is advantageous in an OFDMA system to adaptively allocate the subcarriers to subscribers so that each subscriber enjoys a high channel gain." Li '748 at 1:48-50. For example, "[t]he coding/modulation rate can be adaptively changed according to the channel conditions observed at the receiver after the initial cluster allocation and rate selection." *Id*. at 7:26-28. It would have been obvious for a POSITA to combine Li '748 with Classon '996 at least because both are directed to adaptive transmission of wireless communication signals.

- **Li '748 and Wallace '467:** Wallace '467 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wallace '467 teaches and describes that "the present invention relates to the measurement and report of channel state information in a high efficiency, high performance communications system." Wallace '467 at 1:20-22. Wallace '467 discloses that "[c]hannel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units" and "[i]n one aspect of the invention, disjoint sub-channel sets are assigned to transmit antennas located at a transmitter unit." *Id.* at Abstract. According to Wallace '467, "pilot symbols are generated and transmitted on a subset of the disjoint sub-channels. Upon receipt of the transmitted pilot symbols, the receiver units determine the CSI for the disjoint sub-channels that carried pilot symbols. These CSI values are reported to the transmitter unit, which will use these CSI values to generate CSI estimates for the disjoint sub-channels that did not carry pilot symbols. The amount of information necessary to report CSI on the reverse link can be

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further minimized through compression techniques and resource allocation techniques." *Id.* Wallace '467 further discloses "[g]iven a mobile environment, an optimal performance requires that information regarding channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly" and "[a]s delay of the measurement and reporting process increases, the utility of the channel response information decreases." *Id.* at 2:13-20. According to Wallace '467, "[a] present need exists for efficient techniques that will provide rapid determination of the channel characteristics." *Id.* at 2:20-22. To address these needs, Wallace '467 teaches "a method and apparatus for the measuring and reporting of channel state information in a high efficiency, high performance communications system" and "pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets," which allows "the characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols, wherein K is less than the number of OFDM sub-channels in the system." *Id.* at 2:25-55. It would have been obvious for a POSITA to combine Li '748 with Wallace '467 at least because both are directed to OFDM communication systems that include receiver units feeding channel state information to a transmitter, e.g., a base station, and the transmitter using that information to send transmission parameters for a subsequent transmission to the receiver unit.

- **Li '748 and Jalali '454:** Jalali '454 teaches and describes "[t]ransmitter and receiver units for use in an OFDM communications system and configurable to

support multiple types of services." Jalali '454 at Abstract. "For example, the communications system may include a central system (i.e., similar to a base station in the IS-95 CDMA system) having a number of antennas that transmit data to, and receive data from, a number of remote systems (i.e., subscriber units, similar to remote stations in the CDMA system), some of which may include one antenna and others of which may include multiple antennas." *Id*. at 6:30-37. "In one implementation, each packet includes packet type identifier indicative of a change in the circuit to be used to transmit the next packet, a circuit identifier indicative of a particular circuit to be used to transmit the next packet, and a data field for the payload." *Id*. at 3:37-42. "An indication to use a new circuit can be sent in a field of the packet transmitted on the current circuit or can be sent via a control channel." *Id*. at 3:59-61. "When the transmitter unit is provided with information indicative of the conditions (i.e., the 'state') of the communications links, additional processing can be performed at the transmitter unit to further improve performance and increase efficiency." *Id*. at 10:47-52. It would have been obvious for a POSITA to combine Li '748 with Jalali '454 at least because both are directed to OFDM communication systems that include receiver units feeding channel state information to a transmitter, e.g., a base station, and the transmitter using that information to send transmission parameters for a subsequent transmission to the receiver unit.

- **Li '748 and Wu '434:** Wu '434 teaches and describes "[a]n adaptable orthogonal frequency-division multiplexing system (OFDM) that uses a multiple input multiple output (MIMO) to having OFDM signals transmitted either in accordance

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with time diversity to reducing signal fading or in accordance with spatial diversity to increase the data rate." Wu '434 at Abstract. "Information data is fed into adaptive coding modulation, the modulation is multiplexed and fed into adaptive space/time diversity encoding and assignment. A receiver feedback to provide feedback signals to the adaptive coding of modulation, multiplexer and adaptive space/time diversity is also provided." *Id*. at 4:62-67. "The feedback signal is received at the transmitter side and interpreted by a controller at the transmitter side." *Id*. at 5:34-36. "[T]he feedback signal [is] indicative of a determination for a sub-carrier of the plurality of sub-carriers as to whether time diversity or spatial diversity should be used for subsequent transmission on the sub-carrier." *Id*. at Claim 9. It would have been obvious for a POSITA to combine Li '748 with Wu '434 at least because both are directed to OFDM communication systems that include receiver units providing feedback information to a transmitter, e.g., a base station, and the transmitter using that information for a subsequent transmission to the receiver unit.

- **Li '748 and Heath:** Heath teaches and describes "a wireless communications system for transmitting information between a base transceiver station and a subscriber unit" that "adapts its mode of operation between spatial multiplexing and non-spatial multiplexing in response to transmission-specific variables." Heath at Abstract. "Multiple access protocols that may be utilized by the wireless communications system include … orthogonal frequency division multiple access (OFDMA)." *Id*. at 5:17-23. "Referring to FIG. 3A, the base transceiver station transmits information 312 to the subscriber unit that is utilized to determine the

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appropriate mode of operation between the base transceiver station and the subscriber unit for subsequent subscriber datastream transmissions. The subscriber unit responds back to the base transceiver station to transmit subsequent subscriber datastreams using either spatial multiplexing or non-spatial multiplexing." *Id*. at 8:30-38. "[T]he base transceiver stations and subscriber units communicate information related to the operation mode over a control channel." *Id*. at 8:48-50. It would have been obvious for a POSITA to combine Li '748 with Heath at least because both are directed to OFDM communication systems that include receiver units communicating with base stations over a control channel to adapt operation modes.

- **Li '748 and Catreux:** Catreux teaches and describes "wireless communications between a base station and multiple users." Catreux at 1:12-13. The "communication over the wireless channel uses one of several possible channelization modes" including OFDM. *Id*. at 5:17-39. "An embodiment of the transmit unit 200 of FIG. 2 includes a mode selection block 250. The mode selection block generates a first mode selection based upon a first quality parameter fed back from the receiver unit." *Id*. at 8:61-64. "The transmit unit 200 receives feedback from receive unit 300 via a feedback extractor 260." *Id*. at 9:13-15. "A subsequent transmission mode is selected based upon the predetermined channel database, the error factor and a subsequent channel characterization." *Id*. at Abstract. It would have been obvious for a POSITA to combine Li '748 with Catreux at least because both are directed to OFDM communication systems that

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include receiver units providing feedback information to a base station, and the base station using that information for a subsequent transmission to the receiver unit.

- **Li '748 and Walton '040:** Walton '040 teaches and describes "[t]echniques to achieve better utilization of the available resources and robust performance for the downlink and uplink in a multiple-access MIMO system" and these "[t]echniques are provided to adaptively process data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." Walton '040 at Abstract. Walton '040 is directed to a multi-cell, multiple-access communication system 100 that "provides communication for a number of coverage areas 102a through 102g, each of which is serviced by a corresponding base station 104." *Id.* at [0043]. Walton '040 is a multiple-access MIMO system that employs OFDM. *Id.* at [0010]. Walton '040 discloses adaptive processing data prior to transmission based on channel state information and adjusting operating parameters (e.g., the operating mode, channel, data rate, antenna(s) to transmit from, transmit power, and so on) based on performance metrics, and indicating these parameters to terminals via a control channel. *Id.* at Abstract, [0074]. Walton '040 explains that "[t]he use of multiple antennas at both the transmitter unit and receiver unit (i.e., NR×NT MIMO) is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, LAN, and so on). Using MIMO, a transmitter unit may send multiple independent data streams on the same communication channel to a single or multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive antennas." *Id.* at [0055]. Thus, these references were in the

same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using channel state information and various pilot symbols. It would have been obvious for a POSITA to combine Walton '040 with Li '748 at least because Walton '040 provides a method to facilitate improved data transmissions in a multicarrier system (which can be applied to other OFDM systems like Li '748) using channel state information in order to improve communications and performance in a system capable of supporting more users.

- **Li '748 and Walton '110:** Walton '110 teaches and describes "[t]echniques to schedule terminals for data transmission on the downlink and/or uplink in a MIMO-OFDM system based on the spatial and/or frequency 'signatures' of the terminals." Walton '110 at Abstract. In Walton '110, "[a] scheduler forms one or more sets of terminals for possible (downlink or uplink) data transmission for each of a number of frequency bands" and "[o]ne or more sub-hypotheses may further be formed for each hypothesis, with each sub-hypothesis corresponding to (1) specific assignments of transmit antennas to the terminal(s) in the hypothesis (for the downlink) or (2) a specific order for processing the uplink data transmissions from the terminal(s) (for the uplink). *Id.* Walton '110 discloses "[a] wideband MIMO system typically experiences frequency selective fading, which is characterized by different amounts of attenuation across the system bandwidth" and "[t]his frequency selective fading causes inter-symbol interference (ISI), which is a phenomenon whereby each symbol in a received signal acts as distortion to subsequent symbols in the received signal," which the "distortion degrades

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performance by impacting the ability to correctly detect the received symbols." *Id*. at 1:36-45. According to Walton '110, "[t]here is therefore a need in the art for techniques to allocate resources in a MIMO-OFDM system to provide high system performance." *Id.* at 2:14-16. To address these problems, Walton '110 describes "[t]echniques are provided herein to schedule terminals for data transmission on the downlink and/or uplink based on the spatial and/or frequency 'signatures' of the terminals" in which "[v]arious scheduling schemes are provided herein to select a "proper" set of one or more terminals for data transmission on each frequency band and to assign the available transmission channels to the selected terminals such that system goals (e.g., high throughput, fairness, and so on) are achieved." *Id.* 2:20-32. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions and resource allocation in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '110 with Li '748 at least because Walton '110 provides methods to facilitate improved data transmissions in a multicarrier system (which can be applied to other multi-carrier OFDM systems like Li '748) in order to improve communications and performance in a system capable of supporting more users.

d. The '450 Patent

A person of ordinary skill in the art would have been motivated to combine or modify each piece of prior art identified in Sections III.B-E in such a way as to render the asserted claims of the '450 patent invalid. For example, Defendants identify at least the following grounds (and similar permutations based on the listed references) that render the asserted claims of the '450 patent invalid under 35 U.S.C. § 103:

(i) Wu ’009 in combination with the knowledge of a skilled artisan, Park ’274, Agrawal ’825, Laroia ’005, Teague’465, and/or IEEE 802.16-2004

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Wu ’009 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Wu ’009 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’450 patent was filed. Specifically:

- Wu ’009, Park ’274, Agrawal ’825, Laroia ’005, Teague ’465, and IEEE 802.16-2004 are all directed to systems and methods for recovering information in a wireless packet system using various forms of resource allocation information. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were

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also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Wu '009 and Park '274**: Park '274 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Park '274 teaches and describes "[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system." Park '274 at Abstract. "The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit." *Id.* One goal of Park '274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load "when indicating resource allocation information," *id.* at [0032]. Wu '009 teaches that there "is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service." Wu '009 at 1:56-61. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Wu '009 with Park '274 at least because Wu '009 provides a method for using resource allocation techniques (such as those disclosed in Park '274) in order to accommodate voice traffic while optimizing system resources and maintaining a desired quality of service.

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- **Wu ’009 and Agrawal ’825**: Agrawal ’825 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Agrawal ’825 teaches and describes “a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system.” Agrawal ’825 at 1:52-54. According to Agrawal ’825, “[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system,” which “utilizes orthogonal frequency division multiplexing (OFDM), which itself “is a multi-carrier modulation technique.” *Id.* at 2:60-3:1. The “shared signaling channel may” have fixed parameters, including “resource allocation,” which may be sent from the base station to the terminals. *Id.* at 6:15-26. Agrawal ’825 teaches that its “shared signaling channel” provides for an improved means of transmitting signaling in a multiple-access communication system. Wu ’009 teaches that there “is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service.” Wu ’009 at 1:56-61. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Wu ’009 with Agrawal ’825 at least because Wu ’009 provides a method for using resource allocation techniques (such as those

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disclosed in Agrawal ’825) in order to accommodate voice traffic while optimizing system resources and maintaining a desired quality of service.

- **Wu ’009 and Laroia ’005**: Laroia ’005 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Laroia ’005 “relates to methods and apparatus for efficient use of air link resources for signaling, and more particularly to methods and apparatus for efficient superposition signaling in a wireless communications system.” Laroia ’456 at 1:14-17. According to Laroia ’ 005, “a need exists for more efficient apparatus and methods to use air link resources for downlink traffic channel signaling in wireless communications systems supporting a plurality of users with a wide range of varying resource needs.” *Id*. at 2:34-38. One solution includes allocating resources to minimum transmission units based on modulation symbols in an OFDM multiple access wireless communication system using superposition signaling in the downlink. E.g., *id*. at Abstract, 4:57-63. Wu ’009 teaches that there “is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service.” Wu ’009 at 1:56-61. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved allocation techniques. It would have been obvious for a POSITA to combine Wu ’009 with Laroia ’005 at least because Wu ’009 provides a method for using resource allocation techniques

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(such as those disclosed in Laroia '005) in order to accommodate voice traffic while optimizing system resources and maintaining a desired quality of service.

- **Wu '009 and Teague '465**: Teague '465 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Teague '465 teaches and describes "reducing interference in a wireless communications environment." Teague '465 at 1:15-17. According to Teague '465, "a need exists in the art for systems and methods that facilitate allocating resources in a wireless communication environment in order to improve system throughput and enhance user experience." *Id.* at 1:49-52. For example, Teague '465 discusses the need to permit transmission/reception of information streams associated with, but not limited to, voice information and audio data. *Id.* at 8:8-17. Teague '465 teaches employing various protocols to ensure that a conflicted resource resumes on a next logical resource depending on per-assigned resource parameter and a static system-wide parameters. *Id.* at 3:59-3:8. Wu '009 teaches that there "is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service." Wu '009 at 1:56-61. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved allocation techniques. It would have been obvious for a POSITA to combine Wu '009 with Teague '465 at least because they both provide a method for using resource allocation techniques in

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order to accommodate voice traffic while optimizing system resources and maintaining a desired quality of service.

- **Wu '009 and IEEE 802.16-2004:** IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." Id. at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). Id. at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." Id. at 532 (§8.4.3.1), Fig. 215. Wu '009 teaches that its invention will provide support for voice services in systems using the 802.16 communication standard. Wu '009 at 1:45-2:31. A POSITA would have understood that IEEE802.16-2004 consolidates IEEE Std 802.16, IEEE Std 802.16a, and IEEE Std 802.16c, retaining all modes and major features without adding modes. Therefore, a POSITA would have understood

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that the teachings of IEEE802.16-2004 were directly applicable to Wu '009. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Wu '009's network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Wu '009's network based on the IEEE 802.16 standard), ready for improvement to yield predictable results.

(ii) Park '274 in combination with the knowledge of a skilled artisan, Wu '009, Agrawal '825, Ma '407, Teague '465, and/or IEEE 802.16-2004

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Park '274 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Park '274 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '450 patent was filed. Specifically:

- Park '274, Wu '009, Agrawal '825, Laroia '005, Ma '407, Teague '465, and IEEE 802.16-2004 are all directed to systems and methods for recovering information in a wireless packet system using various forms of resource

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allocation information. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Park '274 and Wu '009**: Wu '009 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wu '009 teaches and describes that there "is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service." Wu '009 at 1:56-61. And it discloses a "a technique for scheduling data, and in particular, scheduling real-time or Voice data for transmissions during a transmit time interval in a multi-carrier communication environment." *Id.* at Abstract. Park '274 teaches and describes "[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system." Park '274 at Abstract. "The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit." *Id.* One goal of Park '274 is to maintain

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flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load "when indicating resource allocation information," *id.* at [0032]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Park '274 with Wu '009 at least because doing so provides a method for using resource allocation techniques in order to accommodate voice traffic while optimizing system resources and maintaining a desired quality of service.

- **Park '274 and Agrawal '825**: Agrawal '825 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Agrawal '825 teaches and describes "a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system." Agrawal '825 at 1:52-54. According to Agrawal '825, "[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system," which "utilizes orthogonal frequency division multiplexing (OFDM), which itself "is a multi-carrier modulation technique." *Id.* at 2:60-3:1. The "shared signaling channel may" have fixed parameters, including "resource allocation," which may be sent from the base station to the terminals. *Id.* at 6:15-26. Agrawal '825 teaches that its "shared signaling channel" provides for an improved means of transmitting signaling in a multiple-access communication system. Park '274 teaches and describes "[a]

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method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system." Park '274 at Abstract. "The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit." *Id.* One goal of Park '274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load "when indicating resource allocation information," *id.* at [0032]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Park '274 with Agrawal '825 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Park '274 and Laroia '005**: Laroia '005 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Laroia '005 "relates to methods and apparatus for efficient use of air link resources for signaling, and more particularly to methods and apparatus for efficient superposition signaling in a wireless communications system." Laroia '005 at 1:14-17. According to Laroia '005, "a need exists for more efficient apparatus and methods to use air link resources for downlink traffic channel signaling in wireless communications systems supporting a plurality of users with a wide

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range of varying resource needs." *Id.* at 2:34-38. One solution includes allocating resources to minimum transmission units based on modulation symbols in an OFDM multiple access wireless communication system using superposition signaling in the downlink. *E.g.*, *id.* at Abstract, 4:57-63. Park '274 teaches and describes "[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system." Park '274 at Abstract. "The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit." *Id.* One goal of Park '274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load "when indicating resource allocation information," *id.* at [0032]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Park '274 with Laroia '005 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Park '274 and Ma '407**: Ma '407 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '407 "relates the field of wireless communications, more specifically to systems and methods employing orthogonal frequency division multiplexed (OFDM) transmission."

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Ma ’407 at 1:15-18. According to Ma ’407, “problems related to noise enhancement can be avoiding during signal processing at the receiver” through the use MIMO transmission schemes that are “easily implemented” on OFDM which “allows for flexible and efficient pilot designs.” *Id.* at 1:42-48. Ma ’407 further teaches transmitting different OFDM symbols such that the same frequency indexes are used for pilots and data for each user transmitting on a transmission band. *E.g.*, *id.* at 13:24-67. Park ’274 teaches and describes “[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system.” Park ’274 at Abstract. “The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit.” *Id.* One goal of Park ’274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load “when indicating resource allocation information,” *id.* at [0032]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Park ’274 with Ma ’407 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

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- **Park ’274 and Teague ’465**: Teague ’465 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Teague ’465 teaches and describes “reducing interference in a wireless communications environment.” Teague ’465 at 1:15-17. According to Teague ’465, “a need exists in the art for systems and methods that facilitate allocating resources in a wireless communication environment in order to improve system throughput and enhance user experience.” *Id.* at 1:49-52. Teague ’465 teaches employing various protocols to ensure that a conflicted resource resumes on a next logical resource depending on per-assigned resource parameter and a static system-wide parameters. *Id.* at 3:59-3:8. Park ’274 teaches and describes “[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system.” Park ’274 at Abstract. “The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit.” *Id.* One goal of Park ’274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load “when indicating resource allocation information,” *id.* at [0032]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Park ’274 with Teague ’465 at least because doing so provides an

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improved means of facilitating resource allocation and signaling in a multiple-access communication system.

- **Park '274 and IEEE 802.16-2004**: IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. Park '274 teaches that its invention will apply using the 802.16-2004 standard. *E.g.*, Park '274 at [0007], [0013], [0014], [0017], [0018], [0036], [0037], [0073], [0075], [0076], [0077], [0078], [0079], [0085]. Therefore, a POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Park '274. Furthermore, a POSITA would have understood that incorporating

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the teachings of IEEE802.16-2004 into Park '274's network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Park '274's network based on the IEEE 802.16 standard), ready for improvement to yield predictable results.

(iii) Agrawal '825 in combination with the knowledge of a skilled artisan, Wu '009, Park '274, Laroia '005, Ma '407, Teague '465, and/or IEEE 802.16-2004

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Agrawal '825 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Agrawal '825 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '450 patent was filed. Specifically:

- Agrawal '825, Park '274, Wu '009, Laroia '005, Ma '407, Teague '465, and IEEE 802.16-2004 are all directed to systems and methods for recovering information in a wireless packet system using various forms of resource allocation information. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier

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communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Agrawal '825 and Wu '009**: Wu '009 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wu '009 teaches and describes that there "is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service." Wu '009 at 1:56-61. And it discloses a "a technique for scheduling data, and in particular, scheduling real-time or Voice data for transmissions during a transmit time interval in a multi-carrier communication environment." *Id.* at Abstract. Agrawal '825 teaches and describes "a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system." Agrawal '825 at 1:52-54. According to Agrawal '825, "[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system," which "utilizes orthogonal frequency division multiplexing (OFDM), which itself "is a multi-carrier modulation technique." *Id.* at 2:60-3:1. The "shared signaling channel may" have fixed parameters, including "resource allocation," which may be sent from the base station to the

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terminals. *Id.* at 6:15-26. Agrawal '825 teaches that its "shared signaling channel" provides for an improved means of transmitting signaling in a multiple-access communication system. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Agrawal '825 with Wu '009 at least because Wu '009 provides a method for using resource allocation techniques (such as those disclosed in Agrawal '825) in order to accommodate voice traffic while optimizing system resources and maintaining a desired quality of service.

- **Agrawal '825 and Park '274**: Park '274 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Park '274 teaches and describes "[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system." Park '274 at Abstract. "The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit." *Id.* One goal of Park '274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load "when indicating resource allocation information," *id.* at [0032]. Agrawal '825 teaches and describes "a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access

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communication system." Agrawal '825 at 1:52-54. According to Agrawal '825, "[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system," which "utilizes orthogonal frequency division multiplexing (OFDM), which itself "is a multi-carrier modulation technique." *Id.* at 2:60-3:1. The "shared signaling channel may" have fixed parameters, including "resource allocation," which may be sent from the base station to the terminals. *Id.* at 6:15-26. Agrawal '825 teaches that its "shared signaling channel" provides for an improved means of transmitting signaling in a multiple-access communication system. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Agrawal '825 with Park '274 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Agrawal '825 and Laroia '005**: Laroia '005 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Laroia '005 "relates to methods and apparatus for efficient use of air link resources for signaling, and more particularly to methods and apparatus for efficient superposition signaling in a wireless communications system." Laroia '005 at 1:14-17. According to Laroia '005, "a need exists for more efficient apparatus and methods to use air link resources for downlink traffic channel

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signaling in wireless communications systems supporting a plurality of users with a wide range of varying resource needs." *Id.* at 2:34-38. One solution includes allocating resources to minimum transmission units based on modulation symbols in an OFDM multiple access wireless communication system using superposition signaling in the downlink. *E.g.*, *id.* at Abstract, 4:57-63. Agrawal '825 teaches and describes "a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system." Agrawal '825 at 1:52-54. According to Agrawal '825, "[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system," which "utilizes orthogonal frequency division multiplexing (OFDM), which itself "is a multi-carrier modulation technique." *Id.* at 2:60-3:1. The "shared signaling channel may" have fixed parameters, including "resource allocation," which may be sent from the base station to the terminals. *Id.* at 6:15-26. Agrawal '825 teaches that its "shared signaling channel" provides for an improved means of transmitting signaling in a multiple-access communication system. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Agrawal '825 with Laroia '005 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

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- **Agrawal ’825 and Ma ’407**: Ma ’407 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma ’407 “relates the field of wireless communications, more specifically to systems and methods employing orthogonal frequency division multiplexed (OFDM) transmission.” Ma ’407 at 1:15-18. According to Ma ’407, “problems related to noise enhancement can be avoiding during signal processing at the receiver” through the use MIMO transmission schemes that are “easily implemented” on OFDM which “allows for flexible and efficient pilot designs.” *Id.* at 1:42-48. Ma ’407 further teaches transmitting different OFDM symbols such that the same frequency indexes are used for pilots and data for each user transmitting on a transmission band. *E.g.*, *id.* at 13:24-67. Agrawal ’825 teaches and describes “a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system.” Agrawal ’825 at 1:52-54. According to Agrawal ’825, “[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system,” which “utilizes orthogonal frequency division multiplexing (OFDM), which itself “is a multi-carrier modulation technique.” *Id.* at 2:60-3:1. The “shared signaling channel may” have fixed parameters, including “resource allocation,” which may be sent from the base station to the terminals. *Id.* at 6:15-26. Agrawal ’825 teaches that its “shared signaling channel” provides for an improved means of transmitting signaling in a multiple-access communication system. Thus, these references were in the same field of endeavor, and shared the same

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fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Agrawal '825 with Ma '407 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Agrawal '825 and Teague '465**: Teague '465 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Teague '465 teaches and describes "reducing interference in a wireless communications environment." Teague '465 at 1:15-17. According to Teague '465, "a need exists in the art for systems and methods that facilitate allocating resources in a wireless communication environment in order to improve system throughput and enhance user experience." *Id.* at 1:49-52. Teague '465 teaches employing various protocols to ensure that a conflicted resource resumes on a next logical resource depending on per-assigned resource parameter and a static system-wide parameters. *Id.* at 3:59-3:8. Agrawal '825 teaches and describes "a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system." Agrawal '825 at 1:52-54. According to Agrawal '825, "[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system," which "utilizes orthogonal frequency division multiplexing (OFDM), which itself "is a multi-carrier modulation technique." *Id.* at 2:60-3:1. The "shared signaling channel

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may" have fixed parameters, including "resource allocation," which may be sent from the base station to the terminals. *Id.* at 6:15-26. Agrawal '825 teaches that its "shared signaling channel" provides for an improved means of transmitting signaling in a multiple-access communication system. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Agrawal '825 with Teague '465 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Agrawal '825 and IEEE 802.16-2004**: IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum

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possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. IEEE802.16-2004 and Agrawal '825 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. A POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Agrawal '825. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Agrawal '825's network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Agrawal '825's network), ready for improvement to yield predictable results.

(iv) Vijayan '089 in combination with the knowledge of a skilled artisan, Wu '009, Park '274, Agrawal '825, Laroia '005, Vijayan '475, IEEE 802.16-2004, Laroia '429, Wu '345, Lane '481, Parikh '647, Holmes '624, Chang '123, and/or Park '148

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Vijayan '089 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Vijayan '089 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element

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for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '450 patent was filed. Specifically:

- Wu '009, Park '274, Agrawal '825, Laroia '005, Vijayan '089, Vijayan '475, IEEE 802.16-2004, Laroia '429, Wu '345, Lane '481, Parikh '647, Holmes '624, Chang '123, and Park '148 are all directed to systems and methods for recovering information in a wireless packet system using various forms of resource allocation information. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Vijayan '089 and Wu '009**: Wu '009 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wu '009 teaches and describes that there "is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service." Wu '009 at 1:56-61. And it discloses "a technique for scheduling data, and in particular, scheduling real-time or Voice data for transmissions during a transmit time interval in a

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multi-carrier communication environment." *Id.* at Abstract. Vijayan '089 teaches and describes an OFDM communication system with base stations and wireless devices. Vijayan '089 at ¶¶36-37, 46-47, 107-111. Vijayan '089 also describes organizing groups of subcarriers into transmission units or "transmission slots." *Id.* at ¶¶56, 59. An assigned communication segment may then be specified by two parameters: the start of the segment (which may be given by the starting subband and symbol period) and the length of the segment." *Id.* at ¶74. Assigning transmission slots in this way "reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC." *Id.* at ¶76. In this manner, Vijayan '089 describes the optimization of allocating resources for communications such as those described in Wu '009. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Vijayan '089 with Wu '009 at least because Wu '009 provides a method for using resource allocation techniques (such as those disclosed in Vijayan '089) in order to accommodate voice traffic while optimizing system resources and maintaining a desired quality of service.

- **Vijayan '089 and Park '274**: Park '274 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Park '274 teaches and describes "[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an

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Orthogonal Frequency Division Multiple Access wireless network system." Park '274 at Abstract. "The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit." *Id.* One goal of Park '274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load "when indicating resource allocation information," *id.* at [0032]. Vijayan '089 teaches and describes an OFDM communication system with base stations and wireless devices. Vijayan '089 at ¶¶36-37, 46-47, 107-111. Vijayan '089 also describes organizing groups of subcarriers into transmission units or "transmission slots." *Id.* at ¶¶56, 59. An assigned communication segment may then be specified by two parameters: the start of the segment (which may be given by the starting subband and symbol period) and the length of the segment." *Id.* at ¶74. Assigning transmission slots in this way "reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC." *Id.* at ¶76. In this manner, Vijayan '089 describes the optimization of allocating resources for communications such as those described in Park '274. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Vijayan '089 with Park '274 at least because Park '274 provides a method for using resource allocation techniques (such as those disclosed in Vijayan '089) in order to optimize system

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resource allocation and reduce overhead signaling in a multiple-access communication system.

- **Vijayan '089 and Agrawal '825**: Agrawal '825 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Agrawal '825 teaches and describes "a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system." Agrawal '825 at 1:52-54. According to Agrawal '825, "[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system," which "utilizes orthogonal frequency division multiplexing (OFDM), which itself "is a multi-carrier modulation technique." *Id.* at 2:60-3:1. The "shared signaling channel may" have fixed parameters, including "resource allocation," which may be sent from the base station to the terminals. *Id.* at 6:15-26. Agrawal '825 teaches that its "shared signaling channel" provides for an improved means of transmitting signaling in a multiple-access communication system. Vijayan '089 teaches and describes an OFDM communication system with base stations and wireless devices. Vijayan '089 at ¶¶36-37, 46-47, 107-111. Vijayan '089 also describes organizing groups of subcarriers into transmission units or "transmission slots." *Id.* at ¶¶56, 59. An assigned communication segment may then be specified by two parameters: the start of the segment (which may be given by the starting subband and symbol period) and the length of the segment." *Id.* at ¶74. Assigning transmission slots in this way "reduce[s] the amount of overhead signaling

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needed to indicate the specific slots assigned to each active PLC." *Id.* at ¶76. In this manner, Vijayan '089 describes the optimization of allocating resources for communications such as those described in Agrawal '825. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Vijayan '089 with Agrawal '825 at least because Agrawal '825 provides a method for using resource allocation techniques (such as those disclosed in Vijayan '089) in order to optimize system resource allocation and reduce overhead signaling in a multiple-access communication system.

- **Vijayan '089 and Laroia '005**: Laroia '005 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Laroia '005 "relates to methods and apparatus for efficient use of air link resources for signaling, and more particularly to methods and apparatus for efficient superposition signaling in a wireless communications system." Laroia '456 at 1:14-17. According to Laroia ' 005, "a need exists for more efficient apparatus and methods to use air link resources for downlink traffic channel signaling in wireless communications systems supporting a plurality of users with a wide range of varying resource needs." *Id*. at 2:34-38. One solution includes allocating resources to minimum transmission units based on modulation symbols in an OFDM multiple access wireless communication system using superposition signaling in the downlink. E.g., *id*. at Abstract,

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4:57-63. Vijayan '089 teaches and describes an OFDM communication system with base stations and wireless devices. Vijayan '089 at ¶¶36-37, 46-47, 107-111. Vijayan '089 also describes organizing groups of subcarriers into transmission units or "transmission slots." *Id.* at ¶¶56, 59. An assigned communication segment may then be specified by two parameters: the start of the segment (which may be given by the starting subband and symbol period) and the length of the segment." *Id.* at ¶74. Assigning transmission slots in this way "reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC." *Id.* at ¶76. In this manner, Vijayan '089 describes the optimization of allocating resources for communications such as those described in Laroia '005. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Vijayan '089 with Laroia '005 at least because Laroia '005 provides a method for using resource allocation techniques (such as those disclosed in Vijayan '089) in order to optimize system resource allocation and reduce overhead signaling in a multiple-access communication system.

- **Vijayan '089 and Vijayan '475**: Vijayan '475 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Vijayan '475 describes an OFDM communication system with base stations and wireless devices. Vijayan '475 at ¶¶26-27, 67-75. To allocate resources for a communication segment, Vijayan '475 uses "slots" defined on a time-

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frequency plane. *Id.* at FIG. 4, ¶¶36-42, 45-49, 56-57. To specify the particular slots of the segment, Vijayan '475 uses "Start Offset" and "Slot Info" parameters to identify a "Start Slot." *Id.* at ¶¶40, 42, 45-47, 56. Vijayan '475 also uses a "Stream Lengths" parameter to define the "number of slots allocated." *Id.* at ¶¶40, 45, 51-52, 54-55. Vijayan '475 describes an encoding mechanism for these parameters to "reduce the number of bits needed to convey this information" and therefore reduce the amount of overhead signaling needed. Id. at ¶¶38, 46, 55. Vijayan '089 teaches and describes an OFDM communication system with base stations and wireless devices. Vijayan '089 at ¶¶36-37, 46-47, 107-111. Vijayan '089 also describes organizing groups of subcarriers into transmission units or "transmission slots." *Id.* at ¶¶56, 59. An assigned communication segment may then be specified by two parameters: the start of the segment (which may be given by the starting subband and symbol period) and the length of the segment." *Id.* at ¶74. Assigning transmission slots in this way "reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC." *Id.* at ¶76. In this manner, Vijayan '089 describes the optimization of allocating resources for communications such as those described in Vijayan '475. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Vijayan '089 with Vijayan '475 at least because Vijayan '475 provides a method for using resource allocation techniques (such as those

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disclosed in Vijayan ’089) in order to optimize system resource allocation and reduce overhead signaling in a multiple-access communication system.

- **Vijayan ’089 and IEEE 802.16-2004**: IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a “base station (BS)” communicating with a “subscriber station (SS).” Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain “OFDMA symbol[s]” and frequency domain “subcarriers.” *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a “minimum possible data allocation unit” which consists of “one slot” in time (each slot consisting of multiple OFDMA symbols) and “one subchannel” in frequency (each subchannel being a “subset” of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this “minimum possible data allocation unit,” IEEE802.16-2004 specifies a “data region” as a “two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols.” *Id.* at 532 (§8.4.3.1), Fig. 215. IEEE802.16-2004 and Vijayan ’089 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. A POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Vijayan ’089. Furthermore, a

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POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Vijayan '089 system would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Vijayan '089's system), ready for improvement to yield predictable results.

- **Vijayan '089 and Laroia '429**: Laroia '429 describes an OFDM system where base stations service respective cells and communicate messages to wireless terminals within respective cells. Laroia '429 at ¶¶38, 40, 53, 65, 109-111. To identify a particular wireless terminal to receive a transmitted message, Laroia describes its base station assigning specific wireless terminal identifications ("base station assigned ID") to the wireless terminals that it is servicing. *Id.* at ¶¶38, 40. The "WT identification information" may allow a wireless terminal to identify that it "is the specific intended recipient" for a particular message. *Id.* at ¶¶40, 53. Vijayan '089 suggests the use of an identifier by describing the transmission of data to "specific wireless devices" when performing "unicast" communications. Vijayan '089 at ¶¶6-7, 35. To implement unicast transmissions or to communicate data to a specific wireless device, a POSITA would have found it obvious to use an identifier to specifically identify that wireless device. This process was ubiquitous in wireless communications and OFDM systems when delivering data or messages to intended recipient devices. Thus, a POSITA would have recognized that combining Vijayan '089 and Laroia '429 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Laroia '429's

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wireless terminal identification information with Vijayan 089's system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Laroia '429 with Vijayan '089 would improve the functionality of Vijayan 089's base stations and wireless devices by allowing the base stations to discern between different wireless devices. As previously explained, Vijayan '089 describes transmitting data to "specific wireless devices" when performing "unicast" communications. Vijayan '089 at ¶¶6-7, 35. A POSITA would have therefore found it obvious to implement Laroia '429's wireless terminal identification to facilitate these unicast communications and direct communications to specific wireless devices.

- **Vijayan '089 and Wu '345**: Wu '345 describes an OFDM system where base stations communicate messages to wireless devices ("user equipment" or "UE"). Wu '345 at Abstract, ¶¶33-34, 87, 94, 98. In order to identify a particular wireless device to receive a transmitted OFDM message, Wu '345 describes its base station assigning a "sixteen bit UE identifier 165" to each UE. *Id.* at ¶¶94, 98. Wu '345's base station assigns and uses the UE identifier when identifying to receivers "which OFDM slots and/or which CDMA slots are for a given receiver." *Id.* at ¶¶20-21, 94. Vijayan '089 suggests the use of an identifier by describing the transmission of data to "specific wireless devices" when performing "unicast" communications. Vijayan '089 at ¶¶6-7, 35. To implement unicast transmissions or to communicate data to a specific wireless device, a POSITA would have found it obvious to use an identifier to specifically identify that wireless device. This process was ubiquitous in

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wireless communications and OFDM systems when delivering data or messages to intended recipient devices. Thus, a POSITA would have recognized that combining Vijayan ’089 and Wu ’345 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Wu ’345’s UE identifier with Vijayan 089’s system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Wu ’345 with Vijayan ’089 would improve the functionality of Vijayan 089’s base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan ’089 describes transmitting data to “specific wireless devices” when performing “unicast” communications. Vijayan ’089 at ¶¶6-7, 35. A POSITA would have found it obvious to implement Wu ’345’s UE identifier to facilitate these unicast communications and direct communications to specific wireless devices.

- **Vijayan ’089 and Lane ’481**: Lane ’481 describes a wireless terminal identifier that is “assigned by the BS being used as the WTs point of network attachment.” Lane ’481 at ¶¶43, 55, 67. “[T]he WT having been accepted by the new terrestrial base station, receives a base station assigned wireless terminal user identifier” and receives and identifies data using this identifier. A POSITA would have recognized that combining Vijayan ’089 and Lane ’481 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Lane ’481’s wireless terminal identification information with Vijayan 089’s system to allow its wireless

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devices to differentiate and identify its own respective messages for reception. Combining Lane ’481 with Vijayan ’089 would improve the functionality of Vijayan 089’s base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan ’089 describes transmitting data to “specific wireless devices” when performing “unicast” communications. Vijayan ’089 at ¶¶6-7, 35. A POSITA would have found it obvious to implement Lane ’481’s wireless terminal identification to facilitate these unicast communications and direct communications to specific wireless devices.

- **Vijayan ’089 and Parikh ’647**: Parikh ’647 describes the use a “mobile station identifier” for connecting mobile stations to wireless networks. Parikh at ¶¶3, 8. Examples include a “conventional identifier, such as an Electronic Serial Number (ESN), a User Identity Module (UIM) ID, a Subscriber Identity Module (SIM) ID, or a Mobile Equipment Identifier (MEID), or the like.” *Id.*, at ¶3. A POSITA would have recognized that combining Vijayan ’089 and Parikh ’647 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Parikh ’647’s mobile station identifier with Vijayan 089’s system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Parikh ’647 with Vijayan ’089 would improve the functionality of Vijayan 089’s base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan ’089 describes transmitting data to “specific wireless devices” when performing “unicast”

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communications. Vijayan ’089 at ¶¶6-7, 35. A POSITA would have found it obvious to implement Parikh ’647’s mobile station identifier to facilitate these unicast communications and direct communications to specific wireless devices.

- **Vijayan ’089 and Holmes ’624**: Holmes ’624 describes using a “Temporary Mobile Station Identification (TMSI)” to identify a mobile station. Holmes ’624 at Abstract. The TMSI is a number assigned to the mobile station and that is used to “voice or data communications.” *Id.* at 2:61-3:16. A POSITA would have recognized that combining Vijayan ’089 and Holmes ’624 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Holmes ’624’s TMSI with Vijayan 089’s system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Holmes ’624 with Vijayan ’089 would improve the functionality of Vijayan 089’s base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan ’089 describes transmitting data to “specific wireless devices” when performing “unicast” communications. Vijayan ’089 at ¶¶6-7, 35. A POSITA would have found it obvious to implement Holmes ’624’s TMSI to facilitate these unicast communications and direct communications to specific wireless devices.
- **Vijayan ’089 and Chang ’123**: Chang ’123 describes “CIDs (Connection Identifiers) assigned from the current serving BS.” Chang ’123 at ¶¶2-5. Example CIDs may include “a basic CID, primary management CID, secondary

management CID and transport CID." *Id.* A mobile terminal can determine whether its own Basic CID (or BCID) has been included in a message to wake up from sleep mode and to process the message. *Id.* at ¶¶9-13, 44. A POSITA would have recognized that combining Vijayan '089 and Chang '123 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Chang '123's CID and/or BCID techniques with Vijayan 089's system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Chang '123 with Vijayan '089 would improve the functionality of Vijayan 089's base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan '089 describes transmitting data to "specific wireless devices" when performing "unicast" communications. Vijayan '089 at ¶¶6-7, 35. A POSITA would have found it obvious to implement Chang '123's CID and/or BCID techniques to facilitate these unicast communications and direct communications to specific wireless devices.

- **Vijayan '089 and Park '148**: Park '148 describes a base station using a "BCID assigned to subscriber terminals" to managing terminal sleep states. Park '148 at Abstract, ¶¶2-8. When a subscriber terminal receives a message, the subscriber terminal "determines whether or not its own basic CIDs (BCIDs) are included in the [] message and then determines whether or not to awake[n] [from] the sleep mode." *Id.* at ¶¶12-13, 53. If the BCID for the subscriber terminal is not present, the terminal returns to sleep mode. *Id.* A POSITA would have recognized that combining Vijayan '089 and Park '148 would have

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amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Park '148's BCID techniques with Vijayan 089's system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Park '148 with Vijayan '089 would improve the functionality of Vijayan 089's base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan '089 describes transmitting data to "specific wireless devices" when performing "unicast" communications. Vijayan '089 at ¶¶6-7, 35. A POSITA would have found it obvious to implement Park '148's BCID techniques to facilitate these unicast communications and direct communications to specific wireless devices.

(v) Vijayan '475 in combination with the knowledge of a skilled artisan, Wu '009, Park '274, Agrawal '825, Laroia '005, Vijayan '089, IEEE 802.16-2004, Laroia '429, Wu '345, Lane '481, Parikh '647, Holmes '624, Chang '123, and/or Park '148

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Vijayan '475 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Vijayan '475 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed

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disclosures were well-known at the time the application leading to the '450 patent was filed. Specifically:

- Wu '009, Park '274, Agrawal '825, Laroia '005, Vijayan '089, Vijayan '475, IEEE 802.16-2004, Laroia '429, Wu '345, Lane '481, Parikh '647, Holmes '624, Chang '123, and Park '148 are all directed to systems and methods for recovering information in a wireless packet system using various forms of resource allocation information. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Vijayan '475 and Wu '009**: Wu '009 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wu '009 teaches and describes that there "is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service." Wu '009 at 1:56-61. And it discloses "a technique for scheduling data, and in particular, scheduling real-time or Voice data for transmissions during a transmit time interval in a multi-carrier communication environment." *Id.* at Abstract. Vijayan '475 describes an OFDM communication system with base stations and wireless

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devices. Vijayan '475 at ¶¶26-27, 67-75. To allocate resources for a communication segment, Vijayan '475 uses "slots" defined on a time-frequency plane. *Id.* at FIG. 4, ¶¶36-42, 45-49, 56-57. To specify the particular slots of the segment, Vijayan '475 uses "Start Offset" and "Slot Info" parameters to identify a "Start Slot." *Id.* at ¶¶40, 42, 45-47, 56. Vijayan '475 also uses a "Stream Lengths" parameter to define the "number of slots allocated." *Id.* at ¶¶40, 45, 51-52, 54-55. Vijayan '475 describes an encoding mechanism for these parameters to "reduce the number of bits needed to convey this information" and therefore reduce the amount of overhead signaling needed. Id. at ¶¶38, 46, 55. In this manner, Vijayan '475 describes the optimization of allocating resources for communications such as those described in Wu '009. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Vijayan '475 with Wu '009 at least because Wu '009 provides a method for using resource allocation techniques (such as those disclosed in Vijayan '475) in order to accommodate voice traffic while optimizing system resources and maintaining a desired quality of service.

- **Vijayan '475 and Park '274**: Park '274 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Park '274 teaches and describes "[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an

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Orthogonal Frequency Division Multiple Access wireless network system." Park '274 at Abstract. "The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit." *Id.* One goal of Park '274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load "when indicating resource allocation information," *id.* at [0032]. Vijayan '475 describes an OFDM communication system with base stations and wireless devices. Vijayan '475 at ¶¶26-27, 67-75. To allocate resources for a communication segment, Vijayan '475 uses "slots" defined on a time-frequency plane. *Id.* at FIG. 4, ¶¶36-42, 45-49, 56-57. To specify the particular slots of the segment, Vijayan '475 uses "Start Offset" and "Slot Info" parameters to identify a "Start Slot." *Id.* at ¶¶40, 42, 45-47, 56. Vijayan '475 also uses a "Stream Lengths" parameter to define the "number of slots allocated." *Id.* at ¶¶40, 45, 51-52, 54-55. Vijayan '475 describes an encoding mechanism for these parameters to "reduce the number of bits needed to convey this information" and therefore reduce the amount of overhead signaling needed. Id. at ¶¶38, 46, 55. In this manner, Vijayan '475 describes the optimization of allocating resources for communications such as those described in Park '274. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Vijayan '475

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with Park ’274 at least because Park ’274 provides a method for using resource allocation techniques (such as those disclosed in Vijayan ’475) in order to optimize system resource allocation and reduce overhead signaling in a multiple-access communication system.

- **Vijayan ’475 and Agrawal ’825**: Agrawal ’825 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Agrawal ’825 teaches and describes “a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system.” Agrawal ’825 at 1:52-54. According to Agrawal ’825, “[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system,” which “utilizes orthogonal frequency division multiplexing (OFDM), which itself “is a multi-carrier modulation technique.” *Id.* at 2:60-3:1. The “shared signaling channel may” have fixed parameters, including “resource allocation,” which may be sent from the base station to the terminals. *Id.* at 6:15-26. Agrawal ’825 teaches that its “shared signaling channel” provides for an improved means of transmitting signaling in a multiple-access communication system. Vijayan ’475 describes an OFDM communication system with base stations and wireless devices. Vijayan ’475 at ¶¶26-27, 67-75. To allocate resources for a communication segment, Vijayan ’475 uses “slots” defined on a time-frequency plane. *Id.* at FIG. 4, ¶¶36-42, 45-49, 56-57. To specify the particular slots of the segment, Vijayan ’475 uses “Start Offset” and “Slot Info” parameters to identify a “Start Slot.” *Id.* at ¶¶40,

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42, 45-47, 56. Vijayan '475 also uses a "Stream Lengths" parameter to define the "number of slots allocated." *Id.* at ¶¶40, 45, 51-52, 54-55. Vijayan '475 describes an encoding mechanism for these parameters to "reduce the number of bits needed to convey this information" and therefore reduce the amount of overhead signaling needed. Id. at ¶¶38, 46, 55. In this manner, Vijayan '475 describes the optimization of allocating resources for communications such as those described in Agrawal '825. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Vijayan '475 with Agrawal '825 at least because Agrawal '825 provides a method for using resource allocation techniques (such as those disclosed in Vijayan '475) in order to optimize system resource allocation and reduce overhead signaling in a multiple-access communication system.

- **Vijayan '475 and Laroia '005**: Laroia '005 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Laroia '005 "relates to methods and apparatus for efficient use of air link resources for signaling, and more particularly to methods and apparatus for efficient superposition signaling in a wireless communications system." Laroia '456 at 1:14-17. According to Laroia ' 005, "a need exists for more efficient apparatus and methods to use air link resources for downlink traffic channel signaling in wireless communications systems supporting a plurality of users

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with a wide range of varying resource needs." *Id*. at 2:34-38. One solution includes allocating resources to minimum transmission units based on modulation symbols in an OFDM multiple access wireless communication system using superposition signaling in the downlink. E.g., *id*. at Abstract, 4:57-63 Vijayan '475 describes an OFDM communication system with base stations and wireless devices. Vijayan '475 at ¶¶26-27, 67-75. To allocate resources for a communication segment, Vijayan '475 uses "slots" defined on a time-frequency plane. *Id.* at FIG. 4, ¶¶36-42, 45-49, 56-57. To specify the particular slots of the segment, Vijayan '475 uses "Start Offset" and "Slot Info" parameters to identify a "Start Slot." *Id.* at ¶¶40, 42, 45-47, 56. Vijayan '475 also uses a "Stream Lengths" parameter to define the "number of slots allocated." *Id.* at ¶¶40, 45, 51-52, 54-55. Vijayan '475 describes an encoding mechanism for these parameters to "reduce the number of bits needed to convey this information" and therefore reduce the amount of overhead signaling needed. Id. at ¶¶38, 46, 55. In this manner, Vijayan '475 describes the optimization of allocating resources for communications such as those described in Laroia '005. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Vijayan '475 with Laroia '005 at least because Laroia '005 provides a method for using resource allocation techniques (such as those

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disclosed in Vijayan ’475) in order to optimize system resource allocation and reduce overhead signaling in a multiple-access communication system.

- **Vijayan ’475 and Vijayan ’089**: Vijayan ’089 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Vijayan ’089 teaches and describes an OFDM communication system with base stations and wireless devices. Vijayan ’089 at ¶¶36-37, 46-47, 107-111. Vijayan ’089 also describes organizing groups of subcarriers into transmission units or “transmission slots.” *Id.* at ¶¶56, 59. An assigned communication segment may then be specified by two parameters: the start of the segment (which may be given by the starting subband and symbol period) and the length of the segment.” *Id.* at ¶74. Assigning transmission slots in this way “reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC.” *Id.* at ¶76. Vijayan ’475 describes an OFDM communication system with base stations and wireless devices. Vijayan ’475 at ¶¶26-27, 67-75. To allocate resources for a communication segment, Vijayan ’475 uses “slots” defined on a time-frequency plane. *Id.* at FIG. 4, ¶¶36-42, 45-49, 56-57. To specify the particular slots of the segment, Vijayan ’475 uses “Start Offset” and “Slot Info” parameters to identify a “Start Slot.” *Id.* at ¶¶40, 42, 45-47, 56. Vijayan ’475 also uses a “Stream Lengths” parameter to define the “number of slots allocated.” *Id.* at ¶¶40, 45, 51-52, 54-55. Vijayan ’475 describes an encoding mechanism for these parameters to “reduce the number of bits needed to convey this information” and therefore reduce the amount of overhead signaling needed. Id. at ¶¶38, 46, 55. In this manner, Vijayan ’475 describes

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the optimization of allocating resources for communications such as those described in Vijayan '089. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved resource allocation techniques. It would have been obvious for a POSITA to combine Vijayan '089 with Vijayan '475 at least because Vijayan '089 provides a method for using resource allocation techniques (such as those disclosed in Vijayan '475) in order to optimize system resource allocation and reduce overhead signaling in a multiple-access communication system.

- **Vijayan '475 and IEEE 802.16-2004**: IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a

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"two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. IEEE802.16-2004 and Vijayan '475 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. A POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Vijayan '475. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Vijayan '475 system would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Vijayan '475's system), ready for improvement to yield predictable results.

- **Vijayan '475 and Laroia '429**: Laroia '429 describes an OFDM system where base stations service respective cells and communicate messages to wireless terminals within respective cells. Laroia '429 at ¶¶38, 40, 53, 65, 109-111. To identify a particular wireless terminal to receive a transmitted message, Laroia describes its base station assigning specific wireless terminal identifications ("base station assigned ID") to the wireless terminals that it is servicing. *Id.* at ¶¶38, 40. The "WT identification information" may allow a wireless terminal to identify that it "is the specific intended recipient" for a particular message. *Id.* at ¶¶40, 53. Vijayan '475 suggests the use of an identifier by describing the transmission of data to a "specific wireless device" when performing "unicast" communications. Vijayan '475 at ¶¶5, 25-26. To implement unicast

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transmissions or to communicate data to a specific wireless device, a POSITA would have found it obvious to use an identifier to specifically identify that wireless device. This process was ubiquitous in wireless communications and OFDM systems when delivering data or messages to intended recipient devices. Thus, a POSITA would have recognized that combining Vijayan '475 and Laroia '429 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Laroia '429's wireless terminal identification information with Vijayan 475's system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Laroia '429 with Vijayan '475 would improve the functionality of Vijayan 475's base stations and wireless devices by allowing the base stations to discern between different wireless devices. As previously explained, Vijayan '475 describes transmitting data to a "specific wireless device" when performing "unicast" communications. Vijayan '475 at ¶¶5, 25-26. A POSITA would have therefore found it obvious to implement Laroia '429's wireless terminal identification to facilitate these unicast communications and direct communications to specific wireless devices.

- **Vijayan '475 and Wu '345**: Wu '345 describes an OFDM system where base stations communicate messages to wireless devices ("user equipment" or "UE"). Wu '345 at Abstract, ¶¶33-34, 87, 94, 98. In order to identify a particular wireless device to receive a transmitted OFDM message, Wu '345 describes its base station assigning a "sixteen bit UE identifier 165" to each UE. *Id.* at ¶¶94, 98. Wu '345's base station assigns and uses the UE identifier when identifying

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to receivers "which OFDM slots and/or which CDMA slots are for a given receiver." *Id.* at ¶¶20-21, 94. Vijayan '475 suggests the use of an identifier by describing the transmission of data to a "specific wireless device" when performing "unicast" communications. Vijayan '475 at ¶¶5, 25-26. To implement unicast transmissions or to communicate data to a specific wireless device, a POSITA would have found it obvious to use an identifier to specifically identify that wireless device. This process was ubiquitous in wireless communications and OFDM systems when delivering data or messages to intended recipient devices. Thus, a POSITA would have recognized that combining Vijayan '475 and Wu '345 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Wu '345's UE identifier with Vijayan 475's system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Wu '345 with Vijayan '475 would improve the functionality of Vijayan 475's base stations and wireless devices by allowing the base stations to discern between different wireless devices. As previously explained, Vijayan '475 describes transmitting data to a "specific wireless device" when performing "unicast" communications. Vijayan '475 at ¶¶5, 25-26. A POSITA would have therefore found it obvious to implement Wu '345's UE identifier to facilitate these unicast communications and direct communications to specific wireless devices.

- **Vijayan '475 and Lane '481**: Lane '481 describes a wireless terminal identifier that is "assigned by the BS being used as the WTs point of network attachment."

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Lane ’481 at ¶¶43, 55, 67. “[T]he WT having been accepted by the new terrestrial base station, receives a base station assigned wireless terminal user identifier” and receives and identifies data using this identifier. A POSITA would have recognized that combining Vijayan ’475 and Lane ’481 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Lane ’481’s wireless terminal identification information with Vijayan 475’s system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Lane ’481 with Vijayan ’475 would improve the functionality of Vijayan 475’s base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan ’475 describes transmitting data to “specific wireless devices” when performing “unicast” communications. Vijayan ’475 at ¶¶5, 25-26. A POSITA would have found it obvious to implement Lane ’481’s wireless terminal identification to facilitate these unicast communications and direct communications to specific wireless devices.

- **Vijayan ’475 and Parikh ’647**: Parikh ’647 describes the use a “mobile station identifier” for connecting mobile stations to wireless networks. Parikh at ¶¶3, 8. Examples include a “conventional identifier, such as an Electronic Serial Number (ESN), a User Identity Module (UIM) ID, a Subscriber Identity Module (SIM) ID, or a Mobile Equipment Identifier (MEID), or the like.” *Id.*, at ¶3. A POSITA would have recognized that combining Vijayan ’475 and Parikh ’647 would have amounted to combining well-known prior art elements

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to yield predictable results. A POSITA would have applied Parikh '647's mobile station identifier with Vijayan 475's system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Parikh '647 with Vijayan '475 would improve the functionality of Vijayan 475's base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan '475 describes transmitting data to a "specific wireless device" when performing "unicast" communications. Vijayan '475 at ¶¶5, 25-26. A POSITA would have found it obvious to implement Parikh '647's mobile station identifier to facilitate these unicast communications and direct communications to specific wireless devices.

- **Vijayan '475 and Holmes '624**: Holmes '624 describes using a "Temporary Mobile Station Identification (TMSI)" to identify a mobile station. Holmes '624 at Abstract. The TMSI is a number assigned to the mobile station and that is used to "voice or data communications." *Id.* at 2:61-3:16. A POSITA would have recognized that combining Vijayan '475 and Holmes '624 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Holmes '624's TMSI with Vijayan 475's system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Holmes '624 with Vijayan '475 would improve the functionality of Vijayan 475's base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan '475 describes transmitting data to a "specific wireless device"

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when performing "unicast" communications. Vijayan '475 at ¶¶5, 25-26. A POSITA would have found it obvious to implement Holmes '624's TMSI to facilitate these unicast communications and direct communications to specific wireless devices.

- **Vijayan '475 and Chang '123**: Chang '123 describes "CIDs (Connection Identifiers) assigned from the current serving BS." Chang '123 at ¶¶2-5. Example CIDs may include "a basic CID, primary management CID, secondary management CID and transport CID." *Id.* A mobile terminal can determine whether its own Basic CID (or BCID) has been included in a message to wake up from sleep mode and to process the message. *Id.* at ¶¶9-13, 44. A POSITA would have recognized that combining Vijayan '475 and Chang '123 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Chang '123's CID and/or BCID techniques with Vijayan 475's system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Chang '123 with Vijayan '475 would improve the functionality of Vijayan 475's base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan '475 describes transmitting data to "specific wireless devices" when performing "unicast" communications. Vijayan '475 at ¶¶5, 25-26. A POSITA would have found it obvious to implement Chang '123's CID and/or BCID techniques to facilitate these unicast communications and direct communications to specific wireless devices.

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- **Vijayan ’475 and Park ’148**: Park ’148 describes a base station using a “BCID assigned to subscriber terminals” to managing terminal sleep states. Park ’148 at Abstract, ¶¶2-8. When a subscriber terminal receives a message, the subscriber terminal “determines whether or not its own basic CIDs (BCIDs) are included in the [] message and then determines whether or not to awake[n] [from] the sleep mode.” *Id.* at ¶¶12-13, 53. If the BCID for the subscriber terminal is not present, the terminal returns to sleep mode. *Id.* A POSITA would have recognized that combining Vijayan ’475 and Park ’148 would have amounted to combining well-known prior art elements to yield predictable results. A POSITA would have applied Park ’148’s BCID techniques with Vijayan 475’s system to allow its wireless devices to differentiate and identify its own respective messages for reception. Combining Park ’148 with Vijayan ’475 would improve the functionality of Vijayan 475’s base stations and wireless devices by allowing the base stations to discern between different wireless devices. Vijayan ’475 describes transmitting data to “specific wireless devices” when performing “unicast” communications. Vijayan ’475 at ¶¶6-7, 35. A POSITA would have found it obvious to implement Park ’148’s BCID techniques to facilitate these unicast communications and direct communications to specific wireless devices.

(vi) Laroia ’005 in combination with the knowledge of a skilled artisan, Wu ’009, Park ’274, Agrawal ’825, and/or IEEE 802.16-2004

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Laroia ’005 with each of these

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references. A person of ordinary skill in the art would have found it obvious to combine Laroia '005 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '450 patent was filed. Specifically:

- Wu '009, Park '274, Agrawal '825, Laroia '005, and IEEE 802.16-2004 are all directed to systems and methods for recovering information in a wireless packet system using various forms of resource allocation information. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Laroia '005 and Wu '009**: Wu '009 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wu '009 teaches and describes that there "is a need to control allocation and assignment

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of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service." Wu '009 at 1:56-61. And it discloses a "a technique for scheduling data, and in particular, scheduling real-time or Voice data for transmissions during a transmit time interval in a multi-carrier communication environment." *Id.* at Abstract. Laroia '005 "relates to methods and apparatus for efficient use of air link resources for signaling, and more particularly to methods and apparatus for efficient superposition signaling in a wireless communications system." Laroia '005 at 1:14-17. According to Laroia '005, "a need exists for more efficient apparatus and methods to use air link resources for downlink traffic channel signaling in wireless communications systems supporting a plurality of users with a wide range of varying resource needs." *Id.* at 2:34-38. One solution includes allocating resources to minimum transmission units based on modulation symbols in an OFDM multiple access wireless communication system using superposition signaling in the downlink. *E.g.*, *id.* at Abstract, 4:57-63. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Laroia '005 with Wu '009 at least because Wu '009 provides a method for using resource allocation techniques (such as those disclosed in Laroia '005) in order to accommodate voice traffic while optimizing system resources and maintaining a desired quality of service.

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- **Laroia ’005 and Park ’274**: Park ’274 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Park ’274 teaches and describes “[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system.” Park ’274 at Abstract. “The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit.” *Id.* One goal of Park ’274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load “when indicating resource allocation information,” *id.* at [0032]. Laroia ’005 “relates to methods and apparatus for efficient use of air link resources for signaling, and more particularly to methods and apparatus for efficient superposition signaling in a wireless communications system.” Laroia ’005 at 1:14-17. According to Laroia ’005, “a need exists for more efficient apparatus and methods to use air link resources for downlink traffic channel signaling in wireless communications systems supporting a plurality of users with a wide range of varying resource needs.” *Id.* at 2:34-38. One solution includes allocating resources to minimum transmission units based on modulation symbols in an OFDM multiple access wireless communication system using superposition signaling in the downlink. *E.g.*, *id.* at Abstract, 4:57-63. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier

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communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Laroia '005 with Park '274 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Laroia '005 and Agrawal '825**: Agrawal '825 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Agrawal '825 teaches and describes "a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system." Agrawal '825 at 1:52-54. According to Agrawal '825, "[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system," which "utilizes orthogonal frequency division multiplexing (OFDM), which itself "is a multi-carrier modulation technique." *Id.* at 2:60-3:1. The "shared signaling channel may" have fixed parameters, including "resource allocation," which may be sent from the base station to the terminals. *Id.* at 6:15-26. Agrawal '825 teaches that its "shared signaling channel" provides for an improved means of transmitting signaling in a multiple-access communication system. Laroia '005 "relates to methods and apparatus for efficient use of air link resources for signaling, and more particularly to methods and apparatus for efficient superposition signaling in a wireless communications system." Laroia '005 at 1:14-17. According to Laroia '005, "a need exists for more efficient apparatus and methods to use air

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link resources for downlink traffic channel signaling in wireless communications systems supporting a plurality of users with a wide range of varying resource needs." *Id.* at 2:34-38. One solution includes allocating resources to minimum transmission units based on modulation symbols in an OFDM multiple access wireless communication system using superposition signaling in the downlink. *E.g.*, *id.* at Abstract, 4:57-63. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Laroia '005 with Agrawal '825 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Laroia '005 and IEEE 802.16-2004**: IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA

symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. IEEE802.16-2004 and Laroia '005 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. A POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Laroia '005. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Laroia '005's network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Laroia '005's network), ready for improvement to yield predictable results.

(vii) Ma '407 in combination with the knowledge of a skilled artisan, Park '274, Agrawal '825, Teague '465, and/or IEEE 802.16-2004

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Ma '407 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Ma '407 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try

and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '450 patent was filed. Specifically:

- Ma '407, Park '274, Agrawal '825, Teague '465, and IEEE 802.16-2004 are all directed to systems and methods for recovering information in a wireless packet system using various forms of resource allocation information. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Ma '407 and Park '274**: Park '274 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Park '274 teaches and describes "[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system." Park '274 at Abstract. "The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a

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predetermined allocation unit." *Id.* One goal of Park '274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load "when indicating resource allocation information," *id.* at [0032]. Ma '407 "relates the field of wireless communications, more specifically to systems and methods employing orthogonal frequency division multiplexed (OFDM) transmission." Ma '407 at 1:15-18. According to Ma '407, "problems related to noise enhancement can be avoiding during signal processing at the receiver" through the use MIMO transmission schemes that are "easily implemented" on OFDM which "allows for flexible and efficient pilot designs." *Id.* at 1:42-48. Ma '407 further teaches transmitting different OFDM symbols such that the same frequency indexes are used for pilots and data for each user transmitting on a transmission band. *E.g.*, *id.* at 13:24-67. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Ma '407 with Park '274 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Ma '407 and Agrawal '825**: Agrawal '825 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Agrawal '825 teaches and describes "a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system." Agrawal '825 at 1:52-54. According to Agrawal

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’825, “[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system,” which “utilizes orthogonal frequency division multiplexing (OFDM), which itself “is a multi-carrier modulation technique.” *Id.* at 2:60-3:1. The “shared signaling channel may” have fixed parameters, including “resource allocation,” which may be sent from the base station to the terminals. *Id.* at 6:15-26. Ma ’407 “relates the field of wireless communications, more specifically to systems and methods employing orthogonal frequency division multiplexed (OFDM) transmission.” Ma ’407 at 1:15-18. According to Ma ’407, “problems related to noise enhancement can be avoiding during signal processing at the receiver” through the use MIMO transmission schemes that are “easily implemented” on OFDM which “allows for flexible and efficient pilot designs.” *Id.* at 1:42-48. Ma ’407 further teaches transmitting different OFDM symbols such that the same frequency indexes are used for pilots and data for each user transmitting on a transmission band. *E.g.*, *id.* at 13:24-67. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Ma ’407 with Agrawal ’825 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

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- **Ma ’407 and Teague ’465**: Teague ’465 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Teague ’465 teaches and describes “reducing interference in a wireless communications environment.” Teague ’465 at 1:15-17. According to Teague ’465, “a need exists in the art for systems and methods that facilitate allocating resources in a wireless communication environment in order to improve system throughput and enhance user experience.” *Id.* at 1:49-52. Teague ’465 teaches employing various protocols to ensure that a conflicted resource resumes on a next logical resource depending on per-assigned resource parameter and a static system-wide parameters. *Id.* at 3:59-3:8. Ma ’407 “relates the field of wireless communications, more specifically to systems and methods employing orthogonal frequency division multiplexed (OFDM) transmission.” Ma ’407 at 1:15-18. According to Ma ’407, “problems related to noise enhancement can be avoiding during signal processing at the receiver” through the use MIMO transmission schemes that are “easily implemented” on OFDM which “allows for flexible and efficient pilot designs.” *Id.* at 1:42-48. Ma ’407 further teaches transmitting different OFDM symbols such that the same frequency indexes are used for pilots and data for each user transmitting on a transmission band. *E.g.*, *id.* at 13:24-67. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Ma ’407 with Teague ’465 at least because doing so provides an improved

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means of resource allocation and signaling in a multiple-access communication system.

- **Ma '407 and IEEE 802.16-2004**: IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. IEEE802.16-2004 and Ma '407 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. A POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Ma '407. Furthermore, a

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POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Ma '407'a network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Ma '407's network), ready for improvement to yield predictable results.

(viii) Teague '465 in combination with the knowledge of a skilled artisan, Wu '009, Park '274, Agrawal '825, Ma '407, and/or IEEE 802.16-2004

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Teague '465 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Teague '465 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '450 patent was filed. Specifically:

- Teague '465, Wu '009, Park '274, Agrawal '825, Ma '407, and IEEE 802.16-2004 are all directed to systems and methods for recovering information in a wireless packet system using various forms of resource allocation information. For example, they relate to wireless communications, and in particular to

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signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Teague '465 and Wu '009**: Wu '009 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wu '009 teaches and describes that there "is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service." Wu '009 at 1:56-61. And it discloses a "a technique for scheduling data, and in particular, scheduling real-time or Voice data for transmissions during a transmit time interval in a multi-carrier communication environment." *Id.* at Abstract. For example, Teague '465 discusses the need to permit transmission/reception of information streams associated with, but not limited to, voice information and audio data. *Id.* at 8:8-17. Teague '465 teaches employing various protocols to ensure that a conflicted resource resumes on a next logical resource depending on per-assigned resource parameter and a static system-wide parameters. *Id.* at 3:59-3:8. Wu '009 teaches that there "is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service." Wu '009 at 1:56-61. Thus, these references were in the same field of endeavor, and shared the same

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fundamental goal of improving data transmissions (e.g., signaling) in multi-carrier communications environments using improved allocation techniques. It would have been obvious for a POSITA to combine Teague '465 with Wu '009 at least because they both provide a method for using resource allocation techniques in order to accommodate voice traffic while optimizing system resources and maintaining a desired quality of service.

- **Teague '465 and Park '274**: Park '274 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Park '274 teaches and describes "[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system." Park '274 at Abstract. "The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit." *Id.* One goal of Park '274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load "when indicating resource allocation information," *id.* at [0032]. Teague '465 teaches and describes "reducing interference in a wireless communications environment." Teague '465 at 1:15-17. According to Teague '465, "a need exists in the art for systems and methods that facilitate allocating resources in a wireless communication environment in order to improve system throughput and enhance user experience." *Id.* at 1:49-52. Teague '465 teaches employing various protocols to ensure that a conflicted resource resumes on a next logical

resource depending on per-assigned resource parameter and a static system-wide parameters. *Id.* at 3:59-3:8. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Teague '465 with Park '274 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Teague '465 and Agrawal '825**: Agrawal '825 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Agrawal '825 teaches and describes "a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system." Agrawal '825 at 1:52-54. According to Agrawal '825, "[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system," which "utilizes orthogonal frequency division multiplexing (OFDM), which itself "is a multi-carrier modulation technique." *Id.* at 2:60-3:1. The "shared signaling channel may" have fixed parameters, including "resource allocation," which may be sent from the base station to the terminals. *Id.* at 6:15-26. Teague '465 teaches and describes "reducing interference in a wireless communications environment." Teague '465 at 1:15-17. According to Teague '465, "a need exists in the art for systems and methods that facilitate allocating resources in a wireless communication environment in

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order to improve system throughput and enhance user experience." *Id.* at 1:49-52. Teague '465 teaches employing various protocols to ensure that a conflicted resource resumes on a next logical resource depending on per-assigned resource parameter and a static system-wide parameters. *Id.* at 3:59-3:8. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Teague '465 with Agrawal '825 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Teague '465 and Ma '407**: Ma '407 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '407 "relates the field of wireless communications, more specifically to systems and methods employing orthogonal frequency division multiplexed (OFDM) transmission." Ma '407 at 1:15-18. According to Ma '407, "problems related to noise enhancement can be avoiding during signal processing at the receiver" through the use MIMO transmission schemes that are "easily implemented" on OFDM which "allows for flexible and efficient pilot designs." *Id.* at 1:42-48. Ma '407 further teaches transmitting different OFDM symbols such that the same frequency indexes are used for pilots and data for each user transmitting on a transmission band. *E.g.*, *id.* at 13:24-67. Teague '465 teaches and describes "reducing interference in a wireless communications environment." Teague '465 at 1:15-17. According to Teague '465, "a need exists in the art for

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systems and methods that facilitate allocating resources in a wireless communication environment in order to improve system throughput and enhance user experience." *Id.* at 1:49-52. Teague '465 teaches employing various protocols to ensure that a conflicted resource resumes on a next logical resource depending on per-assigned resource parameter and a static system-wide parameters. *Id.* at 3:59-3:8. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. It would have been obvious for a POSITA to combine Teague '465 with Ma '407 at least because doing so provides an improved means of resource allocation and signaling in a multiple-access communication system.

- **Teague '465 and IEEE 802.16-2004**: IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA

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symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. IEEE802.16-2004 and Teague '465 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. A POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Teague '465. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Teague '465's network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Teague '465's network), ready for improvement to yield predictable results.

(ix) IEEE 802.16-2004 in combination with the knowledge of a skilled artisan, Wu '009, Park '274, Laroia '005, Agrawal '825, Vijayan '089, Vijayan '475, Ma '407, and/or Teague '465

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine IEEE 802.16-2004 with each of these references. A person of ordinary skill in the art would have found it obvious to combine IEEE 802.16-2004 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite

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number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '450 patent was filed. Specifically:

- IEEE 802.16-2004, Wu '009, Park '274, Laroia '005, Agrawal '825, Vijayan '089, Vijayan '475, Ma '407, and Teague '465 are all directed to systems and methods for recovering information in a wireless packet system using various forms of resource allocation information. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **IEEE 802.16-2004 and Wu '009**: Wu '009 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Wu '009 teaches and describes that there "is a need to control allocation and assignment of OFDM carriers to accommodate voice traffic, while optimizing system resources and maintaining a desired quality of service." Wu '009 at 1:56-61. And it discloses a "a technique for scheduling data, and in particular,

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scheduling real-time or Voice data for transmissions during a transmit time interval in a multi-carrier communication environment." *Id.* at Abstract. Wu '009 further teaches that its invention will provide support for voice services in systems using the 802.16 communication standard. Wu '009 at 1:45-2:31. IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." Id. at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). Id. at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." Id. at 532 (§8.4.3.1), Fig. 215. A POSITA would have understood that IEEE802.16-2004 consolidates IEEE Std 802.16, IEEE Std 802.16a, and IEEE Std 802.16c, retaining all modes and major features without adding modes. Wu '009 describes the optimization of allocating resources for communications such as those described in

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IEEE802.16-2004. Therefore, a POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Wu '009. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Wu '009's network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Wu '009's network based on the IEEE 802.16 standard), ready for improvement to yield predictable results.

- **IEEE 802.16-2004 and Park '274**: Park '274 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Park '274 teaches and describes "[a] method for discretely indicating resource allocation information regardless of previous resource allocation information in an Orthogonal Frequency Division Multiple Access wireless network system." Park '274 at Abstract. "The method includes the steps of . . . indicating resource information allocated to each terminal of the OFDMA wireless network system based on predetermined allocation unit information and an index value of a predetermined allocation unit." *Id.* One goal of Park '274 is to maintain flexibility of resource allocation, *id.* at [0028], [0031], and to reduce load "when indicating resource allocation information," *id.* at [0032]. Park '274 further teaches that its invention will apply using the 802.16-2004 standard. *E.g.*, Park '274 at [0007], [0013], [0014], [0017], [0018], [0036], [0037], [0073], [0075], [0076], [0077], [0078], [0079], [0085]. IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium

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access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. Park '274 describes the optimization of allocating resources for communications such as those described in IEEE802.16-2004. Therefore, a POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Park '274. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Park '274's network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Park '274's network based on the IEEE 802.16 standard), ready for improvement to yield predictable results.

- **IEEE 802.16-2004 and Laroia '005**: Laroia '005 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference.

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Laroia '005 "relates to methods and apparatus for efficient use of air link resources for signaling, and more particularly to methods and apparatus for efficient superposition signaling in a wireless communications system." Laroia '005 at 1:14-17. According to Laroia '005, "a need exists for more efficient apparatus and methods to use air link resources for downlink traffic channel signaling in wireless communications systems supporting a plurality of users with a wide range of varying resource needs." *Id.* at 2:34-38. One solution includes allocating resources to minimum transmission units based on modulation symbols in an OFDM multiple access wireless communication system using superposition signaling in the downlink. *E.g.*, *id.* at Abstract, 4:57-63. IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data

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region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. IEEE802.16-2004 and Laroia '005 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. Laroia '005 describes the allocating resources efficiently for communications such as those described in IEEE802.16-2004. Therefore, a POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Laroia '005. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Laroia '005's network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Laroia '005's network), ready for improvement to yield predictable results.

- **IEEE 802.16-2004 and Agrawal '825**: Agrawal '825 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Agrawal '825 teaches and describes "a shared signaling channel capable of efficiently carrying various types of signaling for terminals in a multiple-access communication system." Agrawal '825 at 1:52-54. According to Agrawal '825, "[t]he shared signaling channel . . . may be used for various communication systems such as an Orthogonal Frequency Division Multiple Access (OFDMA) system," which "utilizes orthogonal frequency division multiplexing (OFDM), which itself "is a multi-carrier modulation technique." *Id.* at 2:60-3:1. The "shared signaling channel may" have fixed parameters,

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including "resource allocation," which may be sent from the base station to the terminals. *Id.* at 6:15-26. IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. Agrawal '825 describes allocating resources efficiently for communications such as those described in IEEE802.16-2004. IEEE802.16-2004 and Agrawal '825 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. Therefore, POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Agrawal '825.

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Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Agrawal '825's network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Agrawal '825's network), ready for improvement to yield predictable results.

- **Vijayan '089 and IEEE 802.16-2004**: Vijayan '089 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Vijayan '089 teaches and describes an OFDM communication system with base stations and wireless devices. Vijayan '089 at ¶¶36-37, 46-47, 107-111. Vijayan '089 also describes organizing groups of subcarriers into transmission units or "transmission slots." *Id.* at ¶¶56, 59. An assigned communication segment may then be specified by two parameters: the start of the segment (which may be given by the starting subband and symbol period) and the length of the segment." *Id.* at ¶74. Assigning transmission slots in this way "reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC." *Id.* at ¶76. IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain

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"subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. Vijayan '089 describes the optimization of allocating resources for communications such as those described in 1EEE802.16-2004. IEEE802.16-2004 and Vijayan '089 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. Therefore, POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Vijayan '089. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Vijayan '089 system would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Vijayan '089's system), ready for improvement to yield predictable results.

- **Vijayan '475 and IEEE 802.16-2004**: Vijayan '475 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Vijayan '475 describes an OFDM communication system with base

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stations and wireless devices. Vijayan '475 at ¶¶26-27, 67-75. To allocate resources for a communication segment, Vijayan '475 uses "slots" defined on a time-frequency plane. *Id.* at FIG. 4, ¶¶36-42, 45-49, 56-57. To specify the particular slots of the segment, Vijayan '475 uses "Start Offset" and "Slot Info" parameters to identify a "Start Slot." *Id.* at ¶¶40, 42, 45-47, 56. Vijayan '475 also uses a "Stream Lengths" parameter to define the "number of slots allocated." *Id.* at ¶¶40, 45, 51-52, 54-55. Vijayan '475 describes an encoding mechanism for these parameters to "reduce the number of bits needed to convey this information" and therefore reduce the amount of overhead signaling needed. *Id.* at ¶¶38, 46, 55. IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of

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contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. Vijayan '475 describes the optimization of allocating resources for communications such as those described in IEEE802.16-2004. IEEE802.16-2004 and Vijayan '475 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. Therefore, POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Vijayan '475. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Vijayan '475 system would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Vijayan '475's system), ready for improvement to yield predictable results.

- **IEEE 802.16-2004 and Teague '465**: Teague '465 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Teague '465 teaches and describes "reducing interference in a wireless communications environment." Teague '465 at 1:15-17. According to Teague '465, "a need exists in the art for systems and methods that facilitate allocating resources in a wireless communication environment in order to improve system throughput and enhance user experience." *Id.* at 1:49-52. Teague '465 teaches employing various protocols to ensure that a conflicted resource resumes on a next logical resource depending on per-assigned resource parameter and a static system-wide parameters. *Id.* at 3:59-3:8. IEEE 802.16-

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2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. Teague '465 describes reducing interference in communications such as those described in IEEE802.16-2004. IEEE802.16-2004 and Teague '465 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. A POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Teague '465. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Teague '465's network

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would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Teague '465's network), ready for improvement to yield predictable results.

- **IEEE 802.16-2004 and Ma '407**: Ma '407 "relates the field of wireless communications, more specifically to systems and methods employing orthogonal frequency division multiplexed (OFDM) transmission." Ma '407 at 1:15-18. According to Ma '407, "problems related to noise enhancement can be avoiding during signal processing at the receiver" through the use MIMO transmission schemes that are "easily implemented" on OFDM which "allows for flexible and efficient pilot designs." *Id.* at 1:42-48. Ma '407 further teaches transmitting different OFDM symbols such that the same frequency indexes are used for pilots and data for each user transmitting on a transmission band. *E.g.*, *id.* at 13:24-67. IEEE 802.16-2004 is an IEEE Standard published on October 1, 2004. It teaches and describes a wireless communication standard that specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed broadband wireless access, BWA systems. IEEE802.16-2004 specifies a standard for a "base station (BS)" communicating with a "subscriber station (SS)." Title, 43 (definition 3.5), 47 (definition 3.56). The signaling structure consists of time domain "OFDMA symbol[s]" and frequency domain "subcarriers." *Id.* at 530 (§§8.4.2.1, 8.4.2.2). Resource allocation in IEEE802.16-2004 is based on a "minimum possible data allocation unit" which consists of "one slot" in time (each slot consisting of multiple OFDMA symbols) and "one subchannel" in frequency (each

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subchannel being a "subset" of subcarriers). *Id.* at 532 (§8.4.3.1), 530 (§8.4.2.2). Based on this "minimum possible data allocation unit," IEEE802.16-2004 specifies a "data region" as a "two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols." *Id.* at 532 (§8.4.3.1), Fig. 215. Ma '407 describes allocating resources efficiently for communications such as those described in IEEE802.16-2004. IEEE802.16-2004 and Ma '407 were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved resource allocation and signaling techniques. A POSITA would have understood that the teachings of IEEE802.16-2004 were directly applicable to Ma '407. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Ma '407'a network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Ma '407's network), ready for improvement to yield predictable results.

e. The '512 Patent

A person of ordinary skill in the art would have been motivated to combine or modify each piece of prior art identified in Sections III.B-E in such a way as to render the asserted claims of the '512 patent invalid. For example, Defendants identify at least the following grounds (and similar permutations based on the listed references) that render the asserted claims of the '512 patent invalid under 35 U.S.C. § 103:

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(i) Laroia ’902 in combination with the knowledge of a skilled artisan, Laroia ’594, Walton ’301, Kim ’618, Kim ’448, Ketchum ’627, Li ’879, Smee ‘007, Alamouti ’570, and/or Tong ’395

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Laroia ’902 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Laroia ’902 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’512 patent was filed. Specifically:

- Laroia’ 902, Laroia ’594, Walton ’301, Kim ’618, Kim ’448, Ketchum ’627, Li ’879, Smee, Alamouti ’570, and Tong ’395 are all directed to systems and methods for transmitting information in wireless multiple-access OFDM communication systems. For example, they relate to wireless communication, and in particular to channel and pilot structures used for mobile device communication. They involve communication protocols and standards, transmission methods (e.g., OFDMA, OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

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- **Laroia ’902 and Laroia ’594**: Laroia ’594 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. These references have overlapping inventors, similar disclosures, and solve similar problems. It woul have been obvious to combine these references, which were in the same field of endeavor and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved sectorization techniques and various forms of pilot signals.
- **Laroia ’902 and Walton ’301**: Walton ’301 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ’301 teaches and describes “[a] multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD.” Walton ’301 at Abstract. According to Walton ’301, the “system (1) uses a channel structure with a number of configurable transport channels, (2) supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities, (3) employs a pilot structure with several types of pilot (e.g., beacon, MIMO, steered reference, and carrier pilots) for different functions, (4) implements rate, timing, and power control loops for proper system operation, and (5) employs random access for system access by the user terminals, fast acknowledgment, and quick resource assignments.” *Id.* According to Walton ’301, its invention solves for a “need in the art for a MIMO WLAN system capable of supporting multiple users and providing high system performance.” *Id.* at 2:1-3. Laroia ’902 teaches that there is “a need for methods and apparatus which will allow sectorization to be used in OFDM systems in a manner that will improve the capacity of such systems

without many of the interference problems associated with sectorization." Laroia '902 at [0019]. To address this problem, Laroia '902 discusses the uses of "beacon signal" in a multi-carrier system which "may be used with minimal or no frequency synchronization between sectors of a cell." *Id.* at [0020]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved sectorization techniques and various forms of pilot signals. It would have been obvious for a POSITA to combine Laroia '902 with Walton '301 at least because Laroia '902 provides a method for using improved beacon signaling techniques (which can be applied to the MIMO WLAN systems of Walton '301) in order to improve communications and performance in a system capable of supporting more users.

- **Laroia '902 and Kim '618**: Kim '618 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kim teaches and describes an invention that "relates to a method for generating a structure of a preamble and a pilot appropriate for downlinks of an OFDMA (orthogonal frequency division multiplexing access)-based cellular system, performing synchronization, and searching cells at a terminal by using the structure." Kim '618 at 1:14-21. Laroia '902 teaches that there is "a need for methods and apparatus which will allow sectorization to be used in OFDM systems in a manner that will improve the capacity of such systems without many of the interference problems associated with sectorization." Laroia '902 at [0019]. To address this problem, Laroia '902 discusses the uses of "beacon signal" in a multi-carrier system which

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"may be used with minimal or no frequency synchronization between sectors of a cell." *Id.* at [0020]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Laroia '902 with Kim '618 at least because Laroia '902 provides a method for using improved beacon signaling techniques (which can be applied to other multi-carrier OFDM systems like Kim '618's) in order to improve communications and performance in a system capable of supporting more users.

- **Laroia '902 and Kim '448:** Kim '448 teaches "downlink signal configuring method and device, and synchronization and cell search method and device using the same" in "OFDMA-based cellular systems." Kim '448 at Abstract, 3:2-5. "A downlink frame has plural symbols into which pilot subcarriers are distributively arranged with respect to time and frequency axes." *Id*. at Abstract. Specifically, "a pilot symbol pattern proper for each cell is transmitted by a position set of pilot subcarriers [] proper for each cell." *Id*. at 16:3-11. Laroia '902 teaches that there is "a need for methods and apparatus which will allow sectorization to be used in OFDM systems in a manner that will improve the capacity of such systems without many of the interference problems associated with sectorization." Laroia '902 at [0019]. To address this problem, Laroia '902 discusses the uses of "beacon signal" in a multi-carrier system which "may be used with minimal or no frequency synchronization between sectors of a cell." *Id.* at [0020]. It would have been obvious to combine these references, which were in the same field of endeavor, and

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shared the same fundamental goal of improving data transmissions in multi-carrier communications environments.

- **Laroia '902 and Ketchum '627**: Ketchum '627 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ketchum '627 teaches and describes "[p]ilots suitable for use in MIMO systems and capable of supporting various functions," where the various types of pilots include "a beacon pilot, a MIMO pilot, a steered reference or steered pilot, and a carrier pilot." Ketchum '627 at Abstract. Laroia '902 teaches that there is "a need for methods and apparatus which will allow sectorization to be used in OFDM systems in a manner that will improve the capacity of such systems without many of the interference problems associated with sectorization." Laroia '902 at [0019]. To address this problem, Laroia '902 discusses the uses of "beacon signal" in a multi-carrier system which "may be used with minimal or no frequency synchronization between sectors of a cell." *Id.* at [0020]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Laroia '902 with Ketchum '627 at least because Laroia '902 provides a method for using improved beacon signaling techniques (which can be applied to other multi-carrier OFDM systems like Ketchum '672's) in order to improve communications and performance in a system capable of supporting more users.
- **Laroia '902 and Li '879**: Li '879 teaches and describes a "method for subcarrier allocation and loading for a multi-carrier, multi-subscriber system" that can be

applied to OFDMA systems, where a carrier is corresponding to a cluster, containing multiple OFDM frequency subcarriers." Li '879 at Abstract, [0019]. Laroia '902 teaches that there is "a need for methods and apparatus which will allow sectorization to be used in OFDM systems in a manner that will improve the capacity of such systems without many of the interference problems associated with sectorization." Laroia '902 at [0019]. To address this problem, Laroia '902 discusses the uses of "beacon signal" in a multi-carrier system which "may be used with minimal or no frequency synchronization between sectors of a cell." *Id.* at [0020]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Laroia '902 with Li '879 at least because Laroia '902 provides a method for using improved beacon signaling techniques (which can be applied to other multi-carrier OFDM systems like Li '879's) in order to improve communications and performance in a system capable of supporting more users.

- **Laroia '902 and Smee '007**: Smee '007 discloses a wireless communication system where pilots from a transmitter assist the receiver in performing a number of functions such as channel estimation, timing and frequency acquisition, and coherent data demodulation. Smee '007 at [0007]. Laroia '902 teaches that there is "a need for methods and apparatus which will allow sectorization to be used in OFDM systems in a manner that will improve the capacity of such systems without many of the interference problems associated with sectorization." Laroia '902 at [0019]. To address this problem, Laroia '902 discusses the uses of "beacon signal"

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in a multi-carrier system which "may be used with minimal or no frequency synchronization between sectors of a cell." *Id.* at [0020]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. Because these references were in the same field of endeavor and shared the same fundamental goal of supporting various wireless system functions using different types of pilot signals, it would have been obvious for a POSITA to combine Laroia '902 and Smee '007.

- **Laroia '902 and Alamouti '570**: Alamouti '570 teaches and describes "improvements to communications systems and methods in a wireless, frequency division duplex communications system." Alamouti '570 at [0005]. However, Alamouti '570 notes that its invention "combines form of time division duplex (TDD), frequency division duplex (FDD), time division multiple access (TDMA), orthogonal frequency division multiplexing (OFDM), spatial diversity, and polarization diversity in various unique combinations." *Id.* at [0027]. "In one embodiment of the invention, TDD, FDD, TDMA, and OFDM are combined to enable a base station to efficiently communicate with many remote stations." *Id.* at [0028]. The method of Alamouti '570 involves the use of various discrete frequency tones. *E.g.*, *id.* at [0028]-[0034]. "Selected tones within each tone set are designated as pilots[.]" *Id.* at [0085]. Laroia '902 teaches that there is "a need for methods and apparatus which will allow sectorization to be used in OFDM systems in a manner that will improve the capacity of such systems without many of the interference problems associated with sectorization." Laroia '902 at [0019].

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To address this problem, Laroia '902 discusses the uses of "beacon signal" in a multi-carrier system which "may be used with minimal or no frequency synchronization between sectors of a cell." *Id.* at [0020]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Laroia '902 with Alamouti '570 at least because Laroia '902 provides a method for using improved beacon signaling techniques (which can be applied to other multi-carrier systems like Alamouti '570's) in order to improve communications and performance in a system capable of supporting more users, even when transmitting pilots to remote stations.

- **Laroia '902 and Tong '395**: Tong '395 teaches and describes an invention that "allows a wireless communication system, such as a base station, to select N antennas from an associated group of M antennas for transmitting multiple streams of data to a given user." Tong '395 at Abstract. Specifically, Tong '395 teaches that its invention "optimizes multiple-input multiple-output (MIMO) transmissions wherein there are more transmit antennas than receive antennas." *Id.* at 3:6-8. To do this, Tong '395 teaches "selectively choosing a select number of antennas within a larger array through which to transmit data to a receiver, as well as techniques for reinforcing transmitted signals using available antennas." *Id.* at 1:5-9. Laroia '902 teaches that there is "a need for methods and apparatus which will allow sectorization to be used in OFDM systems in a manner that will improve the capacity of such systems without many of the interference problems associated with sectorization." Laroia '902 at [0019]. To address this problem, Laroia '902

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discusses the uses of "beacon signal" in a multi-carrier system which "may be used with minimal or no frequency synchronization between sectors of a cell." *Id.* at [0020]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Laroia '902 with Tong '395 at least because Laroia '902 provides a method for using improved beacon signaling techniques (which can be applied to other multi-carrier OFDM systems like Tong '395's, which itself provides improved techniques for reinforcing transmitted signals) in order to improve communications and performance in a system capable of supporting more users.

(ii) Walton '301 in combination with the knowledge of a skilled artisan, Laroia '902, Laroia '594, Kim '618, Kim '448, Ketchum '627, Li '879, Smee '007, Alamouti '570, and/or Tong '395

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Walton '301 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Walton '301 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed

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disclosures were well-known at the time the application leading to the '512 patent was filed. Specifically:

- Laroia' 902, Laroia '594, Walton '301, Kim '618, Kim '448, Ketchum '627, Li '879, Smee '007, Alamouti '570, and Tong '395 are all directed to systems and methods for transmitting information in wireless multiple-access OFDM communication systems. For example, they relate to wireless communication, and in particular to channel and pilot structures used for mobile device communication. They involve communication protocols and standards, transmission methods (e.g., OFDMA, OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Walton '301 and Laroia '902**: Laroia '902 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Laroia '902 teaches that there is "a need for methods and apparatus which will allow sectorization to be used in OFDM systems in a manner that will improve the capacity of such systems without many of the interference problems associated with sectorization." Laroia '902 at [0019]. To address this problem, Laroia '902 discusses the uses of "beacon signal" in a multi-carrier system which "may be used with minimal or no frequency synchronization between sectors of a cell." *Id.* at [0020]. Walton '301 teaches and describes "[a] multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. According to Walton '301, the "system (1) uses a channel structure with a number of configurable transport channels, (2) supports multiple rates and transmission

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modes, which are configurable based on channel conditions and user terminal capabilities, (3) employs a pilot structure with several types of pilot (e.g., beacon, MIMO, steered reference, and carrier pilots) for different functions, (4) implements rate, timing, and power control loops for proper system operation, and (5) employs random access for system access by the user terminals, fast acknowledgment, and quick resource assignments." *Id.* According to Walton '301, its invention solves for a "need in the art for a MIMO WLAN system capable of supporting multiple users and providing high system performance." *Id.* at 2:1-3. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments using improved sectorization techniques and various forms of pilot signals. It would have been obvious for a POSITA to combine Walton '301 with Laroia '902 at least because Laroia '902 provides a method for using improved beacon signaling techniques (which can be applied to the MIMO WLAN systems of Walton '301) in order to improve communications and performance in a system capable of supporting more users.

- **Walton '301 and Kim '618**: Kim '618 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kim teaches and describes an invention that "relates to a method for generating a structure of a preamble and a pilot appropriate for downlinks of an OFDMA (orthogonal frequency division multiplexing access)-based cellular system, performing synchronization, and searching cells at a terminal by using the structure." Kim '618 at 1:14-21. Walton '301 teaches and describes "[a] multiple-access MIMO WLAN

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system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. According to Walton '301, the "system (1) uses a channel structure with a number of configurable transport channels, (2) supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities, (3) employs a pilot structure with several types of pilot (e.g., beacon, MIMO, steered reference, and carrier pilots) for different functions, (4) implements rate, timing, and power control loops for proper system operation, and (5) employs random access for system access by the user terminals, fast acknowledgment, and quick resource assignments." *Id.* According to Walton '301, its invention solves for a "need in the art for a MIMO WLAN system capable of supporting multiple users and providing high system performance." *Id.* at 2:1-3. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '301 with Kim '618 at least because Walton '301 provides a system capable of supporting multiple users and providing high system performance using multiple pilots, and Kim '618 provides an improved pilot structure.

- **Walton '301 and Kim '448:** Kim '448 teaches "downlink signal configuring method and device, and synchronization and cell search method and device using the same" in "OFDMA-based cellular systems." Kim '448 at Abstract, 3:2-5. "A downlink frame has plural symbols into which pilot subcarriers are distributively arranged with respect to time and frequency axes." *Id*. at Abstract. Specifically, "a pilot symbol pattern proper for each cell is transmitted by a position set of pilot

subcarriers [] proper for each cell." *Id*. at 16:3-11. Walton '301 teaches and describes "[a] multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. According to Walton '301, the "system (1) uses a channel structure with a number of configurable transport channels, (2) supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities, (3) employs a pilot structure with several types of pilot (e.g., beacon, MIMO, steered reference, and carrier pilots) for different functions, (4) implements rate, timing, and power control loops for proper system operation, and (5) employs random access for system access by the user terminals, fast acknowledgment, and quick resource assignments." *Id.* According to Walton '301, its invention solves for a "need in the art for a MIMO WLAN system capable of supporting multiple users and providing high system performance." *Id.* at 2:1-3. It would have been obvious to combine these references, which were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments.

- **Walton '301 and Ketchum '627**: Ketchum '627 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ketchum '627 teaches and describes "[p]ilots suitable for use in MIMO systems and capable of supporting various functions," where the various types of pilots include "a beacon pilot, a MIMO pilot, a steered reference or steered pilot, and a carrier pilot." Ketchum '627 at Abstract. Walton '301 teaches and describes "[a] multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD."

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Walton ’301 at Abstract. According to Walton ’301, the “system (1) uses a channel structure with a number of configurable transport channels, (2) supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities, (3) employs a pilot structure with several types of pilot (e.g., beacon, MIMO, steered reference, and carrier pilots) for different functions, (4) implements rate, timing, and power control loops for proper system operation, and (5) employs random access for system access by the user terminals, fast acknowledgment, and quick resource assignments.” *Id.* According to Walton ’301, its invention solves for a “need in the art for a MIMO WLAN system capable of supporting multiple users and providing high system performance.” *Id.* at 2:1-3. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton ’301 with Ketchum ’627 at least because Walton ’301 provides a system capable of supporting multiple users and providing high system performance using multiple pilots, and Ketchum ’627 provides pilots for use in MIMO systems.

- **Walton ’301 and Li ’879**: Li ’879 teaches and describes a “method for subcarrier allocation and loading for a multi-carrier, multi-subscriber system” that can be applied to OFDMA systems, where a carrier is corresponding to a cluster, containing multiple OFDM frequency subcarriers.” Li ’879 at Abstract, [0019]. Walton ’301 teaches and describes “[a] multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD.” Walton ’301 at Abstract. According to Walton ’301, the “system (1) uses a channel structure with a number of

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configurable transport channels, (2) supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities, (3) employs a pilot structure with several types of pilot (e.g., beacon, MIMO, steered reference, and carrier pilots) for different functions, (4) implements rate, timing, and power control loops for proper system operation, and (5) employs random access for system access by the user terminals, fast acknowledgment, and quick resource assignments." *Id.* According to Walton '301, its invention solves for a "need in the art for a MIMO WLAN system capable of supporting multiple users and providing high system performance." *Id.* at 2:1-3. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '301 with Li '879 at least because Walton '301 provides a system capable of supporting multiple users and providing high system performance using multiple pilots, and Li '879 teaches a method for subcarrier allocation and loading for a multi-carrier, multi-subscriber system" that can be applied to OFDMA systems like the one in Walton '301.

- **Walton '301 and Smee '007**: Smee '007 discloses a wireless communication system where pilots from a transmitter assist the receiver in performing a number of functions such as channel estimation, timing and frequency acquisition, and coherent data demodulation. Smee '007 at [0007]. Walton '301 teaches and describes "[a] multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. According to Walton '301, the "system (1) uses a channel structure with a number of configurable transport channels, (2)

supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities, (3) employs a pilot structure with several types of pilot (e.g., beacon, MIMO, steered reference, and carrier pilots) for different functions, (4) implements rate, timing, and power control loops for proper system operation, and (5) employs random access for system access by the user terminals, fast acknowledgment, and quick resource assignments." *Id.* According to Walton '301, its invention solves for a "need in the art for a MIMO WLAN system capable of supporting multiple users and providing high system performance." *Id.* at 2:1-3. Because these references were in the same field of endeavor and shared the same fundamental goal of supporting various wireless system functions using different types of pilot signals, it would have been obvious for a POSITA to combine Walton '301 and Smee '007.

- **Walton '301 and Alamouti '570**: Alamouti '570 teaches and describes "improvements to communications systems and methods in a wireless, frequency division duplex communications system." Alamouti '570 at [0005]. However, Alamouti '570 notes that its invention "combines form of time division duplex (TDD), frequency division duplex (FDD), time division multiple access (TDMA), orthogonal frequency division multiplexing (OFDM), spatial diversity, and polarization diversity in various unique combinations." *Id.* at [0027]. "In one embodiment of the invention, TDD, FDD, TDMA, and OFDM are combined to enable a base station to efficiently communicate with many remote stations." *Id.* at [0028]. The method of Alamouti '570 involves the use of various discrete frequency tones. *E.g.*, *id.* at [0028]-[0034]. "Selected tones within each tone set

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are designated as pilots[.]" *Id.* at [0085]. Walton '301 teaches and describes "[a] multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. According to Walton '301, the "system (1) uses a channel structure with a number of configurable transport channels, (2) supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities, (3) employs a pilot structure with several types of pilot (e.g., beacon, MIMO, steered reference, and carrier pilots) for different functions, (4) implements rate, timing, and power control loops for proper system operation, and (5) employs random access for system access by the user terminals, fast acknowledgment, and quick resource assignments." *Id.* According to Walton '301, its invention solves for a "need in the art for a MIMO WLAN system capable of supporting multiple users and providing high system performance." *Id.* at 2:1-3. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '301 with Alamouti '570 at least because Walton '301 provides a system capable of supporting multiple users and providing high system performance using multiple pilots and Alamouti '570's discloses an improved method for transmitting pilots from base stations to remote stations.

- **Walton '301 and Tong '395**: Tong '395 teaches and describes an invention that "allows a wireless communication system, such as a base station, to select N antennas from an associated group of M antennas for transmitting multiple streams of data to a given user." Tong '395 at Abstract. Specifically, Tong '395 teaches

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that its invention "optimizes multiple-input multiple-output (MIMO) transmissions wherein there are more transmit antennas than receive antennas." *Id.* at 3:6-8. To do this, Tong '395 teaches "selectively choosing a select number of antennas within a larger array through which to transmit data to a receiver, as well as techniques for reinforcing transmitted signals using available antennas." *Id.* at 1:5-9. Walton '301 teaches and describes "[a] multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract. According to Walton '301, the "system (1) uses a channel structure with a number of configurable transport channels, (2) supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities, (3) employs a pilot structure with several types of pilot (e.g., beacon, MIMO, steered reference, and carrier pilots) for different functions, (4) implements rate, timing, and power control loops for proper system operation, and (5) employs random access for system access by the user terminals, fast acknowledgment, and quick resource assignments." *Id.* According to Walton '301, its invention solves for a "need in the art for a MIMO WLAN system capable of supporting multiple users and providing high system performance." *Id.* at 2:1-3. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Walton '301 with Tong '395 at least because Walton '301 provides a system capable of supporting multiple users and providing high system performance using multiple pilots, and Tong '395 provides improved techniques for reinforcing transmitted pilot signals.

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(iii) IEEE Std 802.11a-1999 in combination with the knowledge of a skilled artisan, IEEE Std 802.11-1999, IEEE Std 802.11g-2003, IEEE 802.11-00/269, and and/or Teo '708

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine IEEE Std 802.11a-1999 with each of these references. A person of ordinary skill in the art would have found it obvious to combine IEEE Std 802.11a-1999 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '512 patent was filed. Specifically:

- IEEE Std 802.11a-1999, IEEE Std 802.11-1999, IEEE Std 802.11g-2003, IEEE 802.11-00/269, and Teo '708 are all directed to systems and methods for transmitting information in wireless communication systems. For example, they relate to wireless communication, and in particular to channel and pilot structures used for mobile device communication. They involve communication protocols and standards, transmission methods (e.g., OFDM), and frame formats and different types of pilots, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

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- **IEEE Std 802.11a-1999 and IEEE Std 802.11-1999**: It would have been obvious for a POSITA to combine IEEE Std 802.11a-1999 and IEEE Std 802.11 at least because IEEE Std 802.11a-1999 supplements IEEE Std 802.11-1999. *See* IEEE Std 802.11a-1999 at Title Page ("Supplement to IEEE Std 802.11-1999").
- **IEEE Std 802.11a-1999 and IEEE Std 802.11g-2003**: It would have been obvious for a POSITA to combine IEEE Std 802.11a-1999 and IEEE Std 802.11g-2003 at least because they are part of the same standard for Wireless LAN systems. *See* IEEE Std 802.11g-2003 at Title Page ("Amendment to IEEE Std 802.11, 1999 Edition (Reaff 2003)").
- **IEEE Std 802.11a-1999 and IEEE 802.11-00/269**: IEEE 802.11-00/269 is a working group submission for the IEEE 802.11 standard. IEEE 802.11-00/269 teaches that "[a]ntenna technologies offer a means to boast IEEE802.11 capacity without changing the existing PHYs." IEEE 802.11-00/269 at Slide 2. It further discloses smart antenna operation using multiple antennas. *Id.* at Slide 7. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in Wireless LAN communications environments. It would have been obvious for a POSITA to combine IEEE Std 802.11a-1999 and IEEE 802.11-00/269 at least because IEEE 802.11-00/269 provides an improved smart antenna operation to boast capacity of the IEEE 802.11 standard.
- **IEEE Std 802.11a-1999 and Teo '708**: Teo '708 teaches and describes a "radio system employing Orthogonal Frequency Division Multiplexed (OFDM) includes a Base Transceiver Station (BTS) along with a number of mobile terminals located

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within a coverage area of the BTS." Teo '708 at Abstract. IEEE Std 802.11a-1999 teaches and describes "the PHY services provided to the IEEE 802.11 wireless LAN MAC by the 5GHz (bands) OFDM system." IEEE Std 802.11a-1999 at 4. According to IEEE 802.11-00/269, "[a]ntenna technologies offer a means to boast IEEE802.11 capacity without changing the existing PHYs." IEEE 802.11-00/269 at Slide 2. According to Teo '708, "[s]mart antenna technology includes intelligent antennas, phased arrays, Spatial Division Multiplex Access (SPMA) arrays, digital beam forming arrays, adaptive antenna systems and switched beam antennas." Teo '708 at [0032]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in Wireless LAN communications environments. It would have been obvious for a POSITA to combine IEEE Std 802.11a-1999 and Teo '708 at least because IEEE 802.11-00/269 provides an improved smart antenna technology (including digital beam forming arrays) to boast capacity of the IEEE 802.11 standard.

(iv) IEEE Std 802.16a-2003 in combination with the knowledge of a skilled artisan, IEEE Std 802.16-2001, IEEE 802.16d-04/06, and IEEE 802.16c-01/32

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine IEEE Std 802.16a-2003 with each of these references. A person of ordinary skill in the art would have found it obvious to combine IEEE Std 802.16a-2003 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one

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known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '512 patent was filed. Specifically:

- IEEE Std 802.16a-2003, IEEE Std 802.16-2001, IEEE 802.16d-04/06, and IEEE 802.16c-01/32 are all directed to the air interface of fixed (stationary) point-to-multipoint broadband wireless access systems providing multiple services. For example, they relate to wireless communication, and in particular to data transmission and pilots structures used for mobile device communication. They involve communication protocols and standards, transmission methods (e.g., OFDM or OFDMA), and different types of pilots, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **IEEE Std 802.16a-2003 and IEEE Std 802.16-2001**: It would have been obvious for a POSITA to combine IEEE Std 802.16a-1999 and IEEE Std 802.16-2001 at least because IEEE Std 802.16a-2003 supplements IEEE Std 802.16-2001. *See* IEEE Std 802.16a-2003 at Title Page ("Amendment to IEEE Std 802.16-2001").
- **IEEE Std 802.11a-1999 and IEEE 802.16d-04/06**: IEEE 802.16d-04/06 is a working group discussion submission for the IEEE 802.16 standard. IEEE 802.16d-04/06 teaches that the "object of this document is to improve the support for DL beam forming in OFDM AAS mode [in IEEE Std 802.16-2001]." IEEE 802.16d-04/06 at 2. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in

WirelessMAN communications environments. It would have been obvious for a POSITA to combine IEEE Std 802.16a-2003 and IEEE 802.16d-04/06 at least because IEEE 802.16d-04/06 provides an improved beamforming operation to support the IEEE 802.16 standard.

- **IEEE Std 802.11a-1999 and IEEE 802.16c-01/32**: IEEE 802.16c-01/32 is a working group discussion submission for the IEEE 802.16 standard. IEEE 802.16c-01/32 teaches "an added feature of the proposed framing structure to support beam forming and adaptive antenna technologies [in IEEE Std 802.16-2001]." IEEE 802.16d-04/06 at 2. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in WirelessMAN communications environments. It would have been obvious for a POSITA to combine IEEE Std 802.16a-2003 and 802.16c-01/32 at least because 802.16c-01/32 provides an added feature of beamforming and adaptive antenna technologies to support the IEEE 802.16 standard.

(v) 3GPP TR 25.892 in combination with the knowledge of a skilled artisan, R1-030679, R1-031188, R1-031091, R1-010293, and 3GPP TR 25.887

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine 3GPP TR 25.892 with each of these references. A person of ordinary skill in the art would have found it obvious to combine 3GPP TR 25.892 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both

obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '512 patent was filed. Specifically:

- 3GPP TR 25.892, R1-030679, R1-031188, R1-031091, R1-010293, and 3GPP TR 25.887 are all directed to systems and methods related to communication protocols in 3GPP-based systems. For example, they relate to wireless communications, and in particular to channel and pilot structures used for 3GPP communication. They involve communication protocols and standards, transmission methods (e.g., OFDM), and different types of channels and pilots, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **3GPP TR 25.892 and R1-030679**: It would have been obvious for a POSITA to combine 3GPP TR 25.892 and R1-030679 at least because they are both proposals for the application of OFDM techniques to 3GPP-based systems within the same 3GPP working group.
- **3GPP TR 25.892 and R1-031188**: It would have been obvious for a POSITA to combine 3GPP TR 25.892 and R1-031188at least because they are both proposals for the application of OFDM techniques to 3GPP-based systems within the same 3GPP working group.
- **3GPP TR 25.892 and R1-031091**: It would have been obvious for a POSITA to combine 3GPP TR 25.892 and R1-031091 at least because they are both proposals

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for the application of OFDM techniques to 3GPP-based systems within the same 3GPP working group.

- **3GPP TR 25.892 and R1-010293**: It would have been obvious for a POSITA to combine 3GPP TR 25.892 and R1-031091 at least because they are both proposals for the application of OFDM techniques to 3GPP-based systems within the same 3GPP working group.
- **3GPP TR 25.892 and 3GPP TR 25.887**: It would have been obvious for a POSITA to combine 3GPP TR 25.892 and 3GPP TR 25.887 at least because they are both proposals (different releases) within the same 3GPP working group.

(vi) Ma ’255 in combination with the knowledge of a skilled artisan, Ma ’254, Tong ’395, Ketchum ’627, and and/or Smee ’007

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Ma ’255 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Ma ’255 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’512 patent was filed. Specifically:

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- **Ma ’255, Ma ’254, Tong ’395, Ketchum ’627, and Smee ’007** are all directed to systems and methods for transmitting information in wireless multiple-access OFDM communication systems. For example, they relate to wireless communication, and in particular to channel and pilot structures used for mobile device communication. They involve communication protocols and standards, transmission methods (e.g., OFDMA, OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Ma ’255 and Ma ’254**: Ma ’255 and Ma ’254 share the same inventors and describe the same MIMO-OFDM communication system while emphasizing different portions of the system. For example, Ma ’255 describes an OFDM frame structure with a preamble carrying several pilot channels, scattered pilots and data traffic channels. Ma ’255 at [0106]. Ma ’254 in turn discloses using the scattered pilots for channel estimation to recover the data symbols. *See* e.g. Ma ’254 at Abstract. Thus, these references were in the same field of endeavor, describe the same OFDM system, and share the same inventors. Accordingly, it would have been obvious for a POSITA to combine Ma ’255 with Ma ’254.
- **Ma ’255 and Tong ’395**: Tong ’395 teaches and describes an invention that “allows a wireless communication system, such as a base station, to select N antennas from an associated group of M antennas for transmitting multiple streams of data to a given user.” Tong ’395 at Abstract. Specifically, Tong ’395 teaches that its invention “optimizes multiple-input multiple-output (MIMO) transmissions

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wherein there are more transmit antennas than receive antennas." *Id.* at 3:6-8. To do this, Tong '395 teaches "selectively choosing a select number of antennas within a larger array through which to transmit data to a receiver, as well as techniques for reinforcing transmitted signals using available antennas." *Id.* at 1:5-9. Ma '255 teaches "method and apparatus are provided for performing acquisition, synchronization and cell selection within an MIMO-OFDM communication system." Ma '255 at Abstract. Ma '255 further explains that such systems feature high performance: "Multiple Input Multiple Output-Orthogonal Frequency Division Multiplexing (MIMO-OFDM) is a novel highly spectral efficient technology used to transmit high-speed data through radio channels with fast fading both in frequency and in time." Ma '255 at [0009]. Because these references were in the same field of endeavor, and shared the same fundamental goal of high-speed data transmission in wireless communications environments, it would have been obvious for a POSITA to combine Ma '255 with Tong '395.

- **Ma '255 and Ketchum '627:** Ketchum '627 teaches and describes "[p]ilots suitable for use in MIMO systems and capable of supporting various functions," where the various types of pilots include "a beacon pilot, a MIMO pilot, a steered reference or steered pilot, and a carrier pilot." Ketchum '627 at Abstract. Ma '255 discloses an MIMO-OFDM communication system with various pilots embedded in the preamble and data portion of a frame. Ma '255 at Abstract. These references share the same improving data transmissions in a wireless communications environments by using different pilots for different system support functions such as synchronization, data recovery, cell selection, and beamforming.

- **Ma ’255 and Smee ’007**: Smee ’007 discloses a wireless communication system where pilots from a transmitter assist the receiver in performing a number of functions such as channel estimation, timing and frequency acquisition, and coherent data demodulation. Smee ’007 at [0007]. Ma ’255 discloses a MIMO-OFDM communication system with various pilots embedded in the preamble to allow the user equipment to perform base station identification, framing and timing synchronization, channel estimation, etc. Ma ’255 at [0106]. Because these references were in the same field of endeavor and shared the same fundamental goal of supporting various wireless system functions using different types of pilot signals, it would have been obvious for a POSITA to combine Ma ’255 and Smee ’007.

(vii) Teo ’708 in combination with the knowledge of a skilled artisan, Li ’879, Kim ’448, and/or Kim ’618

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Teo ’708 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Teo ’708 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed

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disclosures were well-known at the time the application leading to the ’512 patent was filed. Specifically:

- **Teo ’708, Li ’879, Kim ’448, and Kim ’618** are all directed to systems and methods for transmitting information in wireless multiple-access OFDM communication systems. For example, they relate to wireless communication, and in particular to channel and pilot structures used for mobile device communication. They involve communication protocols and standards, transmission methods (e.g., OFDMA, OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Teo ’708 and Li ’879**: Li ’879 discloses a multi-carrier, multi-subscriber OFDMA wireless system that uses pilot symbols for various purposes including cell identification, time and frequency synchronization, channel estimation, etc. *See e.g.* Li ’879 at [0019], [0028]. Teo ’708 discloses an OFDM wireless system where mobile terminals receive pilot and signaling information, as well as high data rate traffic information. Teo ’708 at Abstract. Teo ’708 further teaches mobile terminals using the pilots for frequency reference, carrier recovery and channel estimation. Teo ’708 at [0003]. Because these references were in the same field of endeavor, and shared the same fundamental goal of efficiently allocating channel resources, it would have been obvious for a POSITA to combine Teo ’708 and Li ’879.
- **Teo ’708 and Smee ’007**: Smee ’007 discloses a wireless multi-carrier OFDM communication system that allocates pilots to subcarriers such that pilots from

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different base stations are transmitted on disjoint sets of frequency subbands. Smee '007 at Abstract and [0010]. Teo '708 discloses an OFDM wireless system where mobile terminals use pilots transmitted by base stations for frequency reference, carrier recovery and channel estimation. Teo '708 at [0003]. Because these references were in the same field of endeavor and are directed to the same goal of advantageous allocation of pilots to subcarriers, it would have been obvious for a POSITA to combine Teo '708 and Smee '007.

- **Teo '708 and Kim '448**: Kim '448 discloses a wireless OFDMA communication system which uses pilot subcarriers to perform various functions, including time and frequency synchronization and cell search. Kim '448 at 3:8-15, 4:3-12. Kim '448 further discloses each cell allocating pilots to different subcarriers, such that each cell has its own pilot symbol pattern or position set. Kim '448 at 16:3-11. Teo '708 discloses an OFDM wireless system where mobile terminals use pilots transmitted by base stations for frequency reference, carrier recovery, channel estimation, and synchronization. Teo '708 at [0003], [0008]. Because these references were in the same field of endeavor and are directed to the same goal of advantageous allocation of pilots to subcarriers, it would have been obvious for a POSITA to combine Teo '708 and Kim '448.
- **Teo '708 and Kim '618**: Kim '618 discloses a wireless OFDMA-based communication system with a frame structure that uses synchronization and cell search preambles and pilot symbols inserted among data symbols. Kim '618 at Abstract. Kim '618 further teaches each cell having a specific pilot pattern to enable base station identification. Kim '618 at 24:2-11. Teo '708 discloses an

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OFDM wireless system where mobile terminals receive pilot and signaling channels, as well as data traffic channels with embedded pilot symbols. Teo '708 at Abstract, [0008]. Because these references were in the same field of endeavor and are directed to the same goal of advantageous allocation of pilots to subcarriers, it would have been obvious for a POSITA to combine Teo '708 and Kim '618.

(viii) Kim '618 in combination with the knowledge of a skilled artisan, Tong '395, and/or Ketchum '627

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Kim '618 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Kim '618 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '512 patent was filed. Specifically:

- **Kim '618, Tong '395, and Ketchum '627** are all directed to systems and methods for transmitting information in wireless multiple-access OFDM communication systems. For example, they relate to wireless communication, and in particular to channel and pilot structures used for mobile device communication. They involve communication protocols and standards, transmission methods (e.g., OFDMA,

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OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Kim '618 and Tong '395**: Tong '395 teaches and describes an invention that "allows a wireless communication system, such as a base station, to select N antennas from an associated group of M antennas for transmitting multiple streams of data to a given user." Tong '395 at Abstract. Specifically, Tong '395 teaches that its invention "optimizes multiple-input multiple-output (MIMO) transmissions wherein there are more transmit antennas than receive antennas." *Id.* at 3:6-8. To do this, Tong '395 teaches "selectively choosing a select number of antennas within a larger array through which to transmit data to a receiver, as well as techniques for reinforcing transmitted signals using available antennas." *Id.* at 1:5-9. Kim '618 describes "a method for using ***at least one transmit antenna*** in the downlink of the OFDMA-based mobile communication system." Kim '618 at 29:16-17. Kim '618 further explains that how the method could be implemented using a plurality of transmit antennas: "In general, when a plurality of transmit antennas are provided, a pilot transmit power for each antenna can be varied. For example, a common channel and a control channel have fixed data rates and use two default antennas, and a data channel has a variable data rate according to channel conditions and uses not more than four antennas." *Id*. at 31:17-21. Kim '618 also explains that MIMO can provide fast transmission. *Id*. at 31:21-22. Tong '395 also discloses a user element within a cell which receives downlink signal from a base station includes a "channel estimation function 86" that "provides channel responses corresponding

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to channel conditions" of the received downlink signal "to allow the STC decoder 88 to decode the symbols." Tong '395, 6:33-35, 6:39-42, FIG. 5. Tong '395 further discloses that the decoded symbols are provided on a "receive path" that ends with "de-scrambling logic 102" to "recover the originally transmitted data 104." *Id*., 6:35-39, 6:43-58. Kim '618 discloses an improved pilot structure that can facilitate time and frequency synchronization and data recovery, and also teaches "a data channel" can have "a variable data rate according to channel conditions." Kim '618 at 24:20-25:5, 25:6-26:7, 27:2-32:7, 31:1-4, 34:6-35:8, 37:5-20, 38:15-27, 43:16-44:10. Because these references were in the same field of endeavor, and shared the same fundamental goal of high-speed data transmission in wireless communications environments, it would have been obvious for a POSITA to combine Kim '618 with Tong '395.

A POSA would have been further motivated to implement beamforming, as taught by Tong '395, in Kim '618's OFDMA-based cellular system. Kim '618's base station transmits a "downlink signal" to a mobile terminal using "at least one transmit antenna." Kim '618, 29:16-18, 45:21-46:16. Kim '618 seeks to improve signal quality of its downlink signal that is transmitted using the "at least one transmit antenna." *Id*., 29:16-18, 32:3-15, 34:12-17 (selecting common pilot patterns having "a power greater than a predefined reference value"), 45:21-46:16. But Kim '618 does not disclose how its multiple antennas could be used to improve signal quality—a well-known characteristic that had been a motivating force for cellular system designers for years before the '512 patent. A POSA would have

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thus sought references for communication systems teaching efficient antenna transmission techniques. Tong '395 is such a reference.

Like Kim '618, Tong '395 teaches a cellular system that uses OFDM communication techniques to transmit pilot signals from a base station to mobile terminals using multiple antennas. *Id*., 29:16-18, 45:21-46:16; Tong '395, 4:49-55, 5:64-6:5, 8:61-9:4. Tong '395 provides motivation for implementing beam-forming in multiple antenna systems, such as Kim '618's—"there is a need to provide signal reinforcement in the communication channel to provide a beam-forming effect in an efficient manner in a MIMO system." Tong '395, 1:43-67; *see also* Kim '618, 31:17-32:7.

Tong '395 also explains that implementing beam-forming to transmit signals from the base station to the mobile terminals is beneficial to "provide additional gain," to "increase the signal-to-noise ratio at a receiver," and to "improve[e] the system capacity." Tong '395, 8:61-9:4, 11:23-28. Tong '395 further explains that beam forming can be used to "optimize channel capacity, signal-to-noise ratios, or a combination thereof." *Id*., 8:50-66, 11:60-12:6. Tong '395's beam-forming techniques are implemented "in an efficient manner." *Id*., 1:62-67.

A POSA would have understood that cellular systems implementing beam-forming in cellular systems, such as Kim's, would also provide other benefits, such as efficient-utilization of spectral resources by exploiting the spatial (angular) separation of users, cost efficiency, increased range or capacity, and easy integration. Further, such beam-forming enhances reception of signals from

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different angles of arrival, and enhances the quality of transmission of signals to different users.

A POSA would have understood that such benefits could be achieved by implementing beam forming in Kim '618's system to beamform at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers. A POSA would have thus been motivated to implement such techniques in Kim '618's system. In the combined system, Kim '618's "plurality of transmit antennas" would be implemented to provide beam-forming for at least some of the subcarriers of the downlink signal.

In addition to the motivations described above, a POSA would have been further motivated to combine Kim '618 and Tong '395 because both are in the same general field of cellular communications, and address the same problem—efficient communications between base stations and mobile terminals. And a POSA would have had a reasonable expectation of success in implementing beamforming at least because it was a well-known technique commonly used in wireless communication systems. Kim '618's base station already implements multiple antennas to transmit its downlink signal. *E.g.*, Kim '618, 29:16-18, 30:14-16. And Tong '395's beam-forming techniques are provided for multiple antenna (e.g., MIMO) systems, such as Kim '618's. Tong '395, 1:43-67; see also Kim '618, 31:17-32:7. Tong '395 also teaches that its beam-forming techniques are "beneficial in OFDM environments," such as Kim '618's. Tong '395, 14:24-25. Thus, implementation of beamforming in Kim '618's base station would not require additional hardware other than implementing well-known mathematical algorithms related to beamforming

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leveraging the Q1 pilot pattern for channel estimation. For instance, at least one of Kim '618's "plurality of transmit antennas" would be implemented to "redundantly transmit data being transmitted over another of the transmit antennas" to "allow the energy of the multiple transmitted signals to combine in the channel in a constructive fashion." Kim '618, 31:17-18; Tong '395, 8:50-9:2.

Further, as evident from the above discussion, a POSA could have combined the system of Kim '618 with the teachings of Tong '395 by known methods, and the results of the combination would have been predictable to a POSA. A POSA would have readily understood how to adapt Kim '618's transmit antennas 2102 so that the base station implements beamforming, such as by implementing the antennas as arrays (e.g., by leveraging the existing antenna elements) whose transmissions combine "in a constructive fashion." Tong '395, 8:50-66. Thus, a POSA would have understood that implementing beam-forming in Kim '618's system would merely amount to the use of known technique (beam-forming at least some subcarriers of the downlink signal) to improve similar devices (Kim '618 and Tong '395's OFDM cellular base stations) in the same way ("provide a stronger signal at the receiver"). *Id*., 12:1-4).

A POSA would have also been motivated to combine Kim '618 and Tong '395 so that Kim's mobile terminals use the Q1 pilot pattern for channel estimation and to recover the data provided in Kim '618's downlink signal traffic slots. Kim '618, 12:6-10; Tong '395, 6:2-58.

As explained above, Kim '618's "OFDMA-based cellular system" includes a terminal (mobile station) configured to receive and recover "traffic data" on a

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downlink signal transmitted by a base station. Kim ’618, 1:23-2:3. In cellular systems, the downlink signal undergoes variations in phase and amplitude caused during propagation of the signal along the channel between the base station and terminal. This variation in phase and amplitude is called the “channel response.” A POSA would have understood that, to accurately recover the traffic data on the downlink signal, the receiver can determine the channel response, and compensate for the channel degradation of the channel response. The determination of the channel response is called channel estimation.

A POSA would have understood that such channel response issues would affect communication between Kim ’618’s mobile and base stations. Thus, in view of these well-known considerations in wireless communication systems, a POSA would have sought references for estimating channel responses of cellular systems, such as Kim ’618’s. Tong ’395 is such a reference.

Tong ’395’s user element 16 includes a “channel estimation function 86” that “provides channel responses corresponding to channel conditions” of the received downlink signal. Tong ’395, 6:33-35, FIG. 5. “The channel estimates provide sufficient channel response information to allow the STC decoder 88 to decode the symbols.” *Id*., 6:39-42. Tong ’395’s receiver “recover[s] the originally transmitted data 104” based on the channel estimate. *Id*., 6:35-39, 6:43-58.

A POSA would have understood that Tong ’395’s techniques would be beneficial in Kim ’618’s system to estimate the channel response so that the mobile terminal could accurately recover the transmitted data in view of the channel response. Tong ’395 teaches that its receiver “use[s] the pilot signals for channel estimation.”

Id., 6:2-5. Indeed, cellular systems commonly implemented pilot signals for channel estimation. '512 Patent, 1:36-43 ("In multi-carrier wireless communications, many important system functions such as frequency synchronization and channel estimation, depicted in FIG. 1, are facilitated by using the network information provided by a portion of total subcarriers such as pilot subcarriers.").

Thus, a POSA would have sought to enable Kim '618's terminal to use the received common pilot signals (Q1 pilot pattern) for estimating the channel to recover the traffic data provided on the downlink signal. Kim '618 explains that "when the number of cells in the mobile communication system is less than the number of pilot patterns, a specific pilot pattern is allocated to each cell, and when the number of cells is greater than the number of pilot patterns, the cells are grouped by the number of pilot patterns, and different pilot patterns are allocated in a single group. Tong '395, 24:16-19. This means that the cell specific pilot patterns and the pilot patterns that are common to multiple cells depending on the configuration of the networks, i.e., the number of cells versus the number of pilot patterns. The pilot patterns for the cell specific use and the common use come from the same set of pilot patterns and are allocated to be used for both the cell specific use and the common use. As such, a POSA would have been motivated to enable Kim '618's terminal to use the received common pilot signals (Q1 pilot pattern) for estimating the channel to recover the traffic data provided on the downlink signal.

The Kim-Tong mobile terminals would implement a "receive path" including a "channel estimation function," for data recovery, such as taught by Tong '395.

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Tong ’395, 6:33-58, FIG. 5. This would enable Kim ’618’s terminal to determine the channel degradation caused by the channel response so that the terminal can accurately recover the traffic data.

And a POSA would have had a reasonable expectation of success in implementing such features. Indeed, such channel estimation techniques were well-known and commonly implemented in cellular OFDM systems as well as in other wireless systems. A POSA would have understood that such techniques would be a natural and logical use of Kim ’618’s downlink pilot signals. Thus, a POSA would not have encountered any unreasonable technical hurdles in implementing such modifications. Accordingly, a POSA would have understood that such modifications would merely amount to the use of a known technique (pilot aided channel estimation for data recovery) to improve similar devices (Kim ’618’s terminals) in the same way (accurate data recovery based on known channel degradation).

- **Kim ’618 and Ketchum ’627:** Ketchum ’627 teaches and describes “[p]ilots suitable for use in MIMO systems and capable of supporting various functions,” where the various types of pilots include “a beacon pilot, a MIMO pilot, a steered reference or steered pilot, and a carrier pilot.” Ketchum ’627 at Abstract. Kim ’618 provides an OFDMA communication system with an improved pilot structure to facilitate time and frequency synchronization and data recovery, which can be implemented using a plurality of transmit antennas for fast transmission. Kim ’618 at 24:20-25:5, 25:6-26:7, 27:2-32:7, 34:6-35:8, 37:5-20, 38:15-27, 43:16-44:10. These references share the same improving data transmissions in a wireless

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communications environments by using different pilots for different system support functions such as synchronization, data recovery, cell selection, and beamforming.

(ix) Laroia ’594 in combination with the knowledge of a skilled artisan, Tong ’395, Ketchum ’627, Li ’879 and/or Smee ’007

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Laroia ’594 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Laroia ’594 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’512 patent was filed. Specifically:

- **Laroia ’594, Tong ’395, Ketchum ’627, Li ’879 and Smee ’007** are all directed to systems and methods for transmitting information in wireless multiple-access OFDM communication systems. For example, they relate to wireless communication, and in particular to channel and pilot structures used for mobile device communication. They involve communication protocols and standards, transmission methods (e.g., OFDMA, OFDM, CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration

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with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Laroia '594 and Tong '395**: Tong '395 teaches and describes an invention that "allows a wireless communication system, such as a base station, to select N antennas from an associated group of M antennas for transmitting multiple streams of data to a given user." Tong '395 at Abstract. Specifically, Tong '395 teaches that its invention "optimizes multiple-input multiple-output (MIMO) transmissions wherein there are more transmit antennas than receive antennas." *Id.* at 3:6-8. To do this, Tong '395 teaches "selectively choosing a select number of antennas within a larger array through which to transmit data to a receiver, as well as techniques for reinforcing transmitted signals using available antennas." *Id.* at 1:5-9. Tong '395 further teaches that its invention "optimizes multiple-input multiple-output (MIMO) transmissions wherein there are more transmit antennas than receive antennas." *Id.* at 3:6-8. To do this, Tong '395 teaches "selectively choosing a select number of antennas within a larger array through which to transmit data to a receiver, as well as techniques for reinforcing transmitted signals using available antennas." Tong '395 also discloses a user element within a cell which receives downlink signal from a base station includes a "channel estimation function 86" that "provides channel responses corresponding to channel conditions" of the received downlink signal "to allow the STC decoder 88 to decode the symbols." Tong '395, 6:33-35, 6:39-42, FIG. 5. Tong '395 further discloses that the decoded symbols are provided on a "receive path" that ends with "de-scrambling logic 102" to "recover the originally transmitted data 104." *Id*., 6:35-39, 6:43-58. Laroia '594

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discusses the uses of "beacon signal" in a multi-carrier system "to communicate user data, a cell identifier, and/or a sector identifier corresponding to the transmitter which transmitted the particular beacon signal." *Id.* at [0008]. Laroia '594 teaches that "Each cell includes a base station which transmits different signals into each sector or a cell …. Separate antenna and/or transmitter may be provided for each sector of a cell." *Id*. at [0025]. Laroia '594 also discloses base station transmits "regularly downlink signaling, e.g., traffic channel assignment signals, downlink pilot signals, other control signals, and downlink traffic channel signals such as user data to wireless terminals." *Id*., at [0086]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of improving data transmissions in multi-carrier communications environments. It would have been obvious for a POSITA to combine Laroia '594 with Tong '395 at least because Laroia '594 provides a method for using improved beacon signaling techniques (which can be applied to other multi-carrier OFDM systems like Tong '395's, which itself provides improved techniques for reinforcing transmitted signals) in order to improve communications and performance in a system capable of supporting more users.

- **Laroia '594 and Ketchum '627:** Ketchum '627 teaches and describes "[p]ilots suitable for use in MIMO systems and capable of supporting various functions," where the various types of pilots include "a beacon pilot, a MIMO pilot, a steered reference or steered pilot, and a carrier pilot." Ketchum '627 at Abstract. Laroia '594 provides a method for using improved beacon signaling techniques in order to improve communications and performance in a system capable of supporting more

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users. Laroia ’594 at [0002]. These references share the same improving data transmissions in a wireless communications environments by using different pilots for different system support functions such as synchronization, data recovery, cell selection, and beamforming.

- **Larioia ’594 and Smee ’007**: Smee ’007 discloses a wireless communication system where pilots from a transmitter assist the receiver in performing a number of functions such as channel estimation, timing and frequency acquisition, and coherent data demodulation. Smee ’007 at [0007]. Laroia ’594 provides a method for using improved beacon signaling techniques in order to improve communications and performance in a system capable of supporting more users. Laroia ’594 at [0002]. Because these references were in the same field of endeavor and shared the same fundamental goal of supporting various wireless system functions using different types of pilot signals, it would have been obvious for a POSITA to combine Laroia ’594 and Smee ’007.
- **Laroia ’594 and Li ’879**: Li ’879 discloses a multi-carrier, multi-subscriber OFDMA wireless system that uses pilot symbols for various purposes including cell identification, time and frequency synchronization, channel estimation, etc. *See e.g.* Li ’879 at [0019], [0028]. Laroia ’594 provides a method for using improved beacon signaling techniques in order to improve communications and performance in a system capable of supporting more users. Laroia ’594 at [0002]. Because these references were in the same field of endeavor, and shared the same fundamental goal of efficiently allocating channel resources, it would have been obvious for a POSITA to combine Laroia ’594 and Li ’879.

(x) Ketchum ’627 in combination with the knowledge of a skilled artisan, Li ’879, Kim ’448, Kim ’618, and/or Smee ’007

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Ketchum ’627 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Ketchum ’627 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’512 patent was filed. Specifically:

- Ketchum ’627, Li ’879, Kim ’448, Kim ’618, and Smee ’007 are all directed to systems and methods for estimating channel characteristics based on probing or pilot signals. For example, these references all relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM and/or OFDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

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- **Ketchum ’627 and Li ’879**: A POSA would have been motivated to implement Ketchum ’627’s system for cellular communication and such that Ketchum ’627’s base station is OFDMA-compatible, as taught by Li ’879. Li ’879 discloses a cellular communication system that communicates using OFDMA techniques. Li ’879 at [0019], [0028]. Like Ketchum ’627’s system, Li ’879’s OFDMA-compatible system implements carriers “containing multiple OFDM frequency subcarriers.” *Id.*, [0019]. Ketchum ’627’s system is a “multiple-access” system “that supports a number of users.” Ketchum ’627 at [0026]. But Ketchum ’627 does not expressly disclose how its system implements the multiple-access communications. A POSA would have understood that a multiple-access OFDM system could be implemented using a finite number of techniques, such as multicarrier CDMA, OFDM with TDMA, OFDMA, etc. A POSA would have thus sought references for implementing multiple-access communication techniques that leverage OFDM. Li ’879 is such a reference. A POSA would have sought to implement the “multiple-access” aspects of Ketchum ’627’s system using OFDMA techniques, as taught by Li ’879. For instance, a POSA would have understood that OFDMA is a logical extension of OFDM that utilizes OFDM in communicating with multiple users (i.e., multiple-access). Specifically, OFDMA divides a communication channel into subchannels or subcarriers using OFDM techniques. OFDMA then extends OFDM to implement multiple-access by assigning subsets of orthogonal sub-carriers to individual subscriber devices. In other words, in OFDMA, the subcarrier universe that is established via OFDM, but the subset of subcarriers assigned to each user can be (randomly) distributed among the universe

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of subcarriers. Indeed, from the use of multiple subcarriers in OFDM, it is an obvious step to employ frequency hopping among OFDM subcarriers, such as by using OFDMA. And because OFDMA was one of a finite number of identified, predictable solutions for implementing multiple-access in an OFDM system, a POSA would have found it obvious to implement OFDMA in Ketchum '627's system, as explicitly taught by Li '879.

A POSA would have further been motivated to implement Ketchum '627's system as a cellular system, as taught by Li '879, such that Ketchum '627's base stations are implemented to communicate within respective coverage areas, or cells. Ketchum '627 does not limit its "wireless communication system" to a particular type of system. *See* Ketchum '627 at [0006], [0026]. Indeed, a POSA would have understood that implementations of Ketchum '627's system would operate as a cellular system. For instance, Ketchum '627 refers to its access points 110 as "base stations," which is a term commonly associated with cellular systems. *Id.* at [0026]. Ketchum '627's base station also communicates within a particular "coverage area," such as a cell. Ketchum '627 at [0032]. Further, OFDMA cellular systems were well-known in the art.

Thus, in the combined system, each of Ketchum '627's base stations would communicate within respective cells, as taught by the combination of Ketchum '627 and Li '879. *See* Ketchum '627 at [0032]; Li '879 at [0019], [0028]. Each of Ketchum '627-Li '879's base stations would periodically broadcast pilots (e.g., beacon pilots, steered reference pilots, etc.) to every subscriber within its cell,

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as taught by the combination of Ketchum '627 and Li '879. Li '879 at [0028] ("pilot symbols may be different for different cells"); Ketchum '627 at [0217].

In addition to the motivations described above, a POSA would have been further motivated to combine Ketchum '627 and Li '879 because both are in the same general field of wireless communications, and address the same problem—implementing multiple access OFDM communication between base stations and mobile terminals. Accordingly, a POSA would have had a reasonable expectation of success in implementing Ketchum '627's system as a cellular, OFDMA compatible system, as taught by Li '879.

Specifically, both Ketchum '627 and Li '879's base stations are OFDM systems. *See*, e.g., Ketchum '627 at FIG. 2 (showing the exemplary frame structure for data transmission in a TDD MIMO-OFDM system); Li '879 at FIG. 2 (illustrating a time-frequency grid of OFDM symbols, pilots and clusters). More specifically, they are both based on Time Division Duplex (TDD)-OFDM systems. *See, e.g.,* Ketchum '627 at FIG. 2 (showing the exemplary frame structure for data transmission in a TDD MIMO-OFDM system); Li '879 at [0075]. With the same framework for both Ketchum '627 and Li '879, teaching from one can be implemented in the other with relative ease. Moreover, both Ketchum '627 and Li '879 utilize pilot signals (as will be explained below) to identify the cells as well as for the user terminals to estimate the channel conditions.

Thus, because such techniques were well-known and compatible with Ketchum '627's system, a POSA would not have experienced any unreasonable technical hurdles in implementing these modifications. In this manner, a POSA

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would have understood that modifying Ketchum ’627’s system for cellular OFDMA communications would merely amount to combining prior art elements (Ketchum ’627’s multiple-access MIMO system and Li ’879’s OFDMA-based cellular system) according to known methods (implementing Ketchum ’627’s system using OFDMA communication techniques) to yield predictable results.

- **Ketchum ’627 and Kim ’448**: Kim ’448 teaches “downlink signal configuring method and device, and synchronization and cell search method and device using the same” in “OFDMA-based cellular systems.” Kim ’448 at Abstract, 3:2-5. “A downlink frame has plural symbols into which pilot subcarriers are distributively arranged with respect to time and frequency axes.” *Id*. at Abstract. Specifically, “a pilot symbol pattern proper for each cell is transmitted by a position set of pilot subcarriers [] proper for each cell.” *Id*. at 16:3-11. Ketchum ’627 further teaches a “multiple-access MIMO system [] that supports a number of users and is capable of implementing [various types of] pilots.” Ketchum ’627 at [0026]. Ketchum ’627 further discloses access points, or base stations, that communicate within a particular “coverage area,” such as a cell. Ketchum ’627 at [0032]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of facilitating OFDM-based communications between base stations and mobile terminals. It would have been obvious and predictable for a POSITA to combine Ketchum ’627 and Kim ’448 at least because Kim ’448 provides well-known and commonly used techniques for implementing OFDM-based multiple access techniques to support multiple users. Kim ’448 further discloses well-known and commonly used techniques for implementing OFDMA within a cellular system.

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- **Ketchum ’627 and Kim ’618**: Kim ’618 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Kim ’618 teaches an “OFDMA-based cellular system.” Kim ’618 at Abstract, *see also* 1:23-25, 45:21-46:1. Kim discloses downlink signals that include “pilot symbol[s] given with respect to the time axis and the frequency axis.” *Id.* at 12:6-8. Kim ’618 further discloses downlink transmission schemes in which “differentiat[es] the positions of the pilot symbols of antennas for the respective adjacent cells.” Kim ’618 at 31:17-32:22. Ketchum ’627 teaches a “multiple-access MIMO system [] that supports a number of users and is capable of implementing [various types of] pilots.” Ketchum ’627 at [0026]. Ketchum ’627 further discloses access points, or base stations, that communicate within a particular “coverage area,” such as a cell. Ketchum ’627 at [0032]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of facilitating OFDM-based communications between base stations and mobile terminals. It would have been obvious and predictable for a POSITA to combine Ketchum ’627 and Kim ’618 at least because Kim ’618 provides well-known and commonly used techniques for implementing OFDM-based multiple access techniques to support multiple users. Kim ’618 further discloses well-known and commonly used techniques for implementing OFDMA within a cellular system.
- **Ketchum ’627 and Smee**: Smee discloses “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems.” Smee at Abstract. The pilot transmission schemes utilize “frequency orthogonality” by causing different base stations to transmit pilots “on disjoint sets of subbands”

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(subcarriers). *Id.* at [0010], [0039]. "Each cell or sector only transmits pilot on the subbands in the set assigned to that cell/sector." *Id.* at [0046]. For instance, Smee's Table 2 shows an example subband set allocation for frequency orthogonality. *Id.* at [0047]. As can be seen, each "set" includes different subbands or subcarriers. Each set is assigned to a particular cell or cell sector for pilot transmission. *Id.* at [0046]. Each set is assigned to a particular cell or cell sector for pilot transmission. *Id*. Figure 3A shows an example assignment of subband sets to cluster of cells/cell sectors "to achieve frequency orthogonality" based on the subband sets of Table 2. *Id.* at [0056]. "Each of the 9 sectors in the cluster is assigned one of 9 subband sets" (*e.g.,* sets 1-9 as indicated in Table 2 and Figure 3A). *Id.* "Each sector would then transmit its pilot on only the subbands in its assigned set." *Id.*

A POSA would have been motivated to implement the Ketchum '627 system so that a base station transmits beacon pilots on a first plurality of subcarriers that are not aligned in frequency with subcarriers of at least another cell onto which respective cell-specific pilots are inserted, as taught by Smee. Ketchum '627's base stations transmit beacon pilots on certain subcarriers. Ketchum '627 explains that downlink communication channels can experience "external interference." Ketchum '627 at [0006]. But although Ketchum '627 discloses techniques for combating "inter-symbol interference" (*Id.* at [0036]) between different OFDM symbols transmitted by the base station (i.e., within the same cell) (*Id.* [0036]), Ketchum '627 does not explicitly disclose techniques for combating inter-cell interference between signals transmitted by adjacent base stations (cells). Thus, a POSA would have sought references for combating such

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inter-cell interference. Smee is such a reference. Smee's "frequency orthogonality" techniques, described above, "may be used to avoid interference resulting from simultaneous transmission of pilots by multiple base stations." Smee at [0043]. OFDM subcarriers do not experience subcarrier interference because the subcarriers are spaced orthogonally to each other. Thus, by causing adjacent cells to transmit pilots on "disjoint sets of subbands" (Smee at [0010]), such inter-cell interference is avoided. Smee at [0043].

A POSA would have understood that Smee's frequency orthogonality techniques would achieve similar benefits in Ketchum '627's system. A POSA would have thus been motivated to implement the Ketchum '627 system so that a first base station (cell) transmits beacon pilots on a first set of subcarriers, and an adjacent base station (cell) transmits beacon pilots on a second set of subcarriers, as taught by Smee. And a POSA would have had a reasonable expectation of success in implementing such techniques. Indeed, Ketchum '627 discloses that the beacon pilots are provided on "12 specific subbands" out of "52 'usable' subbands." Ketchum '627 at [0035], [0039]. Ketchum '627 also discloses flexibility in determining which subbands are used for providing the beacon pilots. *E.g., id.*, [0040]-[0041] (describing an "exemplary embodiment" of an OFDM symbol in which beacon pilots are transmitted), [0221] ("Various other pilot transmission schemes may also be implemented"). A POSA would have thus readily understood how to implement Ketchum '627's base stations so that adjacent base stations transmit beacon pilots on disjoint subbands or subcarriers. In this manner, a POSA would have understood that such implementation would merely amount to the use

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of a known technique (Smee's frequency orthogonality technique) to improve similar devices (Ketchum '627 and Smee's base stations) in the same way (avoiding interference from adjacent base stations/cells).

f. The '302 Patent

A person of ordinary skill in the art would have been motivated to combine or modify each piece of prior art identified in Sections III.B-E in such a way as to render the asserted claims of the '302 patent invalid. For example, Defendants identify at least the following grounds (and similar permutations based on the listed references) that render the asserted claims of the '302 patent invalid under 35 U.S.C. § 103:

(i) Harel '308 in combination with the knowledge of a skilled artisan, Tong '798, Krishnan '062, Ketchum '291, Uesugi '133, Sudo '141, Walton '301, and/or Cudak '256

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Harel '308 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Harel '308 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '302 patent was filed. Specifically:

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- Harel ’308, Tong ’798, Krishnan ’062, Ketchum ’291, Uesugi ’133, Sudo ’141, Walton ’301, and/or Cudak ’256 are all directed to systems and methods for improving the channel quality in multi-carrier communications environments. For example, they relate to wireless communications, and in particular to channel quality probing, estimation, and improvement. They involve communication protocols and standards, transmission methods (e.g., OFDM, CDMA, MIMO), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Harel ’308 and Tong ’798:** Tong ’798 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Tong ’798 teaches and describes “an effective way to create a virtual MIMO transmission system using mobile terminals that have only one transmit path and antenna . . . by assigning mobile terminals to a group and assigning certain shared resources and user-specific resources to those mobile terminals in the group.” Tong ’798 at Abstract. Tong ’798 describes a base station in which “signals are demodulated and amplified by corresponding RF circuitry 74.” *Id.* at 5:10-14, Fig. 5. Within the circuitry is a channel estimation function, which “provides channel responses corresponding to channel conditions for use by a diversity decoder 88. . . . The channel estimates provide sufficient channel response information to allow the diversity decoder 88 to decode the symbols according to the transmission and/or encoding used by the mobile terminal 16.” *Id.* at 5:37-45, Fig. 5. In addition, a “signal processing function 84 processes basic signaling and header information to

provide information sufficient to generate a channel quality measurement[.]" *Id.* at 5:31-36. Based on the data recovered "[a] channel quality indicator (CQI) may be determined . . . to monitor signal-to-noise ratios, error rates, and [the] like to derive information bearing on individual or overall channel quality." *Id.* at 5:66-6:4. Harel '308 similarly provides systems and methods for improving channel quality: "Although most of the carrier frequencies carry information, some of the carrier frequencies are 'overhead' that are used for management, estimation and calibration of the OFDM channel (i.e., the allocated spectrum used for the OFDM modulation). These 'overhead' carrier frequencies are referred to herein as pilots that can carry pilot signals." Harel '308 at [005]. Pilot signals can be "used to improve the frequency offset, phase noise, amplitude normalization, accurate symbol timing, and/or group delay at the receiver" and additionally can "serve as a channel estimator[.]" *Id.* Thus, these references were in the same field of endeavor, and shared at least one fundamental goal of improving channel quality by providing systems and methods to estimate channel quality. It would have been obvious for a POSITA to combine Harel '308 with Tong '798 at least because Harel '308 provides techniques for estimating channel quality (such as those disclosed in Tong '798) in order to improve channel quality via feedback, symbol timing adjustment, and/or noise reduction.

- **Harel '308 and Krishnan '062:** Krishnan '062 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Krishnan '062 teaches and describes "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system." Krishnan '062 at Abstract. "Pilot

transmissions from the terminals are received, and a channel estimate is derived for each terminal based on the pilot received on the assigned subbands." *Id.* As described by Krishnan '062, "[a]n accurate estimate of the response of the wireless channel between the transmitter and the receiver is normally needed in order to effectively transmit data on the available subbands[,]" which "is typically performed by sending a pilot from the transmitter and measuring the pilot at the receiver." *Id.* at 1:53-61. But "[p]ilot transmission represents overhead in a wireless communication system [and therefore] it is desirable to minimize pilot transmission to the extent possible." *Id.* at 1:62-64. At least one goal of Krishnan '062 was "to transmit pilot signals in a more efficient manner in wireless communication systems (e.g., OFDM systems)." *Id.* at 2:36-39. Similarly, Harel '308 teaches the use of pilot signals "to improve the frequency offset, phase noise, amplitude normalization, accurate symbol timing, and/or group delay at the receiver." Harel '308 at [005]. Thus, these references were in the same field of endeavor, and shared at least the goal of using pilot signals to improve signal quality in wireless communication systems such as those employing OFDM. It would have been obvious for a POSITA to combine Harel '308 with Krishnan '062 at least because Harel '308 provides methods for using pilot signals (such as those disclosed in Krishnan '062) in order to enhance signal quality in wireless communication systems.

- **Harel '308 and Ketchum '291:** Ketchum '291 teaches and describes "MAC [Medium Access Control] processing for efficient use of high throughput systems[.]" Ketchum '291 at Abstract. MAC "protocols are commonly used to

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allocate a shared communication resource between a number of users" and "must be designed to utilize the shared resource efficiently" in order "[t]o benefit from an increase in data rates[.]" *Id.* at [0023]. Ketchum '291 teaches that among the "[v]arious techniques . . . for learning or adapting to the characteristics of the channel between the [Access Point] and a [User Terminal, u]nique pilots may be transmitted from each transmit antenna [and] received at each receive antenna and measured." *Id.* at [0075]. From this measurement, "[c]hannel feedback may then be returned to the transmitting device for use in transmission." *Id.* According to Ketchum '291, "depending on the current channel conditions, varying data rates may be available for transmission to various user terminals throughout the system." *Id.* at [0076]. Thus, these references were in the same field of endeavor, and shared the goal of improving signal quality through the use of feedback techniques. It would have been obvious for a POSITA to combine Harel '308 with Ketchum '291 at least because Harel '308 provides methods and techniques for channel feedback and quality estimation (such as those disclosed in Ketchum '291) in order to improve system efficiency, data throughput, and/or channel quality.

- **Harel '308 and Uesugi '133:** Uesugi '133 teaches and describes "a data transmission apparatus capable of improving the frequency utilization efficiency at both ends of a band[.]" Uesegi '133 at 3:24-30. This capability "is achieved by a multi-carrier transmission method that sets the distance between sub-carriers so that they may be orthogonal to one another, assigns a plurality of sub-carriers to a specific band and assigns low speed variable signals to the guard frequency parts set at both ends of the specific band." *Id.* at 3:31-36. Similarly, Harel '308 has a

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goal "an improved system and method that can significantly reduce the amount of spectrum allocated to communicate a given amount of data or that can significantly increase the amount of data for a given amount of allocated spectrum." Harel '308 at [0004]. Thus, these references were in the same field of endeavor, and shared at least the fundamental goal of improving spectral efficiency in a multi-carrier wireless communications system. It would have been obvious for a POSITA to combine Harel '308 with Uesugi '133 at least because Harel '308 provides methods to improve data signal and throughput in an OFDM scheme (such as those disclosed in Uesugi '133) in order to increase spectral efficiency.

- **Harel '308 and Sudo '141:** Sudo '141 teaches and describes methods and techniques for selecting, for each subcarrier, "[t]he multiplexing degree of the code division multiplexed signal to be transmitted by each subcarrier[.]" Sudo '141 (translation) at Abstract. Sudo '141 teaches that for such subcarrier-specific selection, "unlike situations in which the signal multiplexing degree is determined uniformly for all subcarriers, deterioration in the error rate performance of important information can be prevented without significantly reducing spectrum efficiency, and both good frequency utilization efficiency and error rate performance can be achieved." *Id.* One goal of Sudo '141 is to improve channel quality, particularly for channels carrying important signals "such as retransmission information of control information" by providing lower multiplexing for such channels. *Id.* at [0035]. In addition, the apparatus disclosed in Sudo '141 uses a combination of OFDM and CDMA to leverage "frequency selective fading" (OFDM) with "excellent interference resistance" CDMA. *Id.* at [0002]. Harel '308

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similarly combines OFDM with some aspects of CDMA by providing "a coded group of pilot signals associated with a transmitter communication device[.]" Harel '308 at [0016]-[0017]. Harel '308 had as one goal to "significantly reduce the amount of spectrum allocated to communicate a given amount of data or that can significantly increase the amount of data for a given amount of allocated spectrum." *Id.* at [0004]. Thus, these references were in the same field of endeavor, and shared at least the common goal of improving spectral efficiency. It would have been obvious for a POSITA to combine Harel '308 with Sudo '141 at least because Harel '308 provides techniques for reducing inter-channel interference and errors (such as those disclosed in Sudo '141) in order to optimize spectral efficiency in a wireless communication system.

- **Harel '308 and Walton '301:** Walton '301[7] teaches and describes "[a] multiple-access MIMO WLAN system . . . [that] supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities [and] employs a pilot structure with several types of pilot . . . for different functions . . . ." Walton '301 at Abstract. Walton '301 further describes "[a] pilot structure with several types of pilot used for different functions" such as frequency and system acquisition, channel estimation or phase tracking. *Id.* at 3:50-55. One goal of Walton '301 is to provide "a MIMO WLAN system capable of supporting multiple uses and providing high system performance." *Id.* at 2:1-3. Thus, these references were in the same field of endeavor, and shared at least the

[7] Walton '301 is charted separately against the '908 patent.

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fundamental goal of improving performance in multiple-access wireless communication systems. It would have been obvious for a POSITA to combine Harel '308 with Walton '301 at least because Harel '308 provides techniques for using pilot signals (such as those disclosed in Walton '301) in order to improve system performance.

- **Harel '308 and Cudak '256:** Cudak '256 teaches and describes a method and system for providing feedback about channel quality between a base station and a remote station in a wireless communication system. Cudak '256 at Abstract. The method involves a base station requesting quality information from one or more remote stations, in response to which the remote station(s) will transmit the information requested until it is received by the base station. *Id.* The base station then "adjusts the modulation and coding of the remote stations accordingly." *Id.* One goal of Cudak '256 is to provide an efficient use of uplink resources by providing only that channel quality information that is necessary to improve performance, without wasting uplink resources on unnecessary information. *Id.* at [0003]-[0004]. Similarly, Harel '308 has the goal of efficiently using system resources for channel estimation. Harle '308 at [0015]-[0018]. Thus, these references were in the same field of endeavor, and shared at least the goal of efficiently using system resources to improve channel quality. It would have been obvious for a POSITA to combine Harel '308 with Cudak '256 at least because Harel '308 provides techniques for reducing redundant information transmission and reception (such as those disclosed in Cudak '256) in order to improve resource use efficiency.

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(ii) Tong ’798 in combination with the knowledge of a skilled artisan, Ma ’858, Ketchum ’627, Cudak ’256, Smee, ’007, Walton ’538, Ma ’429, Walton ’609, Krishnan ’062, Ketchum ’291, Harel ’308, Walton ’301, Jacobsen, Sumasu, Auer, Engstrom, Wahlqvist, Uesugi ’133, Sudo ’141, and/or Nee

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Tong ’798 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Tong ’798 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’302 patent was filed. Specifically:

- Tong ’798, Ma ’858, Ketchum ’627, Cudak ’256, Smee, ’007, Walton ’538, Ma ’429, Walton ’609, Krishnan ’062, Ketchum ’291, Walton ’301, Jacobsen, Sumasu, Auer, Engstrom, Wahlqvist, Uesugi ’133, Sudo ’141, and Nee are all directed to systems and methods for estimating channel characteristics, for instance, based on probing or pilot signals. For example, these references all relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g.,

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OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Tong '789 and Ma '858**: Ma '858 teaches and describes the use of "pilot signals for channel estimation and interference suppression." Ma '858 at 7:49-54. Ma '858 further discloses that the pilot signals include a "pseudo-noise sequence" that is used to identify the sender of the pilot signal. *Id*. at 11:9-13. One goal of Ma '858 is to "use[] a pilot signal for channel parameter estimation to keep track of channel characteristics caused by the movement of the mobile terminal." *Id.* at 9:47-54. Tong '789 further teaches a base station that "extract[s] pilot signals" from uplink signals to "estimate the MIMO channels" between mobile terminals and the base station. Tong '789 at 9:18-28. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious for a POSITA to combine Tong '789 with Ma '858 such that Tong '789's pilot signals include pseudo-noise sequences for identifying the sender of the pilots. Ma '858's pilot teachings further provide benefits in "initial interference measurement," and in "determin[ing] the relative transmission delays" of the pilot transmissions. Ma '858 at 9:11-20, 19:38-42.
- **Tong '789 and Ketchum '627:** Ketchum '627 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ketchum '627 teaches and describes "[p]ilots suitable for use in MIMO systems

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and capable of supporting various functions." Ketchum '627 at Abstract. Ketchum '627 teaches that "MIMO pilots" are provided in uplink signals and are "used for channel estimation." *Id*. at Abstract, [0132]. Ketchum '627 further teaches that "[v]arious orthogonal codes may be used to cover" the MIMO pilots to "allow for identification of the individual transmit antennas." *Id*. at [0051], [0091]. Tong '789 further teaches mobile terminals that are "MIMO compliant" in that they have "two transmission paths and antennas." Tong '789 at 8:12-17, *see also* 6:59-61. These mobile terminals are configured to send pilot signals on the uplink to enable base stations to estimate the channel. *Id*. at 8:12-19. Thus, these references were in the same field of endeavor, and shared the same fundamental goal enabling base stations to estimate channel conditions using pilot signals received from mobile terminals. It would have been obvious and predictable for a POSITA to combine Tong '789 and Ketchum '627 such that Tong '789's pilot signals were covered using orthogonal codes to "allow for identification of the individual transmit antennas" that sent the pilot signals *Id*. at [0051], [0091].

- **Tong '789 and Cudak '256**: Cudak '256 teaches "a method and apparatus for providing channel-quality feedback" in which "a base station will request the transmission of quality information from [] particular remote stations only when data is queued to be transmitted to the remote stations." Cudak '256 at [0013]. "The base station receives the channel quality information and adjusts the modulation and coding of the remote stations accordingly." *Id*. The received channel quality information can include a "channel sounding waveform," which is "a known waveform received by the transmitter and used to estimate the channel at the

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transmitter." Cudak '256 at [0040]. Cudak '256 explains that its communication techniques are advantageous for "providing channel quality feedback within a communication system that does not provide unnecessary feedback, wasting uplink resources." *Id*. at [0004]. Tong '789 further teaches a base station that assigns uplink resources for pilot signal transmission by different mobile terminals. Tong '798 at 7:11-31. The base station receives and "extract[s] pilot signals" from uplink signals to "estimate the MIMO channels" between mobile terminals and the base station. Tong '789 at 9:18-28. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious for a POSITA to combine Tong '789 with Cudak '256 such that Tong '789's base station requests sounding waveforms, or pilot signals, from mobile stations when data is queued to be transmitted to the remote stations. A POSA would have recognized that such techniques would conserve uplink resources, as explicitly taught by Cudak '256.

- **Tong '789 and Smee '007**: Smee '007 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Smee '007 teaches "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems." Smee '007 at Abstract. The pilot schemes utilize time and/or frequency orthogonality. *Id*. Time orthogonality is achieved by transmitting pilots using different orthogonal codes (e.g., Walsh codes). *Id*. "The pilots may also be scrambled with different scrambling codes, which are used to randomize pilot interference and to enable identification of the transmitters of these

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pilots." *Id*. Smee '007 explains that its techniques "efficiently facilitate both channel estimation and pilot detection." *Id*. at [0011]. "These schemes allow terminals in the system to obtain high quality wideband channel estimates and pilot strength estimates." *Id*. Smee '007's schemes also enable the system to "estimate and cancel pilot interference." *Id*. at [0012]. Tong '789 further teaches a base station that assigns uplink resources for pilot signal transmission by different mobile terminals. Tong '798 at 7:11-31. The base station receives and "extract[s] pilot signals" from uplink signals to "estimate the MIMO channels" between mobile terminals and the base station. Tong '789 at 9:18-28. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious for a POSITA to combine Tong '789 with Smee '007 at least because Smee '007 provides efficiencies and implementation details for implementing Tong '798's goal of channel estimation via pilot signals. Indeed, a POSITA would have understood that Smee '007's above-described benefits would be achieved by implementing Smee '007's teachings in Tong '789.

- **Tong '789 and Walton '538**: Walton '538 teaches "a multiple-access OFDM-CDMA system" in which "data spreading is performed in the frequency domain by spreading each data stream with a respective spreading code selected from a set of available spreading codes." Walton '538 at Abstract. "A pilot may be transmitted by each transmitter unit to assist the receiver units perform acquisition, timing synchronization, carrier recovery, handoff, channel estimation, coherent data

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demodulation, and so on." *Id*. The "pilot data is spread (e.g., in the frequency domain) with a known spreading code (e.g., Walsh code 0) and…may further be covered with a cover code." *Id*. at [0119]. This enables the receivers to "discriminate and distinguish the different transmitters of the pilots by their unique cover codes." *Id*. Tong '789 further teaches a base station that assigns uplink resources for pilot signal transmission by different mobile terminals. Tong '798 at 7:11-31. The base station receives and "extract[s] pilot signals" from uplink signals to "estimate the MIMO channels" between mobile terminals and the base station. Tong '789 at 9:18-28. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious for a POSITA to combine Tong '789 with Walton '538 at least because Walton '538 provides efficiencies and implementation details for implementing Tong '798's goal of channel estimation via pilot signals. Indeed, a POSITA would have understood that such teaching would enable Tong '798's system to better distinguish the different pilot transmitters, as taught by Walton '538.

- **Tong '789 and Ketchum '291:** Ketchum '291 discloses wireless communication systems that implement techniques for "MAC processing for efficient use of high throughput systems." Ketchum '291 at [0025]. Ketchum '291 further teaches the use of pilot signals "for learning or adapting to the characteristics of the channel between" a base station and mobile terminals. *Id*. at [0075]. "Channel feedback may then be returned to the transmitting device for use in transmission." *Id*. For

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instance, Ketchum ’291 teaches using “different coding and modulation scheme[s] based on the channel quality.” *Id*. at [0136]-[0137]. Tong ’789 further teaches a base station that assigns uplink resources for pilot signal transmission by different mobile terminals. Tong ’798 at 7:11-31. The base station receives and “extract[s] pilot signals” from uplink signals to “estimate the MIMO channels” between mobile terminals and the base station. Tong ’789 at 9:18-28. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious for a POSITA to combine Tong ’789 with Ketchum ’291 at least because Ketchum ’291 provides efficiencies and implementation details for implementing Tong ’798’s goal of channel estimation via pilot signals. Ketchum ’291 further discloses benefits in adapting transmission schemes based on such channel estimation.

- **Tong ’789 and Harel ’308:** Harel ’308 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Harel ’308 teaches an “OFDM multiple-access scheme [that] has multiple OFDM transmitters using at least overlapping frequency spectrums, during at least overlapping time period, in at least overlapping geographic areas.” Harel ’308 at Abstract. Harel ’308 further teaches the use of pilot signals for channel estimation. *Id*. at [0005]. “Each pilot signal from the set of pilot signals is uniquely associated with its own code from a set of codes.” *Id*. at Abstract. “A group of pilot signals from the set of pilot signals is identified based on its uniquely associated code.” *Id*. The code can further identify the device that transmitted the pilot. *Id*. at [0020]. For instance, “four pilots

signals modulated with BPSK modulation can generate up to 16 unique codes," such that "up to 16 different transmitting communication devices can use the same frequency channel, at the same time, in the same geographic area." *Id*. Tong '789 further teaches a base station that assigns uplink resources for pilot signal transmission by different mobile terminals. Tong '798 at 7:11-31. The base station receives and "extract[s] pilot signals" from uplink signals to "estimate the MIMO channels" between mobile terminals and the base station. Tong '789 at 9:18-28. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious for a POSITA to combine Tong '789 with Harel '308 at least because Harel '308 provides efficiencies and implementation details for implementing Tong '798's goal of channel estimation via pilot signals. For instance, a POSA would have understood that Harel '308's pilot coding techniques would enable frequency reuse in the same geographic area.

- **Tong '789 and Ma '429:** Ma '429 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '429 teaches "a new uplink OFDM protocol." Ma '429 at Abstract. More specifically, Ma '429 teaches that an "OFDM band is divided into two frequency bands 51, 53 which can be used interchangeably to provide two different OFDMA modes." *Id*. at [0124]. Tong '789 provides a virtual MIMO transmission system for mobile terminals that have only one transmit path and antenna by assigning shared resources (e.g., a common sub-carrier block) to transmit data (including voice and control

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information) and assigning user-specific resources to pilot signals. Tong ’789 at 1:46-56, 3:65-4:1, 6:56-59. However, Tong ’789 does not address how to improve data rate in the uplink transmissions to provide connectivity for higher rate bursty packet. Furthermore, although Tong ’789 uses the pilot signals for channel estimation in the uplink transmission, Tong ’789 does not teach how the channel estimation is used in the subsequent transmissions. *Id*. at 5:6-9, FIG. 7. A POSA would have understood that an important aspect of channel estimation is to use those estimates to dictate future transmissions. Because Tong ’789 does not disclose such teachings, a POSA would have been motivated to look to the prior art, such as Ma ’429, for such details, especially in the context of an orthogonal frequency division multiplexing (OFDM) system supporting multiple users.

Like Tong ’789, Ma ’429 discloses multiple access wireless communication systems employing OFDM. Ma ’429 at [0110]. However, Ma ’429 emphasizes the importance of separating uplink transmissions into two transmission modes: a low rate mode in a first frequency band and a burst mode in a second frequency band that is distinct from the first frequency band. *Id*. at [0010], [0124], Abstract. “This has the effect of significantly reducing intra-cell interference.” *Id*. at [0135]. Ma ’429 also teaches that resource allocation for the two transmission modes can be dynamically configured based on the traffic load. *Id*. at [0126].

Based on the teachings of Ma ’429, a POSA would have been motivated to modify Tong ’789 so as to incorporate Ma ’429’s low rate transmission mode and the burst mode transmission at least for the purpose of improving Tong ’789’s uplink transmissions and reducing interference. Furthermore, a POSA would have been

motivated to modify Tong ’789 so as to incorporate Ma ’429’s teachings of adjusting the transmission rate of the burst mode according to the measurements from the pilot signals in the low rate mode transmissions—e.g., an example of using channel estimation to dictate future transmissions. Ma ’429 at [0255]-[0262]. A POSA would have understood that modifying Tong ’789 with Ma ’429 would have required minimal modifications. For example, Tong ’789’s second portion of spectrum used to transmit data including control information, can be divided into two frequency bands like in Ma ’429 for Mode-1 and Mode-2 transmissions, respectively. The resulting system would then process data transmissions in each mode in the same or similar manner as disclosed in Tong ’789. The resulting system would also then use Tong ’789’s pilot signals P1 and P2 to perform channel estimation, and use those estimates to dictate the Mode-1 and Mode-2 transmissions.

In addition to the motivations described above, a POSA would have been further motivated to combine Tong ’789 and Ma ’429 because both are in the same field—wireless communication systems employing OFDM—and address the same problem—reducing interference between uplink transmission from multiple terminals. Ma ’429 at [0110], [0135]; Tong ’789 at 5:6-9, 7:53-58. Additionally, both Ma ’429 and Tong ’789 use pilot signals for channel estimation. Ma ’429 at [0110], [0202], FIG. 14; Tong ’789 at 1:6-9, 5:6-9, FIG. 7. And while Ma ’429 and Tong ’789 both support MIMO operations, neither system requires multiple antennas for the mobile terminals. Ma ’429 at [0139]-[0140]; Tong ’789 at 8:12-19. Further, as evident from the above discussion, a POSA would have combined

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the system of Tong ’789 with the teachings of Ma ’429 by known methods and the results of the combination would have been predictable to a POSA (e.g., improved uplink transmission with dual-mode). Finally, the proposed combination of Tong ’789 and Ma ’429 would involve nothing more than incorporating well-known concepts (i.e., dividing the resources into different frequency bands for dual mode transmission) into a well-known system (i.e., Tong ’789’s OFDM system).

- **Tong ’789 and Walton ’609:** Walton ’609 teaches and describes “[c]losed-loop rate control for data transmission on multiple parallel channels.” Walton ’609 at Abstract. More specifically, Walton ’609 teaches an access point that “selects [] transmission modes” based on pilot signals received from a mobile terminal. Walton ’609 at 14:58-15:3, 23:19-21. “A transmission mode may indicate (or may be associated with) a particular data rate, a particular coding scheme or code rate, a particular interleaving scheme, a particular modulation scheme, and so on, to use for data transmission.” *Id*. at 3:36-53. Tong ’789 further teaches base stations that receive pilot signals from mobile terminals. Tong ’789 at Abstract. Tong ’789’s base stations “control[] how the information is relayed and transmitted from the various mobile terminals 16.” Tong ’789 at 9:34-38. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Tong ’789 and Walton ’609 at least because Walton ’609 provides techniques for Tong 789’s base station to control how information is transmitted

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from mobile terminals—by enabling the base stations to determine and select appropriate transmission modes for communication with mobile terminals. This would enable Tong '789's system to efficiently adapt to specific channel conditions.

- **Tong '789 and Krishnan '062**: Krishnan '062 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Krishnan '062 teaches "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system." Krishnan '062 at Abstract. On the uplink, "[p]ilot transmissions from the terminals are received" at a base station, and "a channel estimate is derived for each terminal based on the pilot received on the assigned subbands." *Id*. Krishnan further teaches that "the modulation scheme used by each terminal is not fixed, but can be selected based on the channel conditions." *Id*. at 11:17-29. Tong '789 further teaches base stations that receive pilot signals from mobile terminals to determine channel conditions. Tong '789 at Abstract. Tong '789's base stations further "control[] how the information is relayed and transmitted from the various mobile terminals 16." Tong '789 at 9:34-38. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. A POSA would have recognized the benefit in Tong '789 of controlling and selecting the modulation scheme for uplink transmissions based on the channel conditions, as taught by Krishnan '062. It would have been obvious and predictable for a POSITA to combine Tong '789 and Krishnan '062 at least because Krishnan '062 provides techniques for Tong 789's base station to control how information is transmitted

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from mobile terminals—by enabling the base stations to determine and select appropriate modulation schemes for communication with mobile terminals. This would enable Tong '789's system to efficiently adapt to specific channel conditions.

- **Tong '789 and Jacobsen:** Jacobsen teaches and describes that an "access point may select modulation orders on a per subcarrier basis for upstream communications received from the wireless communication devices." Jacobsen at Abstract. The modulation orders are selected based on "channel measurements" to "compensate for the channel effects." Jacobsen at [0019]-[0020]. Jacobsen explains that "selection of modulation orders may be performed as often as the channel conditions change, depending on the coherence time of the channel." Jacobsen at [0021]-[0022]. Tong '789 teaches that its system can use multiple different modulation schemes, such as "Quadrature Amplitude Modulation (QAM) or Quadrature Phase Shift Key (QPSK) modulation." Tong '789 further teaches the use of pilot signals to determine channel conditions. Tong '789 at 5:37-45. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Tong '789 and Jacobsen at least because Jacobsen provides techniques for determining and selecting different modulation orders or schemes based on channel conditions. Jacobsen explains that such techniques provide an "improved OFDM communication system… that allows an OFDM channel to approach its 'water-filling capacity.'" Jacobsen at [0004]. Such

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teachings would thus enable Tong '789's system to efficiently adapt to specific channel conditions.

- **Tong '789 and Sumasu:** Tong '798 uses user-specific pilot sub-carriers for pilot signals (e.g., pilot P1 and P2) to achieve virtual MIMO uplink transmissions for multiple mobile terminals. Tong '798 at 7:32-58, FIG. 8A. In one implementation, Tong '798 places the pilot signal P1 and P2 on the end of each sub-carrier block, where data including control information are placed in the middle of each sub-carrier block. *Id.* at 7:37-53, FIG. 8A. The goal of Tong '798's pilot placement strategy is to avoid interference between the pilot information provided by both of the mobile terminals UE1 and UE2 "to allow decoding of the transmitted information as if it were simultaneously transmitted from a single mobile terminal 16 having multiple transmission paths and antennas 40." *Id.* at 7:53-58.

  A POSA would have understood that other placement strategies for the pilot signals could also fulfill Tong '798's goal of avoiding interference between the pilot information transmitted from different UEs. In fact, a POSA would have understood that different pilot placement strategies would be beneficial in different circumstances. For example, a POSA would have understood that placing pilot signals in a center portion and data at outer portions of a sub-carrier block would have had the benefit of utilizing subcarriers involving DC components, which would not be used for information transmission by conventional multicarriers, as disclosed in Sumasu. Sumasu at Abstract. As the goal of pilot signals is to help the base station correctly decode the received data from the mobile terminals, the pilot signals are placed at different subcarriers that can inform the channel conditions for

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the subcarriers near the pilot subcarriers. With this, the pilot signals can be placed near the center, if the bandwidth used for carrying the data is narrow around the center or spread across the entire bandwidth if a wide bandwidth is used. In all, a POSA would have known that the placement of the pilot signals depends on the specific allocation of the bandwidth and may differ according to the situation. Various different pilot placement strategies were known a POSA before the effective filing date of the '302 patent. Therefore, a POSA would have been motivated to look to the prior art for other pilot placement strategies for use in Tong '798 to improve transmission efficiency while also fulfilling Tong '798's goal of avoiding interference between the pilot information transmitted from different UEs. Sumasu is such a reference.

Like Tong '798, Sumasu discloses an improved system and method of transmitting pilot signals for channel estimation, where the pilo t signals have time-varying patterns and can be sent using subcarriers involving DC components. Sumasu at [0030], [0052], FIG. 2. As explained, the DC subcarriers are often not used for carrying data because "the subcarriers involving DC components suffer deterioration of the decoding accuracy due to influences of DC offsets generated in analog circuits" and thereby the absence of data at the DC subcarriers can help the receivers. *Id*. at [0007], [0048]. The DC subcarriers, however, can be utilized to carry the pilot signals (not the data) since the patterns of the pilot signals are known to the receiver (whereas the data signals are not known) and become helpful for the receivers to decode the data received via the subcarriers near the DC subcarriers.

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Id. at [0048]-[0052], [0082]. Sumasu explicitly discloses placing the pilot signals in a center portion and data at outer portions of a subband. *Id*. at [0029], FIG. 2.

Based on the teachings of Sumasu, a POSA would have been motivated to modify Tong '798's system to incorporate Sumasu's technique of placing the pilot signals in a center portion of a subcarrier. Modifying Tong '798 with Sumasu would have required minimal modifications—e.g., merely placing Tong '798's pilot signal P1 and P2 in a center portion of the sub-carrier block, and placing the data including control information at the ends of the sub-carrier block using Tong '798's existing circuitry. A POSA would have been further motivated to combine Tong '798 and Sumasu because both are in the same general field of wireless communications, and address the same problem—avoiding interference between the pilot information transmitted from different UEs. Tong '798 at 5:6-9; Sumasu at ¶64. Further, as evident from the above discussion, a POSA would have combined the system of Tong '798 with the teachings of Sumasu by known methods, and the results of the combination would have been predictable to a POSA. Finally, the proposed combination of Tong '798 and Sumasu would involve nothing more than incorporating a well-known concept (i.e., pilot placement techniques) into a well-known system (i.e., Tong '798's OFDM system).

Therefore, a POSA would have been motivated to implement Sumasu's pilot signal scheme in Tong '798 to improve transmission efficiency.

- **Tong '789 and Auer:** Auer teaches and describes "pilot-symbol aided channel estimation" for "MIMO communication systems." Auer at 10. Auer teaches an "efficient use of pilot symbols" that provides "increased flexibility in channel

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estimation." *Id*. at 5. "The reason for this is that by dividing the separation task of the superimposed transmission signals in time and frequency direction, a more efficient usage of the pilot symbols is possible." *Id*. Tong '798 further teaches an uplink pilot configuration for channel estimation. Tong '798 at 5:6-9. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Tong '789 and Auer at least because Auer provides implementation details for uplink pilot signal configurations for use in achieving Tong '798's channel estimation function.

- **Tong '798 and Nee:** Nee is a textbook titled "OFDM For Wireless Multimedia Communications." Nee teaches "a two-dimensional channel estimator that estimates the reference values based on a few known pilot values." Nee at 96. Nee further teaches exemplary pilot patterns that can be used to perform such channel estimation. *Id*. Tong '798 further teaches an uplink pilot configuration for channel estimation. Tong '798 at 5:6-9. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Tong '789 and Nee at least because Nee provides implementation details for uplink pilot signal configurations that for use in achieving Tong '798's channel estimation function.

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- **Tong ’798 and Walton ’301:** Walton ’301 teaches “[a] multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD.” Walton ’301 at Abstract. Walton ’301’s system “supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities.” *Id*. Specifically, the rates and transmission modes “are configurable based on estimates of the channel conditions and may be independently selected for the downlink and uplink.” On the uplink, Walton ’301 implements a “pilot structure” to allow the access points “to perform…channel estimation.” Walton ’301 at 69:18-25. Tong ’789 further teaches base stations that receive pilot signals from mobile terminals to determine channel conditions. Tong ’789 at Abstract. Tong ’789’s base stations further “control[] how the information is relayed and transmitted from the various mobile terminals 16.” Tong ’789 at 9:34-38. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Tong ’789 and Walton ’301 such that Tong ’798’s system determines and selects appropriate code rates and transmission modes based on channel conditions, such as those determined through channel estimation. Indeed, Walton ’301 teaches that such techniques enable its system to “easily adapt to changing channel and loading conditions.” Walton ’301 at 2:22-24. The system is thus enabled to “achieve high performance,” and to “attain high throughput [and] combat deleterious path effects.” *Id*. at 2:7-38.

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- **Tong ’798 and Engstrom:** Engstrom teaches a “random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital radio communication system.” Engstrom at Abstract. “In [the] random access protocol, a mobile station transmits a known signal sequence to a base station.” *Id*. at 1:58-67. “The base station can lock onto the known sequence, detect it and estimate the time delay.” *Id*. Engstrom implements its random access protocol using “certain sub-carriers dedicated to the random access channel.” *Id*. at 3:31-40. Tong ’798 further teaches communication between a mobile station and a base station by “assigning mobile terminals to a group and assigning certain shared resources and user-specific resources to those mobile terminals in the group.” Tong ’798 at Abstract. “Preferably, the shared resources bear on how the data is transmitted, and the user-specific resources relate to pilot signals.” *Id*. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communication between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Tong ’789 and Engstrom at least because Engstrom teaches implementation details for implementing uplink signaling, such as that taught by Tong ’798.
- **Tong ’798 and Wahlqvist:** Wahlqvist teaches “[t]ime synchronization in the uplink of an OFDM system.” Wahlqvist, Title. Wahlqvist teaches certain “subcarriers dedicated for the RACH.” Wahlqvist at 3 (1571). “Other users will not utilize the random access dedicated subcarriers so the interference on these frequencies will only be background noise.” *Id*. Tong ’798 further teaches

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communication between a mobile station and a base station by "assigning mobile terminals to a group and assigning certain shared resources and user-specific resources to those mobile terminals in the group." Tong '798 at Abstract. "Preferably, the shared resources bear on how the data is transmitted, and the user-specific resources relate to pilot signals." *Id*. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communication between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Tong '789 and Wahlqvist at least because Wahlqvist teaches implementation details for implementing uplink signaling, such as that taught by Tong '798.

- **Tong '798 and Uesugi '133:** Uesugi '133 discloses a "data transmission apparatus" for an "OFDM system." Uesugi '133 at 5:7-11. The data transmission apparatus is "capable of improving the frequency utilization efficiency at both ends of a band." *Id*. 3:24-36. For instance, Uesugi '133 "assigns a plurality of sub-carriers to a specific band and assigns low-speed variable signals to the guard frequency parts set at both ends of the specific band." *Id*. Tong '798 further teaches communication between a mobile station and a base station by "assigning mobile terminals to a group and assigning certain shared resources and user-specific resources to those mobile terminals in the group." Tong '798 at Abstract. "Preferably, the shared resources bear on how the data is transmitted, and the user-specific resources relate to pilot signals." *Id*. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communication

between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Tong '789 and Uesugi '133 at least because Uesugi '133 teaches implementation details for implementing uplink signaling, such as that taught by Tong '798.

- **Tong '798 and Sudo '141:** Sudo '141 teaches a "radio transmitting apparatus and radio transmission method" for an OFDM system. Sudo '141 at 1:6-10. Sudo '141 teaches "allocating data such as retransmission information or control information, for which better channel quality is required than for other data, to subcarriers for which the degree of signal multiplexing is set low." *Id*. at 9:4-10. For instance, Sudo '141 teaches that, "[b]y reducing the degree of signal multiplexing of subcarriers at a distance from the center frequency… the transmission power of subcarriers at a distance from the center frequency can be decreased, and thus side lobes can also be decreased." *Id*. 10:37-46. Tong '798 further teaches communication between a mobile station and a base station by "assigning mobile terminals to a group and assigning certain shared resources and user-specific resources to those mobile terminals in the group." Tong '798 at Abstract. "Preferably, the shared resources bear on how the data is transmitted, and the user-specific resources relate to pilot signals." *Id*. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communication between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Tong '789 and Sudo '141 at least because Sudo '141 teaches

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implementation details for implementing uplink signaling, such as that taught by Tong '798.

(iii) Ma '429 in combination with the knowledge of a skilled artisan, Ketchum '627, Tong '798, Krishnan '062, Cudak '256, Ketchum '291, Sumasu, Auer, Engstrom, Wahlqvist, Uesugi '133, Sudo '141, and/or Nee

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Ma '429 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Ma '429 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '302 patent was filed. Specifically:

- Ma '429, Ketchum '627, Tong '798, Krishnan '062, Cudak '256, Ketchum '291, Sumasu, Auer, Engstrom, Wahlqvist, Uesugi '133, Sudo '141, and Nee are all directed to systems and methods for implementing wireless communication techniques between base stations and mobile stations. For example, these references all relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating

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resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Ma '429 and Ketchum '627:** Ketchum '627 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ketchum '627 teaches and describes "[p]ilots suitable for use in MIMO systems and capable of supporting various functions." Ketchum '627 at Abstract. Ketchum '627 teaches that "MIMO pilots" are provided in uplink signals and are "used for channel estimation." *Id*. at Abstract, [0132]. Ketchum '627 further teaches that an access point or base station can assign uplink pilot resources by "schedul[ing]" pilot transmissions. *E.g.,* Ketchum '627 at [0013], [0101]. Ma '429 teaches that a wireless terminal can "receiv[e] channel assignment information" from a base station for uplink transmission. Ma '429 at [0025], [0241]-[0242]. Ma's mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma '429 and Ketchum '627 at least because Ketchum '627 provides implementation details for assigning uplink signal resources for use in achieving Ma '429's channel estimation function. Ma '429 at [0132].

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- **Ma ’429 and Tong ’798:** Tong ’798 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Tong ’798 teaches and describes that a base station “assign[s] mobile terminals to a group and assign[s] certain shared resources and user-specific resources to those mobile terminals in the group.” Tong ’798 at Abstract. The user-specific resources include “pilot sub-carriers.” Tong ’798 at 7:11-17. Tong ’798’s mobile terminals transmit pilot signals that were “previously assigned by the base station” so that the base station can perform channel estimation. Tong ’798 at 5:4-9. Ma ’429 teaches that a wireless terminal can “receiv[e] channel assignment information” from a base station for uplink transmission. Ma ’429 at [0025], [0241]-[0242]. Ma’s mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma ’429 and Tong ’798 at least because Tong ’798 provides implementation details for assigning uplink signal resources for use in achieving Ma ’429’s channel estimation function. Ma ’429 at [0132].
- **Ma ’429 and Krishnan ’062:** Krishnan ’062 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Krishnan ’062 teaches “[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system." Krishnan ’062 at Abstract. On the uplink, “[p]ilot transmissions from the terminals are received,” at a base station, and “a channel

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estimate is derived for each terminal based on the pilot received on the assigned subbands." *Id*. Krishnan '062 further teaches that "[o]ne group of subbands is assigned to each active terminal for uplink pilot transmission," and "[t]he subband assignment may be determined at call setup or at a later time, and may be signaled to the terminal." *Id.,* 7:61-64, FIG. 5. Ma '429 teaches that a wireless terminal can "receiv[e] channel assignment information" from a base station for uplink transmission. Ma '429 at [0025], [0241]-[0242]. Ma 429's mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma '429 and Krishnan '062 at least because Krishnan '062 provides implementation details for assigning uplink signal resources for use in achieving Ma '429's channel estimation function. Ma '429 at [0132].

- **Ma '429 and Cudak '256:** Cudak '256 teaches "a method and apparatus for providing channel-quality feedback" in which "a base station will request the transmission of quality information from [] particular remote stations only when data is queued to be transmitted to the remote stations." Cudak '256 at [0013]. "The base station receives the channel quality information and adjusts the modulation and coding of the remote stations accordingly." *Id*. The received channel quality information can include a "channel sounding waveform," which is "a known waveform received by the transmitter and used to estimate the channel at the

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transmitter." Cudak '256 at [0040]. Cudak '256 explains that its communication techniques are advantageous for "providing channel quality feedback within a communication system that does not provide unnecessary feedback, wasting uplink resources." *Id*. at [0004]. Ma '429 teaches that a wireless terminal can "receiv[e] channel assignment information" from a base station for uplink transmission. Ma '429 at [0025], [0241]-[0242]. Ma 429's mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma '429 and Cudak '256 such that Ma '429's base station requests sounding waveforms, or pilot signals, from mobile stations when data is queued to be transmitted to the remote stations. A POSA would have recognized that such techniques would conserve uplink resources, as explicitly taught by Cudak '256.

- **Ma '429 and Ketchum '291:** Ketchum '291 discloses wireless communication systems that implement techniques for "MAC processing for efficient use of high throughput systems." Ketchum '291 at [0025]. Ketchum '291 further teaches the use of pilot signals "for learning or adapting to the characteristics of the channel between" a base station and mobile terminals. *Id*. at [0075]. Ketchum '291 teaches use of a radio resource control (RRC) for "[a]llocation [of] dedicated physical layer overhead such as pilot signals." *Id*. at [0129]-[0134]. "Channel feedback may then be returned to the transmitting device for use in transmission." *Id*. For instance,

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Ketchum ’291 teaches using “different coding and modulation scheme[s] based on the channel quality.” *Id*. at [0136]-[0137]. Ma ’429 teaches that a wireless terminal can “receiv[e] channel assignment information” from a base station for uplink transmission. Ma ’429 at [0025], [0241]-[0242]. Ma 429’s mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma ’429 and Ketchum ’291 at least because Ketchum ’291 provides efficiencies and implementation details for implementing Ma ’429’s goal of channel estimation via pilot signals. Ketchum ’291 further discloses further benefits in adapting transmission schemes based on such channel estimation.

- **Ma ’429 and Sumasu:** Sumasu discloses an improved system and method of transmitting pilot signals for channel estimation, where the pilot signals have time-varying patterns and can be sent using subcarriers involving DC components. Sumasu at [0030], [0052], FIG. 2. In Samasu, the DC subcarriers are often not used for carrying data because “the subcarriers involving DC components suffer deterioration of the decoding accuracy due to influences of DC offsets generated in analog circuits” and thereby the absence of data at the DC subcarriers can help the receivers. *Id*. at [0007], [0048]. The DC subcarriers, however, can be utilized to carry the pilot signals (not the data) since the patterns of the pilot signals are known to the receiver (whereas the data signals are not known) and become helpful for the

receivers to decode the data received via the subcarriers near the DC subcarriers. *Id*. at [0048]-[0052], [0082]. Sumasu explicitly discloses placing the pilot signals in a center portion and data at outer portions of a subband. *Id*. at [0029], FIG. 2. Ma '429 teaches that pilot symbols are provided on the uplink "to support coherent detection." Ma '429 at [0132]. Ma '429 teaches that a wireless terminal can "receiv[e] channel assignment information" from a base station for uplink transmission. Ma '429 at [0025], [0241]-[0242]. Ma 429's mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma '429 and Sumasu at least because Sumasu provides efficiencies and implementation details for assigning uplink signal resources for use in achieving Ma '429's channel estimation function. Ma '429 at [0132].

- **Ma '429 and Auer:** Auer teaches and describes "pilot-symbol aided channel estimation" for "MIMO communication systems." Auer at 10. Auer teaches an "efficient use of pilot symbols" that provides "increased flexibility in channel estimation." *Id*. at 5. "The reason for this is that by dividing the separation task of the superimposed transmission signals in time and frequency direction, a more efficient usage of the pilot symbols is possible." *Id*. Ma '429 teaches that pilot symbols are provided on the uplink "to support coherent detection." Ma '429 at [0132]. Ma '429 teaches that a wireless terminal can "receiv[e] channel assignment

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information" from a base station for uplink transmission. Ma '429 at [0025], [0241]-[0242]. Ma 429's mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma '429 and Auer at least because Auer provides efficiencies and implementation details for assigning uplink signal resources for use in achieving Ma '429's channel estimation function. Ma '429 at [0132].

- **Ma '429 and Nee:** Nee is a textbook titled "OFDM For Wireless Multimedia Communications." Nee teaches "a two-dimensional channel estimator that estimates the reference values based on a few known pilot values." Nee at 96. Nee further teaches exemplary pilot patterns that can be used to perform such channel estimation. *Id*. Ma '429 teaches that pilot symbols are provided on the uplink "to support coherent detection." Ma '429 at [0132]. Ma '429 teaches that a wireless terminal can "receiv[e] channel assignment information" from a base station for uplink transmission. Ma '429 at [0025], [0241]-[0242]. Ma 429's mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma '429 and

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Nee at least because Nee provides efficiencies and implementation details for assigning uplink signal resources for use in achieving Ma '429's channel estimation function. Ma '429 at [0132].

- **Ma '429 and Engstrom:** Engstrom teaches a "random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital radio communication system." Engstrom at Abstract. "In [the] random access protocol, a mobile station transmits a known signal sequence to a base station." *Id*. at 1:58-67. "The base station can lock onto the known sequence, detect it and estimate the time delay." *Id*. Engstrom implements its random access protocol using "certain sub-carriers dedicated to the random access channel." *Id*. Ma '429 teaches that pilot symbols are provided on the uplink "to support coherent detection." Ma '429 at [0132]. Ma '429 teaches that a wireless terminal can "receiv[e] channel assignment information" from a base station for uplink transmission. Ma '429 at [0025], [0241]-[0242]. Ma 429's mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma '429 and Engstrom at least because Engstrom provides efficiencies and implementation details for assigning uplink signal resources for use Ma '429.
- **Ma '429 and Wahlqvist:** Wahlqvist teaches "[t]ime synchronization in the uplink of an OFDM system." Wahlqvist, Title. Wahlqvist teaches certain "subcarriers

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dedicated for the RACH." Wahlqvist at 3 (1571). "Other users will not utilize the random access dedicated subcarriers so the interference on these frequencies will only be background noise." *Id*. Ma '429 teaches that pilot symbols are provided on the uplink "to support coherent detection." Ma '429 at [0132]. Ma '429 teaches that a wireless terminal can "receiv[e] channel assignment information" from a base station for uplink transmission. Ma '429 at [0025], [0241]-[0242]. Ma 429's mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma '429 and Wahlqvist at least because Wahlqvist provides efficiencies and implementation details for assigning uplink signal resources for use Ma '429.

- **Ma '429 and Uesugi '133:** Uesugi '133 discloses a "data transmission apparatus" for an "OFDM system." Uesugi '133 at 5:7-11. The data transmission apparatus is "capable of improving the frequency utilization efficiency at both ends of a band." *Id*. 3:24-36. For instance, Uesugi '133 "assigns a plurality of sub-carriers to a specific band and assigns low-speed variable signals to the guard frequency parts set at both ends of the specific band." *Id*. Ma '429 teaches that pilot symbols are provided on the uplink "to support coherent detection." Ma '429 at [0132]. Ma '429 teaches that a wireless terminal can "receiv[e] channel assignment information" from a base station for uplink transmission. Ma '429 at [0025], [0241]-[0242]. Ma 429's mobile terminals then provide pilot signals on the uplink to enable the base

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station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ma '429 and Uesugi '133 at least because Uesugi '133 provides efficiencies and implementation details for assigning uplink signal resources for use Ma '429.

- **Ma '429 and Sudo '141:** Sudo '141 teaches a "radio transmitting apparatus and radio transmission method" for an OFDM system. Sudo '141 at 1:6-10. Sudo '141 teaches "allocating data such as retransmission information or control information, for which better channel quality is required than for other data, to subcarriers for which the degree of signal multiplexing is set low." *Id*. at 9:4-10. For instance, Sudo '141 teaches that, "[b]y reducing the degree of signal multiplexing of subcarriers at a distance from the center frequency… the transmission power of subcarriers at a distance from the center frequency can be decreased, and thus side lobes can also be decreased." *Id*. 10:37-46. Ma '429 teaches that pilot symbols are provided on the uplink "to support coherent detection." Ma '429 at [0132]. Ma '429 teaches that a wireless terminal can "receiv[e] channel assignment information" from a base station for uplink transmission. Ma '429 at [0025], [0241]-[0242]. Ma 429's mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM

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communication systems. It would have been obvious and predictable for a POSITA to combine Ma '429 and Sudo '141 at least because Sudo '141 provides efficiencies and implementation details for assigning uplink signal resources for use Ma '429.

(iv) Ketchum '627 in combination with the knowledge of a skilled artisan, Tong '798, Krishnan '062, Cudak '256, Ketchum '291, Smee '007, Harel '308, Walton '301, Ma '429, Walton '609, Jacobsen, Sumasu, Engstrom, Wahlqvist, Uesugi '133, Sudo '141, Nee, and/or Auer

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Ketchum '627 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Ketchum '627 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '302 patent was filed. Specifically:

- Ketchum '627, Tong '798, Krishnan '062, Cudak '256, Ketchum '291, Smee '007, Harel '308, Walton '301, Ma '429, Walton '609, Jacobsen, Sumasu, Engstrom, Wahlqvist, Uesugi '133, Sudo '141, Nee, and Auer are all directed to systems and methods for implementing wireless communications between base stations and mobile stations. For example, they relate to wireless communications, and in

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particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Ketchum '627 and Tong '798:** Tong '798 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Tong '798 teaches and describes that a base station "assign[s] mobile terminals to a group and assign[s] certain shared resources and user-specific resources to those mobile terminals in the group." Tong '798 at Abstract. The user-specific resources include "pilot sub-carriers." Tong '798 at 7:11-17. Tong '798's mobile terminals transmit pilot signals that were "previously assigned by the base station" so that the base station can perform channel estimation. Tong '798 at 5:4-9. Specifically, Tong '789's mobile terminals transmit uplink signals, including the pilot signals, "[i]n a synchronized fashion… in concert, as if they were a single entity having multiple transmission paths and antennas." Tong '789 at Abstract. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Ketchum '627 further discloses that "[e]ach user terminal may communicate with one or possibly multiple access points on the downlink and/or uplink at any given moment." Ketchum '627

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at [0027]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Tong '798 at least because Tong '798 provides implementation details for assigning uplink signal resources for use in achieving Ketchum '627's channel estimation function. Tong '798 further provides efficiencies in the coordination and configuration for transmission of uplink pilot, data, and control signals for various system functions.

- **Ketchum '627 and Krishnan '062:** Krishnan '062 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Krishnan '062 teaches "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system." Krishnan '062 at Abstract. On the uplink, "[p]ilot transmissions from the terminals are received," at a base station, and "a channel estimate is derived for each terminal based on the pilot received on the assigned subbands." *Id*. Krishnan '062 further teaches that "[o]ne group of subbands is assigned to each active terminal for uplink pilot transmission," and "[t]he subband assignment may be determined at call setup or at a later time, and may be signaled to the terminal." *Id.* at 7:61-64, FIG. 5. Thus, Krishnan '062 teaches uplink transmission schemes in which "[m]ultiple terminals may transmit simultaneously on their assigned subbands." *Id*. at Abstract, *see also* 6:45-56. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel."

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Ketchum ’627 at [0218]. Ketchum ’627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum ’627 at [0013], [0101]. Ketchum ’627 further discloses that “[e]ach user terminal may communicate with one or possibly multiple access points on the downlink and/or uplink at any given moment.” Ketchum ’627 at [0027]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum ’627 and Krishnan ’062 at least because Krishnan ’062 provides efficiencies and implementation details for assigning uplink signal resources for use in achieving Ketchum ’627’s channel estimation function. Krishnan ’062 further provides efficiencies in the coordination and configuration for transmission of uplink pilot, data, and control signals for various system functions.

- **Ketchum ’627 and Cudak ’256:** Cudak ’256 teaches “a method and apparatus for providing channel-quality feedback” in which “a base station will request the transmission of quality information from [] particular remote stations only when data is queued to be transmitted to the remote stations.” Cudak ’256 at [0013]. “The base station receives the channel quality information and adjusts the modulation and coding of the remote stations accordingly.” *Id*. The received channel quality information can include a “channel sounding waveform,” which is “a known waveform received by the transmitter and used to estimate the channel at the transmitter.” Cudak ’256 at [0040]. Cudak ’256 explains that its communication

techniques are advantageous for "providing channel quality feedback within a communication system that does not provide unnecessary feedback, wasting uplink resources." *Id*. at [0004]. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Ketchum '627 further discloses that "[e]ach user terminal may communicate with one or possibly multiple access points on the downlink and/or uplink at any given moment." Ketchum '627 at [0027]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Cudak '256 such that Ketchum '627's base station requests sounding waveforms, or pilot signals, from mobile stations when data is queued to be transmitted to the remote stations. A POSA would have recognized that such techniques would conserve uplink resources, as explicitly taught by Cudak '256.

- **Ketchum '627 and Ketchum '291:** Ketchum '291 discloses wireless communication systems that implement techniques for "MAC processing for efficient use of high throughput systems." Ketchum '291 at [0025]. Ketchum '291 further teaches the use of pilot signals "for learning or adapting to the characteristics of the channel between" a base station and mobile terminals. *Id*. at [0075]. "Channel feedback may then be returned to the transmitting device for use in

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transmission." *Id*. For instance, Ketchum '291 teaches using "different coding and modulation scheme[s] based on the channel quality." *Id*. at [0136]-[0137]. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Ketchum '627 further discloses that "[e]ach user terminal may communicate with one or possibly multiple access points on the downlink and/or uplink at any given moment." Ketchum '627 at [0027]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Ketchum '291 at least because Ketchum '291 provides efficiencies and implementation details for implementing Ketchum '627's goal of channel estimation via pilot signals. Ketchum '291 further discloses further benefits in adapting transmission schemes based on such channel estimation.

- **Ketchum '627 and Smee '007:** Smee '007 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Smee '007 teaches "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems." Smee '007 at Abstract. The pilot schemes utilize time and/or frequency orthogonality. *Id*. Time orthogonality is achieved by transmitting pilots using different orthogonal codes (e.g., Walsh codes). *Id*. "The pilots may also be scrambled with different scrambling codes, which are used to

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randomize pilot interference and to enable identification of the transmitters of these pilots." *Id*. Smee '007 explains that its techniques "efficiently facilitate both channel estimation and pilot detection." *Id*. at [0011]. "These schemes allow terminals in the system to obtain high quality wideband channel estimates and pilot strength estimates." *Id*. Smee '007's schemes also enable the system to "estimate and cancel pilot interference." *Id*. at [0012]. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Ketchum '627 further discloses that "[e]ach user terminal may communicate with one or possibly multiple access points on the downlink and/or uplink at any given moment." Ketchum '627 at [0027]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Smee '007 at least because Smee '007 provides efficiencies and implementation details for implementing Ketchum '627's goal of channel estimation via pilot signals.

- **Ketchum '627 and Harel '308:** Harel '308 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Harel '308 teaches an "OFDM multiple-access scheme [that] has multiple OFDM transmitters using at least overlapping frequency spectrums, during at least overlapping time period, in at least overlapping geographic areas." Harel '308 at Abstract. Harel '308

further teaches the use of pilot signals for channel estimation. *Id*. at [0005]. "Each pilot signal from the set of pilot signals is uniquely associated with its own code from a set of codes." *Id*. at Abstract. "A group of pilot signals from the set of pilot signals is identified based on its uniquely associated code." *Id*. The code can further identify the device that transmitted the pilot. *Id*. at [0020]. For instance, "four pilots signals modulated with BPSK modulation can generate up to 16 unique codes," such that "up to 16 different transmitting communication devices can use the same frequency channel, at the same time, in the same geographic area." *Id*. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Ketchum '627 further discloses that "[e]ach user terminal may communicate with one or possibly multiple access points on the downlink and/or uplink at any given moment." Ketchum '627 at [0027]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Harel '308 at least because Harel '308 provides efficiencies and implementation details for implementing Ketchum '627's goal of channel estimation via pilot signals. For instance, a POSA would have understood that Harel '308's pilot coding techniques would enable frequency reuse in the same geographic area.

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- **Ketchum ’627 and Ma ’429:** Ma ’429 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma ’429 teaches “a new uplink OFDM protocol.” Ma ’429 at Abstract. More specifically, Ma ’429 teaches that an “OFDM band is divided into two frequency bands 51, 53 which can be used interchangeably to provide two different OFDMA modes.” *Id*. at [0124]. Ma ’429 teaches that a wireless terminal can “receiv[e] channel assignment information” from a base station for uplink transmission. Ma ’429 at [0025], [0241]-[0242]. Ma ’429’s mobile terminals then provide pilot signals on the uplink to enable the base station to estimate the communication channel. Ketchum ’627 discloses that base stations, or access points, receive pilot signals from mobile terminals “to derive an estimate of the uplink channel.” Ketchum ’627 at [0218]. Ketchum ’627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum ’627 at [0013], [0101]. Ketchum ’627 further discloses that “[e]ach user terminal may communicate with one or possibly multiple access points on the downlink and/or uplink at any given moment.” Ketchum ’627 at [0027]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum ’627 and Ma ’429 at least because Ma ’429 provides efficiencies and implementation details for assigning uplink signal resources for use in achieving Ketchum ’627’s channel estimation function. Ma ’429 further provides efficiencies in the coordination and configuration for transmission of uplink pilot, data, and control signals for various

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system functions, more instance, by implementing multiple transmission modes for uplink signaling.

- **Ketchum '627 and Walton '609:** Walton '609 teaches and describes "[c]losed-loop rate control for data transmission on multiple parallel channels." Walton '609 at Abstract. More specifically, Walton '609 teaches an access point that "selects [] transmission modes" based on pilot signals received from a mobile terminal. Walton '609 at 14:58-15:3, 23:19-21. "A transmission mode may indicate (or may be associated with) a particular data rate, a particular coding scheme or code rate, a particular interleaving scheme, a particular modulation scheme, and so on, to use for data transmission." *Id*. at 3:36-53. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Walton '609 at least because Walton '609 provides efficiencies and implementation details for the coordination and configuration for transmission of uplink pilot, data, and control signals for various system functions, more instance, by implementing multiple selectable transmission modes for uplink signaling.
- **Ketchum '627 and Walton '301:** Walton '301 teaches "[a] multiple-access MIMO WLAN system that employs MIMO, OFDM, and TDD." Walton '301 at Abstract.

Walton ’301’s system “supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities.” *Id*. Specifically, the rates and transmission modes “are configurable based on estimates of the channel conditions and may be independently selected for the downlink and uplink.” On the uplink, Walton ’301 implements a “pilot structure” to allow the access points “to perform…channel estimation.” Walton ’301 at 69:18-25. Ketchum ’627 discloses that base stations, or access points, receive pilot signals from mobile terminals “to derive an estimate of the uplink channel.” Ketchum ’627 at [0218]. Ketchum ’627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum ’627 at [0013], [0101]. Ketchum ’627 further discloses that “[e]ach user terminal may communicate with one or possibly multiple access points on the downlink and/or uplink at any given moment.” Ketchum ’627 at [0027]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum ’627 and Walton ’301 such that Ketchum ’627’s system determines and selects appropriate code rates and transmission modes based on channel conditions, such as those determined through channel estimation. Indeed, Walton ’301 teaches that such techniques enable its system to “easily adapt to changing channel and loading conditions.” Walton ’301 at 2:22-24. The system is thus enabled to “achieve high performance,” and to “attain high throughput [and] combat deleterious path effects.” *Id*. at 2:7-38.

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- **Ketchum ’627 and Jacobsen:** Jacobsen teaches and describes that an “access point may select modulation orders on a per subcarrier basis for upstream communications received from the wireless communication devices.” Jacobsen at Abstract. The modulation orders are selected based on “channel measurements” to “compensate for the channel effects.” Jacobsen at [0019]-[0020]. Jacobsen explains that “selection of modulation orders may be performed as often as the channel conditions change, depending on the coherence time of the channel.” Jacobsen at [0021]-[0022]. Ketchum ’627 discloses that base stations, or access points, receive pilot signals from mobile terminals “to derive an estimate of the uplink channel.” Ketchum ’627 at [0218]. Ketchum ’627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum ’627 at [0013], [0101]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum ’627 and Jacobsen at least because Jacobsen provides techniques for determining and selecting different modulation orders or schemes based on channel conditions. Jacobsen explains that such techniques provide an “improved OFDM communication system… that allows an OFDM channel to approach its ‘water-filling capacity.’” Jacobsen at [0004].
- **Ketchum ’627 and Sumasu:** Sumasu discloses an improved system and method of transmitting pilot signals for channel estimation, where the pilot signals have time-varying patterns and can be sent using subcarriers involving DC components.

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Sumasu at [0030], [0052], FIG. 2. In Samasu, the DC subcarriers are often not used for carrying data because "the subcarriers involving DC components suffer deterioration of the decoding accuracy due to influences of DC offsets generated in analog circuits" and thereby the absence of data at the DC subcarriers can help the receivers. *Id*. at [0007], [0048]. The DC subcarriers, however, can be utilized to carry the pilot signals (not the data) since the patterns of the pilot signals are known to the receiver (whereas the data signals are not known) and become helpful for the receivers to decode the data received via the subcarriers near the DC subcarriers. *Id*. at [0048]-[0052], [0082]. Sumasu explicitly discloses placing the pilot signals in a center portion and data at outer portions of a subband. *Id*. at [0029], FIG. 2. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Sumasu at least because Sumasu provides efficiencies and implementation details for assigning uplink signal resources for use in achieving Ketchum '627's channel estimation function.

- **Ketchum '627 and Auer:** Auer teaches and describes "pilot-symbol aided channel estimation" for "MIMO communication systems." Auer at 10. Auer teaches an "efficient use of pilot symbols" that provides "increased flexibility in channel

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estimation." *Id*. at 5. "The reason for this is that by dividing the separation task of the superimposed transmission signals in time and frequency direction, a more efficient usage of the pilot symbols is possible." *Id*. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Auer at least because Auer provides efficiencies and implementation details for assigning uplink signal resources for use in achieving Ketchum '627's channel estimation function.

- **Ketchum '627 and Engstrom:** Engstrom teaches a "random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital radio communication system." Engstrom at Abstract. "In [the] random access protocol, a mobile station transmits a known signal sequence to a base station." *Id*. at 1:58-67. "The base station can lock onto the known sequence, detect it and estimate the time delay." *Id*. Engstrom implements its random access protocol using "certain sub-carriers dedicated to the random access channel." *Id*. at 3:31-40. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals

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are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Engstrom at least because Engstrom provides efficiencies and implementation details for assigning uplink signal resources for use in Ketchum '627.

- **Ketchum '627 and Wahlqvist:** Wahlqvist teaches "[t]ime synchronization in the uplink of an OFDM system." Wahlqvist, Title. Wahlqvist teaches certain "subcarriers dedicated for the RACH." Wahlqvist at 3 (1571). "Other users will not utilize the random access dedicated subcarriers so the interference on these frequencies will only be background noise." *Id*. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Wahlqvist at least because Wahlqvist provides efficiencies and implementation details for assigning uplink signal resources for use in Ketchum '627.

- **Ketchum ’627 and Uesugi ’133:** Uesugi ’133 discloses a “data transmission apparatus” for an “OFDM system.” Uesugi ’133 at 5:7-11. The data transmission apparatus is “capable of improving the frequency utilization efficiency at both ends of a band.” *Id*. 3:24-36. For instance, Uesugi ’133 “assigns a plurality of sub-carriers to a specific band and assigns low-speed variable signals to the guard frequency parts set at both ends of the specific band.” *Id*. Ketchum ’627 discloses that base stations, or access points, receive pilot signals from mobile terminals “to derive an estimate of the uplink channel.” Ketchum ’627 at [0218]. Ketchum ’627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum ’627 at [0013], [0101]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum ’627 and Uesugi ’133 at least because Uesugi ’133 provides efficiencies and implementation details for assigning uplink signal resources for use in Ketchum ’627.
- **Ketchum ’627 and Sudo ’141:** Sudo ’141 teaches a “radio transmitting apparatus and radio transmission method” for an OFDM system. Sudo ’141 at 1:6-10. Sudo ’141 teaches “allocating data such as retransmission information or control information, for which better channel quality is required than for other data, to subcarriers for which the degree of signal multiplexing is set low.” *Id*. at 9:4-10. For instance, Sudo ’141 teaches that, “[b]y reducing the degree of signal multiplexing of subcarriers at a distance from the center frequency… the

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transmission power of subcarriers at a distance from the center frequency can be decreased, and thus side lobes can also be decreased." *Id*. 10:37-46. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Ketchum '627 and Sudo '141 at least because Sudo '141 provides efficiencies and implementation details for assigning uplink signal resources for use in Ketchum '627.

- **Ketchum '627 and Nee:** Nee is a textbook titled "OFDM For Wireless Multimedia Communications." Nee teaches "a two-dimensional channel estimator that estimates the reference values based on a few known pilot values." Nee at 96. Nee further teaches exemplary pilot patterns that can be used to perform such channel estimation. *Id*. Ketchum '627 discloses that base stations, or access points, receive pilot signals from mobile terminals "to derive an estimate of the uplink channel." Ketchum '627 at [0218]. Ketchum '627 discloses that mobile terminals are assigned resources for uplink pilot transmission. *E.g.,* Ketchum '627 at [0013], [0101]. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been

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obvious and predictable for a POSITA to combine Ketchum '627 and Nee at least because Nee provides efficiencies and implementation details for assigning uplink signal resources for use in Ketchum '627.

(v) IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems—Amendment 2: Medium Access Control Modification and Additional Physical Layer Specifications for 2-11 GHz, IEEE 802.16a-2003 and IEEE Standard for Local and Metropolitan Area Networks - Part 16: Air Interface for Fixed Broadband Wireless Access Systems, IEEE 802.16a-2001 (collectively "WiMAX") in combination with the knowledge of a skilled artisan, Tong '798, Krishnan '062, Uesugi '133, Sudo '141, Auer, Nee, Engstrom, and/or Wahlqvist

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine WiMAX with each of these references. A person of ordinary skill in the art would have found it obvious to combine WiMAX with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '302 patent was filed. Specifically:

- WiMAX, Tong '798, Krishnan '062, Uesugi '133, Sudo '141, Auer, Nee, Engstrom, and/or Wahlqvist are all directed to systems and methods for implementing wireless

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communications between base stations and mobile stations. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **WiMAX and Tong '798:** Tong '798 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Tong '798 teaches and describes that a base station "assign[s] mobile terminals to a group and assign[s] certain shared resources and user-specific resources to those mobile terminals in the group." Tong '798 at Abstract. The user-specific resources include "pilot sub-carriers." Tong '798 at 7:11-17. Tong '798's mobile terminals transmit pilot signals that were "previously assigned by the base station" so that the base station can perform channel estimation. Tong '798 at 5:4-9. WiMAX teaches and describes an OFDM based communication system which could use a ranging signal as pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure" *See* WiMAX Source 2 at 37, 50, 51, 93 and 94. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine WiMAX and Tong '798 at least because Tong '798 provides

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implementation details for assigning uplink signal resources compatible with the WiMAX standard for OFDM signal transmission. Finally, the proposed combination of WiMAX and Tong '798 would involve nothing more than incorporating well-known concepts (i.e., Tong '798's implementation of pilot sub-carriers) into a well-known system (i.e., WiMAX's OFDM system).

- **WiMAX and Krishnan '062:** Krishnan '062 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Krishnan '062 teaches "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system." Krishnan '062 at Abstract. On the uplink, "[p]ilot transmissions from the terminals are received," at a base station, and "a channel estimate is derived for each terminal based on the pilot received on the assigned subbands." *Id*. Krishnan '062 further teaches that "[o]ne group of subbands is assigned to each active terminal for uplink pilot transmission," and "[t]he subband assignment may be determined at call setup or at a later time, and may be signaled to the terminal." *Id.,* 7:61-64, FIG. 5. WiMAX teaches and describes an OFDM based communication system which could use a ranging signal as pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure" *See* WiMAX Source 2 at 37, 50, 51, 93 and 94. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine WiMAX and Krishnan '062 at least because Krishnan '062 provides

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implementation details for assigning uplink signal resources compatible with the WiMAX standard for OFDM signal transmission. Finally, the proposed combination of WiMAX and Krishnan '062 would involve nothing more than incorporating well-known concepts (i.e., Krishnan '062's implementation of pilot sub-carriers) into a well-known system (i.e., WiMAX's OFDM system).

- **WiMAX and Uesugi '133:** Uesugi '133 discloses a "data transmission apparatus" for an "OFDM system." Uesugi '133 at 5:7-11. The data transmission apparatus is "capable of improving the frequency utilization efficiency at both ends of a band." *Id*. 3:24-36. For instance, Uesugi '133 "assigns a plurality of sub-carriers to a specific band and assigns low-speed variable signals to the guard frequency parts set at both ends of the specific band." *Id*. WiMAX teaches and describes an OFDM based communication system which could use a ranging signal as pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure" *See* WiMAX Source 2 at 37, 50, 51, 93 and 94. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine WiMAX and Uesugi '133 at least because Uesugi '133 provides efficiencies and implementation details for assigning uplink signal resources compatible with the WiMAX standard for OFDM signal transmission. Finally, the proposed combination of WiMAX and Uesugi '133 would involve nothing more

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than incorporating well-known concepts (i.e., Uesugi ’133’s assignment of sub-carriers) into a well-known system (i.e., WiMAX’s OFDM system).

- **WiMAX and Sudo ‘141:** Sudo ’141 teaches a “radio transmitting apparatus and radio transmission method” for an OFDM system. Sudo ’141 at 1:6-10. Sudo ’141 teaches “allocating data such as retransmission information or control information, for which better channel quality is required than for other data, to subcarriers for which the degree of signal multiplexing is set low.” *Id*. at 9:4-10. For instance, Sudo ’141 teaches that, “[b]y reducing the degree of signal multiplexing of subcarriers at a distance from the center frequency… the transmission power of subcarriers at a distance from the center frequency can be decreased, and thus side lobes can also be decreased.” *Id*. 10:37-46. WiMAX teaches and describes an OFDM based communication system which could use a ranging signal as pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure” *See* WiMAX Source 2 at 37, 50, 51, 93 and 94. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine WiMAX and Sudo ’141 at least because Sudo ’141 provides efficiencies and implementation details for assigning uplink signal resources for use WiMAX. Finally, the proposed combination of WiMAX and Sudo ‘141 would involve nothing more than incorporating well-known concepts (i.e., Sudo ‘141’s

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allocation of data such as retransmission information or control information) into a well-known system (i.e., WiMAX's OFDM system).

- **WiMAX and Auer:** Auer teaches and describes "pilot-symbol aided channel estimation" for "MIMO communication systems." Auer at 10. Auer teaches an "efficient use of pilot symbols" that provides "increased flexibility in channel estimation." *Id*. at 5. "The reason for this is that by dividing the separation task of the superimposed transmission signals in time and frequency direction, a more efficient usage of the pilot symbols is possible." *Id*. WiMAX teaches and describes an OFDM based communication system which could use a ranging signal as pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure" *See* WiMAX Source 2 at 37, 50, 51, 93 and 94. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine WiMAX and Auer at least because Auer provides efficiencies and implementation details for assigning uplink signal resources compatible with the WiMAX standard for OFDM signal transmission. Finally, the proposed combination of WiMAX and Auer would involve nothing more than incorporating well-known concepts (i.e., Auer's use of pilot symbols) into a well-known system (i.e., WiMAX's OFDM system).
- **WiMAX and Nee:** Nee is a textbook titled "OFDM For Wireless Multimedia Communications." Nee teaches "a two-dimensional channel estimator that

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estimates the reference values based on a few known pilot values." Nee at 96. Nee further teaches exemplary pilot patterns that can be used to perform such channel estimation. *Id*. WiMAX teaches and describes an OFDM based communication system which could use a ranging signal as pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure" *See* WiMAX Source 2 at 37, 50, 51, 93 and 94. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine WiMAX and Nee at least because Nee provides efficiencies and implementation details for assigning uplink signal resources compatible with the WiMAX standard for OFDM signal transmission. Finally, the proposed combination of WiMAX and Nee would involve nothing more than incorporating well-known concepts (i.e., Nee's use of pilot patterns that can be used to perform such channel estimation) into a well-known system (i.e., WiMAX's OFDM system).

- **WiMAX and Engstrom:** Engstrom teaches a "random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital radio communication system." Engstrom at Abstract. "In [the] random access protocol, a mobile station transmits a known signal sequence to a base station." *Id*. at 1:58-67. "The base station can lock onto the known sequence, detect it and estimate the time delay." *Id*. Engstrom implements its random access protocol using "certain sub-carriers dedicated to the random access channel." *Id*.

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WiMAX teaches and describes an OFDM based communication system which could use a ranging signal as pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure" *See* WiMAX Source 2 at 37, 50, 51, 93 and 94. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine WiMAX and Engstrom at least because Engstrom provides efficiencies and implementation details for assigning uplink signal resources compatible with the WiMAX standard for OFDM signal transmission. Finally, the proposed combination of WiMAX and Engstrom would involve nothing more than incorporating well-known concepts (i.e., Engstrom's signal sequence and certain sub-carriers dedicatied to the random access channel) into a well-known system (i.e., WiMAX's OFDM system).

- **WiMAX and Wahlqvist:** Wahlqvist teaches "[t]ime synchronization in the uplink of an OFDM system." Wahlqvist, Title. Wahlqvist teaches certain "subcarriers dedicated for the RACH." Wahlqvist at 3 (1571). "Other users will not utilize the random access dedicated subcarriers so the interference on these frequencies will only be background noise." *Id*. WiMAX teaches and describes an OFDM based communication system which could use a ranging signal as pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure" *See* WiMAX Source 2 at 37, 50, 51, 93 and 94. Thus, these references were in the same field of endeavor,

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and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine WiMAX and Wahlqvist at least because Wahlqvist provides efficiencies and implementation details for assigning uplink signal resources compatible with the WiMAX standard for OFDM signal transmission. Finally, the proposed combination of WiMAX and Wahlqvist would involve nothing more than incorporating well-known concepts (i.e., Wahlqvist's dedicated random access subcarriers) into a well-known system (i.e., WiMAX's OFDM system).

(vi) U.S. Patent No. 5,867,478 ("Baum '478") in combination with the knowledge of a skilled artisan, Tong '798, Krishnan '123, Sudo '141, Cudak '256, Krishnan '062, Ketchum '291, Smee '007, and/or Ma '429

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine WiMAX with each of these references. A person of ordinary skill in the art would have found it obvious to combine WiMAX with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '302 patent was filed. Specifically:

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- Baum ‘478, Tong ’798, Sudo ‘141, Cudak ‘256, Krishnan ’062, Ketchum ‘291, Smee ‘007, and Ma ‘429 are all directed to systems and methods for implementing wireless communications between base stations and mobile stations. For example, they relate to wireless communications, and in particular to signaling, scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM and CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Baum ‘478 and Tong ’798:** Tong ’798 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Tong ’798 teaches and describes that a base station “assign[s] mobile terminals to a group and assign[s] certain shared resources and user-specific resources to those mobile terminals in the group.” Tong ’798 at Abstract. The user-specific resources include “pilot sub-carriers.” Tong ’798 at 7:11-17. Tong ’798’s mobile terminals transmit pilot signals that were “previously assigned by the base station” so that the base station can perform channel estimation. Tong ’798 at 5:4-9. Baum ’478 teaches and describes a pilot code scheme used in an OFDM system which could improve system synchronization. *See* Baum ’478 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA

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to combine Baum ‘478 and Tong ’798 at least because Tong ’798 provides implementation details for assigning uplink signal resources to reduce the impact of interference in OFDM wireless communications systems. Finally, the proposed combination of Baum ‘478 and Tong ’798 would involve nothing more than incorporating well-known concepts (i.e., Tong ’798’s implementation of pilot sub-carriers) into a well-known system (i.e., Baum ‘478’s OFDM system).

- **Baum ‘478 and Sudo ‘141:** Sudo ’141 teaches and describes methods and techniques for selecting, for each subcarrier, “[t]he multiplexing degree of the code division multiplexed signal to be transmitted by each subcarrier[.]” Sudo ’141 (translation) at Abstract. Sudo ’141 teaches that for such subcarrier-specific selection, “unlike situations in which the signal multiplexing degree is determined uniformly for all subcarriers, deterioration in the error rate performance of important information can be prevented without significantly reducing spectrum efficiency, and both good frequency utilization efficiency and error rate performance can be achieved.” *Id.* One goal of Sudo ’141 is to improve channel quality, particularly for channels carrying important signals “such as retransmission information of control information” by providing lower multiplexing for such channels. *Id.* at [0035]. In addition, the apparatus disclosed in Sudo ’141 uses a combination of OFDM and CDMA to leverage “frequency selective fading” (OFDM) with “excellent interference resistance” CDMA. *Id.* at [0002]. Baum ’478 teaches and describes a pilot code scheme used in an OFDM system which could improve system synchronization. *See* Baum ’478 at Abstract. Thus, these references were in the same field of endeavor, and shared at least the common goal

of improving spectral efficiency. It would have been obvious for a POSITA to combine Baum '478 with Sudo '141 at least because Baum '478 provides techniques for reducing inter-channel interference and errors (such as those disclosed in Sudo '141) in order to optimize spectral efficiency in a wireless communication system. Finally, the proposed combination of Baum '478 and Sudo '141 would involve nothing more than incorporating well-known concepts (i.e., Sudo '141's channel quality information system method) into a well-known system (i.e., Baum '478's OFDM system).

- **Baum '478 and Cudak '256:** Cudak '256 teaches and describes a method and system for providing feedback about channel quality between a base station and a remote station in a wireless communication system. Cudak '256 at Abstract. The method involves a base station requesting quality information from one or more remote stations, in response to which the remote station(s) will transmit the information requested until it is received by the base station. *Id.* The base station then "adjusts the modulation and coding of the remote stations accordingly." *Id.* One goal of Cudak '256 is to provide an efficient use of uplink resources by providing only that channel quality information that is necessary to improve performance, without wasting uplink resources on unnecessary information. *Id.* at [0003]-[0004]. Baum '478 teaches and describes a pilot code scheme used in an OFDM system which could improve system synchronization. *See* Baum '478 at Abstract. Thus, these references were in the same field of endeavor, and shared at least the common goal of improving spectral efficiency. It would have been obvious for a POSITA to combine Baum '478 with Cudak '256 at least because

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Cudak ‘256 provides techniques for reducing redundant information transmission and reception (such as those disclosed in Cudak ’256) in order to reduce interference. Finally, the proposed combination of Baum ‘478 and Cudak ’256 would involve nothing more than incorporating well-known concepts (i.e., Cudak ‘256’s channel quality information system method) into a well-known system (i.e., Baum ‘478’s OFDM system).

- **Baum ‘478 and Krishnan ’062:** Krishnan ’062 teaches “[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system.” Krishnan ’062 at Abstract. On the uplink, “[p]ilot transmissions from the terminals are received,” at a base station, and “a channel estimate is derived for each terminal based on the pilot received on the assigned subbands.” *Id*. Krishnan ’062 further teaches that “[o]ne group of subbands is assigned to each active terminal for uplink pilot transmission,” and “[t]he subband assignment may be determined at call setup or at a later time, and may be signaled to the terminal.” *Id.,* 7:61-64, FIG. 5. Baum ’478 teaches and describes a pilot code scheme used in an OFDM system which could improve system synchronization. *See* Baum ’478 at Abstract. Thus, these references were in the same field of endeavor, and shared at least the common goal of improving spectral efficiency. It would have been obvious and predictable for a POSITA to combine Baum ‘478 and Krishnan ’062 at least because Krishnan ’062 provides implementation details for assigning uplink signal resources to reduce the impact of interference in OFDM wireless communications systems. Finally, the proposed combination of Baum ‘478 and Krishnan ’062 would involve nothing more than incorporating well-known concepts (i.e.,

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Krishnan ’062’s pilot transmission scheme) into a well-known system (i.e., Baum ‘478’s OFDM system). Further, it would have been obvious to and predictable for a POSITA to combine Baum ‘478 and U.S. Patent Publication No. 2004/0081123 (Krishnan ’123) for the same reasons as Krishnan ‘062 since Krishnan ‘123 disclosure mirrors that of Krishnan ’062. Krishnan ‘123 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference.

- **Baum ‘478 and Ketchum ‘291:** Ketchum ’291 discloses wireless communication systems that implement techniques for “MAC processing for efficient use of high throughput systems.” Ketchum ’291 at [0025]. Ketchum ’291 further teaches the use of pilot signals “for learning or adapting to the characteristics of the channel between” a base station and mobile terminals. *Id.* at [0075]. “Channel feedback may then be returned to the transmitting device for use in transmission.” *Id.* For instance, Ketchum ’291 teaches using “different coding and modulation scheme[s] based on the channel quality.” *Id.* at [0136]-[0137]. Baum ’478 teaches and describes a pilot code scheme used in an OFDM system which could improve system synchronization. *See* Baum ’478 at Abstract. Thus, these references were in the same field of endeavor, and shared at least the common goal of improving spectral efficiency. It would have been obvious and predictable for a POSITA to combine Baum ‘478 and Ketchum ’291 at least because Ketchum ’291 provides efficiencies and implementation details for implementing the Baum ‘478 goal of reducing interference through configuration of pilot signals. Finally, the proposed combination of Baum ‘478 and Ketchum ’291 would involve nothing more than

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incorporating well-known concepts (i.e., Ketchum '291's pilot transmission scheme) into a well-known system (i.e., Baum '478's OFDM system).

- **Baum '478 and Smee '007:** Smee '007 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Smee '007 teaches "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems." Smee '007 at Abstract. The pilot schemes utilize time and/or frequency orthogonality. *Id*. Time orthogonality is achieved by transmitting pilots using different orthogonal codes (e.g., Walsh codes). *Id*. "The pilots may also be scrambled with different scrambling codes, which are used to randomize pilot interference and to enable identification of the transmitters of these pilots." *Id*. Smee '007 explains that its techniques "efficiently facilitate both channel estimation and pilot detection." *Id*. at [0011]. "These schemes allow terminals in the system to obtain high quality wideband channel estimates and pilot strength estimates." *Id*. Smee '007's schemes also enable the system to "estimate and cancel pilot interference." *Id*. at [0012]. Baum '478 teaches and describes a pilot code scheme used in an OFDM system which could improve system synchronization. *See* Baum '478 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Baum '478 and Smee '007 at least because Smee '007 provides efficiencies and implementation details for implementing the Baum '478 goal of reducing interference through configuration of pilot signals. Finally, the proposed

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combination of Baum ‘478 and Smee ‘007 would involve nothing more than incorporating well-known concepts (i.e., Smee ‘007’s pilot transmission scheme) into a well-known system (i.e., Baum ‘478’s OFDM system).

- **Baum ‘478 and Ma ‘429:** Ma ’429 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma ’429 teaches “a new uplink OFDM protocol.” Ma ’429 at Abstract. More specifically, Ma ’429 teaches that an “OFDM band is divided into two frequency bands 51, 53 which can be used interchangeably to provide two different OFDMA modes.” *Id*. at [0124]. Ma ’429 emphasizes the importance of separating uplink transmissions into two transmission modes: a low rate mode in a first frequency band and a burst mode in a second frequency band that is distinct from the first frequency band. *Id*. at [0010], [0124], Abstract. “This has the effect of significantly reducing intra-cell interference.” *Id*. at [0135]. Ma ’429 also teaches that resource allocation for the two transmission modes can be dynamically configured based on the traffic load. *Id*. at [0126]. Based on the teachings of Ma ’429, a POSA would have been motivated to modify Baum ‘478 so as to incorporate Ma ’429’s low rate transmission mode and the burst mode transmission at least for the purpose of improving Baum ‘478’s uplink transmissions and reducing interference. Furthermore, a POSA would have been motivated to modify Baum ‘478 so as to incorporate Ma ’429’s teachings of adjusting the transmission rate of the burst mode according to the measurements from the pilot signals in the low rate mode transmissions—e.g., an example of using channel estimation to dictate future transmissions. Ma ’429 at [0255]-[0262]. A POSA would have understood that

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modifying Baum ‘478 with Ma ’429 would have required minimal modifications. In addition to the motivations described above, a POSA would have been further motivated to combine Baum ‘478 and Ma ’429 because both are in the same field—wireless communication systems employing OFDM—and address the same problem—reducing interference between uplink transmission from multiple terminals. Ma ’429 at [0110], [0135]. Further, as evident from the above discussion, a POSA would have combined the system of Baun ‘478 with the teachings of Ma ’429 by known methods and the results of the combination would have been predictable to a POSA (e.g., improved uplink transmission). Finally, the proposed combination of Baum ‘478 and Ma ’429 would involve nothing more than incorporating well-known concepts (i.e., dividing the resources into different frequency bands) into a well-known system (i.e., Baum ‘478’s OFDM system).

(vii) U.S. Patent Publication No. 2004/0081131 (“Walton ‘131”) in combination with the knowledge of a skilled artisan, Tong ’798, Krishnan ‘123, Krishnan ’062, Ketchum ‘291, Uesugi ‘ 133, Sudo ‘141, Walton ‘301, Cudak ‘256, Smee ‘007, Walton ‘538, Ketchum ‘627, Sumasu, Walton ‘609, Nee, Engstrom, Wahlqvist, and/or Ma ‘429

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine WiMAX with each of these references. A person of ordinary skill in the art would have found it obvious to combine WiMAX with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to

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obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '302 patent was filed. Specifically:

- Walton '131, Tong '798, Krishnan '123, Krishnan '062, Ketchum '291, Uesugi ' 133, Sudo '141, Walton '301, Cudak '256, Smee '007, Walton '538, Ketchum '627, Sumasu, Walton '609, Nee, Engstrom, Wahlqvist, and Ma '429 are all directed to systems and methods for implementing wireless communications between base stations and mobile stations. For example, they relate to wireless communications, and in particular to signaling, 0scheduling traffic in a multi-carrier communication environment, and indicating resource allocation information. They involve communication protocols and standards, transmission methods (e.g., OFDM and CDMA), and modulation schemes, that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Walton '131 and Tong '798:** Tong '798 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Tong '798 teaches and describes that a base station "assign[s] mobile terminals to a group and assign[s] certain shared resources and user-specific resources to those mobile terminals in the group." Tong '798 at Abstract. The user-specific resources include "pilot sub-carriers." Tong '798 at 7:11-17. Tong '798's mobile terminals transmit pilot signals that were "previously assigned by the base station" so that the base station can perform channel estimation. Tong '798 at 5:4-9. Walton '131 teaches

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and describes using "OFDM symbols of different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Baum '478 and Tong '798 at least because Tong '798 provides implementation details for assigning uplink signal resources to reduce the impact of interference in OFDM wireless communications systems. Finally, the proposed combination of Baum '478 and Tong '798 would involve nothing more than incorporating well-known concepts (i.e., Tong '798's implementation of pilot sub-carriers) into a well-known system (i.e., Walton '131's OFDM system).

- **Walton '131 Krishnan '062:** Krishnan '062 teaches "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system." Krishnan '062 at Abstract. On the uplink, "[p]ilot transmissions from the terminals are received," at a base station, and "a channel estimate is derived for each terminal based on the pilot received on the assigned subbands." *Id*. Krishnan '062 further teaches that "[o]ne group of subbands is assigned to each active terminal for uplink pilot transmission," and "[t]he subband assignment may be determined at call setup or at a later time, and may be signaled to the terminal." *Id.,* 7:61-64, FIG. 5. Walton '131 teaches and describes using "OFDM symbols of different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted

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using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Walton '131 and Krishnan '062 at least because Krishnan '062 provides implementation details for assigning uplink signal resources to reduce the impact of interference in OFDM wireless communications systems. Finally, the proposed combination of Walton '131 and Krishnan '062 would involve nothing more than incorporating well-known concepts (i.e., Krishnan '062's pilot transmission scheme) into a well-known system (i.e., Walton '131's OFDM system). Further, it would have been obvious to and predictable for a POSITA to combine Walton '131 and U.S. Patent Publication No. 2004/0081123 (Krishnan '123) for the same reasons as Krishnan '062 since Krishnan '123 disclosure mirrors that of Krishnan '062. Krishnan '123 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference.

- **Walton '131 and Ketchum '291:** Ketchum '291 discloses wireless communication systems that implement techniques for "MAC processing for efficient use of high throughput systems." Ketchum '291 at [0025]. Ketchum '291 further teaches the use of pilot signals "for learning or adapting to the characteristics of the channel between" a base station and mobile terminals. Id. at [0075]. "Channel feedback may then be returned to the transmitting device for use in transmission." *Id.* For instance, Ketchum '291 teaches using "different coding and modulation scheme[s] based on the channel quality." Id. at [0136]-[0137].

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Walton ’131 teaches and describes using “OFDM symbols of different sizes to achieve greater efficiency for OFDM systems” and “pilot data may be transmitted using OFDM symbols of a third size or the first size” Walton ’131 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Walton ‘131 and Ketchum ’291 at least because Ketchum ’291 provides efficiencies and implementation details for implementing the Walton ‘131’s goal of reducing interference through configuration of pilot signals. Finally, the proposed combination of Walton ‘131 and Ketchum ’291 would involve nothing more than incorporating well-known concepts (i.e., Ketchum ’291’s pilot transmission scheme) into a well-known system (i.e., Walton ‘131’s OFDM system).

- **Walton ‘131 and Uesugi ‘ 133:** Uesugi ’133 teaches and describes “a data transmission apparatus capable of improving the frequency utilization efficiency at both ends of a band[.]” Uesegi ’133 at 3:24-30. This capability “is achieved by a multi-carrier transmission method that sets the distance between sub-carriers so that they may be orthogonal to one another, assigns a plurality of sub-carriers to a specific band and assigns low speed variable signals to the guard frequency parts set at both ends of the specific band.” *Id.* at 3:31-36. Walton ’131 teaches and describes using “OFDM symbols of different sizes to achieve greater efficiency for OFDM systems” and “pilot data may be transmitted using OFDM symbols of a third size or the first size” Walton ’131 at Abstract. Thus, these references were

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in the same field of endeavor, and shared at least the fundamental goal of improving spectral efficiency in a multi-carrier wireless communications system. It would have been obvious for a POSITA to combine Walton '131 with Uesugi '133 at least because Walton '131 provides methods to improve data signal and throughput in an OFDM scheme (such as those disclosed in Uesugi '133) in order to increase spectral efficiency. Finally, the proposed combination of Walton '131 and Ketchum '291 would involve nothing more than incorporating well-known concepts (i.e., Ketchum '291's pilot transmission scheme) into a well-known system (i.e., Walton '131's OFDM system).

- **Walton '131 and Sudo '141:** Sudo '141 teaches and describes methods and techniques for selecting, for each subcarrier, "[t]he multiplexing degree of the code division multiplexed signal to be transmitted by each subcarrier[.]" Sudo '141 (translation) at Abstract. Sudo '141 teaches that for such subcarrier-specific selection, "unlike situations in which the signal multiplexing degree is determined uniformly for all subcarriers, deterioration in the error rate performance of important information can be prevented without significantly reducing spectrum efficiency, and both good frequency utilization efficiency and error rate performance can be achieved." *Id.* One goal of Sudo '141 is to improve channel quality, particularly for channels carrying important signals "such as retransmission information of control information" by providing lower multiplexing for such channels. *Id.* at [0035]. In addition, the apparatus disclosed in Sudo '141 uses a combination of OFDM and CDMA to leverage "frequency selective fading" (OFDM) with "excellent interference resistance" CDMA. *Id.* at [0002]. Walton

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’131 teaches and describes using “OFDM symbols of different sizes to achieve greater efficiency for OFDM systems” and “pilot data may be transmitted using OFDM symbols of a third size or the first size” Walton ’131 at Abstract. Thus, these references were in the same field of endeavor, and shared at least the common goal of improving spectral efficiency. It would have been obvious for a POSITA to combine Walton ‘131 with Sudo ’141 at least because Walton ‘131 provides techniques for reducing inter-channel interference and errors (such as those disclosed in Sudo ’141) in order to optimize spectral efficiency in a wireless communication system. Finally, the proposed combination of Walton ‘131 and Sudo ’141would involve nothing more than incorporating well-known concepts (i.e., Sudo ’141’s channel quality information system method) into a well-known system (i.e., Walton ‘131’s OFDM system).

- **Walton ‘131 and Walton ‘301:** Walton ’301[8] teaches and describes “[a] multiple-access MIMO WLAN system . . . [that] supports multiple rates and transmission modes, which are configurable based on channel conditions and user terminal capabilities [and] employs a pilot structure with several types of pilot . . . for different functions . . . .” Walton ’301 at Abstract. Walton ’301 further describes “[a] pilot structure with several types of pilot used for different functions” such as frequency and system acquisition, channel estimation or phase tracking. *Id.* at 3:50-55. One goal of Walton ’301 is to provide “a MIMO WLAN system capable of supporting multiple uses and providing high system performance.” *Id.* at 2:1-3.

[8] Walton ’301 is charted separately against the ’908 patent.

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Walton ’131 teaches and describes using “OFDM symbols of different sizes to achieve greater efficiency for OFDM systems” and “pilot data may be transmitted using OFDM symbols of a third size or the first size” Walton ’131 at Abstract. Thus, these references were in the same field of endeavor, and shared at least the fundamental goal of improving performance in multiple-access wireless communication systems. It would have been obvious for a POSITA to combine Walton ‘131 with Walton ’301 at least because Walton ‘131 provides techniques for using pilot signals (such as those disclosed in Walton ’301) in order to improve system performance. Finally, the proposed combination of Walton ‘131 and Walton ’301 would involve nothing more than incorporating well-known concepts (i.e., Walton ’301’s pilot structures with several types of pilots used for different functions) into a well-known system (i.e., Walton ‘131’s OFDM system).

- **Walton ‘131 and Cudak ‘256:** Cudak ’256 teaches and describes a method and system for providing feedback about channel quality between a base station and a remote station in a wireless communication system. Cudak ’256 at Abstract. The method involves a base station requesting quality information from one or more remote stations, in response to which the remote station(s) will transmit the information requested until it is received by the base station. *Id.* The base station then “adjusts the modulation and coding of the remote stations accordingly.” *Id.* One goal of Cudak ’256 is to provide an efficient use of uplink resources by providing only that channel quality information that is necessary to improve performance, without wasting uplink resources on unnecessary information. *Id.* at [0003]-[0004]. Walton ’131 teaches and describes using “OFDM symbols of

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different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Thus, these references were in the same field of endeavor, and shared at least the fundamental goal of improving performance in multiple-access wireless communication systems. It would have been obvious for a POSITA to combine Walton '131 with Cudak '256 at least because Cudak '256 provides techniques for reducing redundant information transmission and reception (such as those disclosed in Cudak '256) in order to reduce interference. Finally, the proposed combination of Walton '131 and Cudak '256 would involve nothing more than incorporating well-known concepts (i.e., Cudak '256's channel quality information system method) into a well-known system (i.e., Walton '131's OFDM system).

- **Walton '131 and Smee '007:** Smee '007 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Smee '007 teaches "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems." Smee '007 at Abstract. The pilot schemes utilize time and/or frequency orthogonality. *Id*. Time orthogonality is achieved by transmitting pilots using different orthogonal codes (e.g., Walsh codes). *Id*. "The pilots may also be scrambled with different scrambling codes, which are used to randomize pilot interference and to enable identification of the transmitters of these pilots." *Id*. Smee '007 explains that its techniques "efficiently facilitate both channel estimation and pilot detection." *Id*. at [0011]. "These schemes allow terminals in the system to obtain high quality wideband channel estimates and pilot strength estimates." *Id*. Smee '007's schemes also enable the system to "estimate

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and cancel pilot interference." *Id*. at [0012]. Walton '131 teaches and describes using "OFDM symbols of different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Walton '131 and Smee '007 at least because Smee '007 provides efficiencies and implementation details for implementing the Walton '131's goal of reducing interference through configuration of pilot signals. Finally, the proposed combination of Walton '131 and Smee '007 would involve nothing more than incorporating well-known concepts (i.e., Smee '007's pilot transmission scheme) into a well-known system (i.e., Walton '131's OFDM system).

- **Walton '131 and Walton '538:** Walton '538 teaches "a multiple-access OFDM-CDMA system" in which "data spreading is performed in the frequency domain by spreading each data stream with a respective spreading code selected from a set of available spreading codes." Walton '538 at Abstract. "A pilot may be transmitted by each transmitter unit to assist the receiver units perform acquisition, timing synchronization, carrier recovery, handoff, channel estimation, coherent data demodulation, and so on." *Id*. The "pilot data is spread (e.g., in the frequency domain) with a known spreading code (e.g., Walsh code 0) and…may further be covered with a cover code." *Id*. at [0119]. This enables the receivers to "discriminate and distinguish the different transmitters of the pilots by their unique

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cover codes." *Id*. Walton '131 teaches and describes using "OFDM symbols of different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious for a POSITA to combine Walton '131 with Walton '538 at least because Walton '538 provides efficiencies and implementation details for implementing Walton '131's goal of channel estimation via pilot signals. Indeed, a POSITA would have understood that such teaching would enable Walton '131's system to better distinguish the different pilot transmitters, as taught by Walton '538. Finally, the proposed combination of Walton '131 and Walton '538 would involve nothing more than incorporating well-known concepts (i.e., Walton '538's pilot transmission scheme) into a well-known system (i.e., Walton '131's OFDM system).

- **Walton '131 and Ketchum '627:** Ketchum '627 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ketchum '627 teaches and describes "[p]ilots suitable for use in MIMO systems and capable of supporting various functions." Ketchum '627 at Abstract. Ketchum '627 teaches that "MIMO pilots" are provided in uplink signals and are "used for channel estimation." *Id*. at Abstract, [0132]. Ketchum '627 further teaches that an access point or base station can assign uplink pilot resources by "schedul[ing]" pilot transmissions. *E.g.,* Ketchum '627 at [0013], [0101].

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Walton ’131 teaches and describes using “OFDM symbols of different sizes to achieve greater efficiency for OFDM systems” and “pilot data may be transmitted using OFDM symbols of a third size or the first size” Walton ’131 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Walton ‘131 and Ketchum ’627 at least because Ketchum ’627 provides implementation details for assigning uplink signal resources for use in achieving Walton ‘131’s channel estimation function. Finally, the proposed combination of Walton ‘131 and Ketchum ’627 would involve nothing more than incorporating well-known concepts (i.e., Ketchum ’627’s pilots suitable for use in MIMO systems and capable of supporting various functions) into a well-known system (i.e., Walton ‘131’s OFDM system).

- **Walton ‘131 and Sumasu:** Sumasu discloses an improved system and method of transmitting pilot signals for channel estimation, where the pilot signals have time-varying patterns and can be sent using subcarriers involving DC components. Sumasu at [0030], [0052], FIG. 2. In Samasu, the DC subcarriers are often not used for carrying data because “the subcarriers involving DC components suffer deterioration of the decoding accuracy due to influences of DC offsets generated in analog circuits” and thereby the absence of data at the DC subcarriers can help the receivers. *Id*. at [0007], [0048]. The DC subcarriers, however, can be utilized to carry the pilot signals (not the data) since the patterns of the pilot signals are known to the receiver (whereas the data signals are not known) and become helpful for the

receivers to decode the data received via the subcarriers near the DC subcarriers. *Id*. at [0048]-[0052], [0082]. Sumasu explicitly discloses placing the pilot signals in a center portion and data at outer portions of a subband. *Id*. at [0029], FIG. 2. Walton '131 teaches and describes using "OFDM symbols of different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Walton '131 and Sumasu at least because Sumasu provides efficiencies and implementation details for assigning uplink signal resources for use in achieving Walton 131's channel estimation function. Finally, the proposed combination of Walton '131 and Sumasu would involve nothing more than incorporating well-known concepts (i.e., Sumasu's teachings for placing the pilot signals in a center portion and data at outer portions of a subband) into a well-known system (i.e., Walton '131's OFDM system).

- **Walton '131 and Walton '609:** Walton '609 teaches and describes "[c]losed-loop rate control for data transmission on multiple parallel channels." Walton '609 at Abstract. More specifically, Walton '609 teaches an access point that "selects [] transmission modes" based on pilot signals received from a mobile terminal. Walton '609 at 14:58-15:3, 23:19-21. "A transmission mode may indicate (or may be associated with) a particular data rate, a particular coding scheme or code rate, a particular interleaving scheme, a particular modulation scheme, and so on, to use

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for data transmission." *Id*. at 3:36-53. Walton '131 teaches and describes using "OFDM symbols of different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of estimating communication channels between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Walton '131 and Walton '609 at least because Walton '609 provides efficiencies and implementation details for the coordination and configuration for transmission of uplink pilot, data, and control signals for various system functions, more instance, by implementing multiple selectable transmission modes for uplink signaling. Finally, the proposed combination of Walton '131 and Walton '609 would involve nothing more than incorporating well-known concepts (i.e., Walton '609's transmission modulation scheme) into a well-known system (i.e., Walton '131's OFDM system).

- **Walton '131 and Nee:** Nee is a textbook titled "OFDM For Wireless Multimedia Communications." Nee teaches "a two-dimensional channel estimator that estimates the reference values based on a few known pilot values." Nee at 96. Nee further teaches exemplary pilot patterns that can be used to perform such channel estimation. *Id*. Walton '131 teaches and describes using "OFDM symbols of different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Thus, these references were in the same field of endeavor,

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and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Walton '131 and Nee at least because Nee provides efficiencies and implementation details for assigning uplink signal resources for use in Walton '131. Finally, the proposed combination of Walton '131 and Nee would involve nothing more than incorporating well-known concepts (i.e., Nee's two-dimensional channel estimator that estimates the reference values based on a few known pilot values) into a well-known system (i.e., Walton '131's OFDM system).

- **Walton '131 and Engstrom:** Engstrom teaches a "random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital radio communication system." Engstrom at Abstract. "In [the] random access protocol, a mobile station transmits a known signal sequence to a base station." *Id.* at 1:58-67. "The base station can lock onto the known sequence, detect it and estimate the time delay." *Id.* Engstrom implements its random access protocol using "certain sub-carriers dedicated to the random access channel." *Id.* at 3:31-40. Walton '131 teaches and describes using "OFDM symbols of different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Walton '131 and Engstrom

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at least because Engstrom provides efficiencies and implementation details for assigning uplink signal resources for use in Walton '131. Finally, the proposed combination of Walton '131 and Engstrom would involve nothing more than incorporating well-known concepts (i.e., Engstrom's random access protocol system) into a well-known system (i.e., Walton '131's OFDM system).

- **Walton '131 and Wahlqvist:** Wahlqvist teaches "[t]ime synchronization in the uplink of an OFDM system." Wahlqvist, Title. Wahlqvist teaches certain "subcarriers dedicated for the RACH." Wahlqvist at 3 (1571). "Other users will not utilize the random access dedicated subcarriers so the interference on these frequencies will only be background noise." *Id.* Walton '131 teaches and describes using "OFDM symbols of different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Thus, these references were in the same field of endeavor, and shared the same fundamental goal of implementing wireless communications between base stations and mobile terminals in OFDM communication systems. It would have been obvious and predictable for a POSITA to combine Walton '131 and Wahlqvist at least because Wahlqvist provides efficiencies and implementation details for assigning uplink signal resources for use in Walton '131. Finally, the proposed combination of Walton '131 and Engstrom would involve nothing more than incorporating well-known concepts (i.e., Wahlqvist's random access protocol) into a well-known system (i.e., Walton '131's OFDM system).

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- **Walton '131 and Ma '429:** Ma '429 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma '429 teaches "a new uplink OFDM protocol." Ma '429 at Abstract. More specifically, Ma '429 teaches that an "OFDM band is divided into two frequency bands 51, 53 which can be used interchangeably to provide two different OFDMA modes." *Id*. at [0124]. Ma '429 emphasizes the importance of separating uplink transmissions into two transmission modes: a low rate mode in a first frequency band and a burst mode in a second frequency band that is distinct from the first frequency band. *Id*. at [0010], [0124], Abstract. "This has the effect of significantly reducing intra-cell interference." *Id*. at [0135]. Ma '429 also teaches that resource allocation for the two transmission modes can be dynamically configured based on the traffic load. *Id*. at [0126]. Based on the teachings of Ma '429, a POSA would have been motivated to modify Walton '131 so as to incorporate Ma '429's low rate transmission mode and the burst mode transmission at least for the purpose of improving Walton '131's uplink transmissions and reducing interference. Furthermore, a POSA would have been motivated to modify Walton '131 so as to incorporate Ma '429's teachings of adjusting the transmission rate of the burst mode according to the measurements from the pilot signals in the low rate mode transmissions. A POSA would have understood that modifying Walton '131 with Ma '429 would have required minimal modifications. In addition to the motivations described above, a POSA would have been further motivated to combine Walton '131 and Ma '429 because both are in the same field—wireless communication systems employing OFDM—and address the same problem—

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reducing interference between uplink transmission from multiple terminals. Further, as evident from the above discussion, a POSA would have combined the system of Walton '131 with the teachings of Ma '429 by known methods and the results of the combination would have been predictable to a POSA (e.g., improved uplink transmission). Finally, the proposed combination of Walton '133 and Ma '429 would involve nothing more than incorporating well-known concepts (i.e., dividing the resources into different frequency bands) into a well-known system (i.e., Walton '131's OFDM system).

(viii) Krishnan '123 in combination with the knowledge of a skilled artisan, Smee '007, Sumasu '776, Sumasu '634, Krishnan '062, Engstrom, Wahlqvist, Cudak, Walton '538, Walton '301, Walton '131, Walton '609, Tong '798, Ketchum '627, Ketchum '291, Uesugi '133, Sudo '141, Harel, Baum '478, Ma '858, Ma '429, Auer, Nee, Jacobsen, and/or WiMAX.

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Krishnan '123 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Krishnan '123 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the '302 patent was filed. Specifically:

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- Smee ’007, Sumasu ’776 / Sumasu ’634, Krishnan ’062, Engstrom, Wahlqvist, Cudak, Walton ’538, Walton ’301, Walton ’131, Walton ’609, Tong ’798, Ketchum ’627, Ketchum ’291, Uesugi ’133, Sudo ’141, Harel, Baum ’478, Ma ’858, Ma ’429, Auer, Nee, Jacobsen and/or WiMAX are all directed to systems and methods for a broadband wireless communication using OFDM transmission. For example, they relate to broadband wireless communication between a mobile station and a base station using OFDM transmission, and in particular to uplink and probing signal (e.g. pilot signal) protocols. They involve same or similar communication protocols, standards, OFDM transmission methods, and access schemes that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.
- **Krishnan ’123 and Smee ’007**: Smee ’007 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Smee ’007 teaches and describes “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems” Smee ’007 at Abstract, [0010]. “pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink.” *Id.* at [0036]. Similarly, Krishnan ’123 teaches and describes the “[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system” Krishnan ’123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using

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OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Smee '007 at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Smee '007) in order to carry out channel estimation. In addition, both Krishnan '123 and Smee '007 are assigned to Qualcomm. They are based on same or similar system architecture and use same subband structure supporting subband multiplexing and pilot transmission. *See*, Figs. 2A and 7 of Smee '007; *See*, Figs. 4 and 7 of Krishnan '123. A POSITA would have combined the system of Krishnan '123 with the teachings of Smee '007 by known methods and the results of the combination would have been predictable to a POSITA. The proposed combination of Krishnan '123 and Smee '007 would involve nothing more than incorporating the disclosed technical details of one system into a system that uses the same or similar channel allocation techniques and has the same or similar system architecture. Further, Krishnan '123 and Smee '007 identify the common problem of providing enhancements to pilot transmission and channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095], Fig. 6A and Fig. 6B. A POSITA would have been motivated to combine Krishnan '123 with Smee '007 because Smee '007 provides pilot transmission and channel estimation implementation details to the problem

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identified by Krishnan ’123 . *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095].

- **Krishnan ’123 and Sumasu ’776 / Sumasu ’634**: Sumasu ’634 is a WIPO counterpart of Sumasu ’776. Sumasu ’776 / Sumasu ’634 are charted separately, and the citations in those charts for each limitation are incorporated herein by reference. Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Similarly, Krishnan ’123 teaches and describes the “[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system” Krishnan ’123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan ’123 with Sumasu ’776 / Sumasu ’634 at least because Krishnan ’123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that

disclosed in Sumasu ’776 / Sumasu ’634) in order to carry out channel estimation. In addition, Krishnan ’123 and Sumasu ’776 / Sumasu ’634 identify the common problem of providing enhancements to pilot transmission and channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; *see* Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2. A POSITA would have been motivated to combine Krishnan ’123 with Sumasu ’776 / Sumasu ’634 because Sumasu ’776 / Sumasu ’634 provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan ’123, *e.g*. placing pilot signals in a center portion would have had the benefit of utilizing subcarriers for better channel performance and less interference. *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; *see* Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2.

- **Krishnan ’123 and Krishnan ’062:** A POSITA would be motivated to combine Krishnan ’123 with Krishnan ’062. They have the same specification. Krishnan ’062 is the issued patent of U.S. patent application US 10/340,507, which was published as Krishnan ’123.
- **Krishnan ’123 and Engstrom**: Engstrom teaches and describes “a random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital communication system” Engstrom at Abstract. Engstrom further describes a channel timing estimation method using an uplink

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signal in an OFDM system. *See* Engstrom at 1:8-13, 2:51-3:8, 7:38-54. Engstrom further discloses using dedicated channels for the uplink signal to improve channel estimation performance. *See* Engstrom at 6:36-7:4, 7:17-67 and Fig. 8. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Engstrom at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Engstrom) in order to carry out channel estimation. In addition, Krishnan '123 and Engstrom identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Engstrom at Abstract, 6:36-7:4, 7:17-67 and Fig. 8. A POSITA would have been motivated to combine Krishnan '123 with Engstrom because Engstrom provides pilot (e.g. initial access and ranging signals) transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Engstrom at Abstract, 6:36-7:4, 7:17-67.

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- **Krishnan ’123 and Wahlqvist**: Wahlqvist teaches and describes “[the] use of orthogonal frequency division multiplex[ing] [OFDM] in a cellular system requir[ing] that the base station and the mobile station are time and frequency synchronized in order to preserve orthogonality between the subcarriers.” Wahlqvist at Abstract. Wahlqvist further discloses “an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol” and related estimation algorithms. *See* Wahlqvist at 1, 3. Similarly, Krishnan ’123 teaches and describes the “[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system” Krishnan ’123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan ’123 with Wahlqvist at least because Krishnan ’123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Wahlqvist) in order to carry out channel estimation. In addition, Krishnan ’123 and Wahlqvist identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Wahlqvist at Abstract, 2-3 and Fig. 5. A POSITA would have been motivated to combine Krishnan ’123 with Wahlqvist because Wahlqvist provides pilot (e.g. initial access and ranging signals) transmission and channel

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estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Wahlqvist at Abstract, 2-3 and Fig. 5.

- **Krishnan '123 and Cudak**: Cudak teaches and describes channel quality feedback procedures within a communication system, e.g. OFDM. *See* Cudak at [0001], [0038], [0057], [0058], [0071]. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Cudak at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Cudak) in order to carry out channel estimation. In addition, Krishnan '123 and Cudak identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Cudak at [0013], [0015], [0020]-[0022], [0066]-[0067], Fig. 6 and Fig. 7. A POSITA would have been motivated to combine Krishnan '123 with Cudak because Cudak provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048],

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[0054]-[0056]; *see* Cudak at [0013], [0015], [0020]-[0022], [0066]-[0067], Fig. 6 and Fig. 7.

- **Krishnan '123 and Walton '538**: Walton '538 teaches and describes "a multiple-access OFDM-CDMA system" in which "[a] pilot may be transmitted by each transmitter unit to assist the receiver units perform acquisition, timing synchronization, carrier recovery, handoff, channel estimation, coherent data demodulation, and so on" Walton '538 at Abstract. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Walton '538 at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton '538) in order to carry out channel estimation. In addition, Krishnan '123 and Walton '538 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Walton '538 at [0117]-[0123]. A POSITA would have been motivated to combine Krishnan '123 with Walton '538 because Walton '538 provides pilot transmission and channel estimation implementation

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details to the problem identified by Krishnan ’123 . *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Walton ’538 at [0117]-[0123].

- **Krishnan ’123 and Walton ’301**: Walton ’301 teaches and describes an OFDM-based wireless local area network communication which a pilot structure is employed for different. *See* Walton ’301 at Abstract. Similarly, Krishnan ’123 teaches and describes the “[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system” Krishnan ’123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan ’123 with Walton ’301 at least because Krishnan ’123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton ’301) in order to carry out channel estimation. In addition, Krishnan ’123 and Walton ’301 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Walton ’301 at 69:17-77:12. A POSITA would have been motivated to combine Krishnan ’123 with Walton ’301 because Walton ’301 provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan ’123 . *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Walton ’301 at 69:17-77:12.

- **Krishnan ’123 and Walton ’131**: Walton ’131 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ’131 teaches and describes using “OFDM symbols of different sizes to achieve greater efficiency for OFDM systems” and “pilot data may be transmitted using OFDM symbols of a third size or the first size” Walton ’131 at Abstract. Similarly, Krishnan ’123 teaches and describes the “[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system” Krishnan ’123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan ’123 with Walton ’131 at least because Krishnan ’123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton ’131) in order to carry out channel estimation. In addition, Krishnan ’123 and Walton ’131 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Walton ’131 at [0041], [0051]-[0052], [0102]-[0104], [0131]-[0133]. A POSITA would have been motivated to combine Krishnan ’123 with Walton ’131 because Walton ’131 provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan ’123 . *See*

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Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Walton ’131 at [0041], [0051]-[0052], [0102]-[0104], [0131]-[0133].

- **Krishnan ’123 and Walton ’609**: Walton ’609 teaches and describes “[a]n inner loop estimates the channel conditions for a communication link and selects a suitable data rate for each of the multiple parallel channels based on the channel estimates.” in an MIMO-OFDM system, Walton ’609 at Abstract. Similarly, Krishnan ’123 teaches and describes the “[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system” Krishnan ’123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan ’123 with Walton ’609 at least because Krishnan ’123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton ’609) in order to carry out channel estimation. In addition, Krishnan ’123 and Walton ’609 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Walton ’609 at 9:18-28, 10:23-33, 21:10-30, 24:42-51, 26:6-31, 26:39-52, and Fig. 7. A POSITA would have been motivated to combine Krishnan ’123 with Walton ’609 because Walton ’609 provides pilot transmission and channel estimation implementation

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details to the problem identified by Krishnan '123. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Walton '609 at 9:18-28, 10:23-33, 21:10-30, 24:42-51, 26:6-31, 26:39-52, and Fig. 7.

- **Krishnan '123 and Tong '798**: Tong '798 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Tong '798 teaches and describes a virtual MIMO transmission system which is applicable to OFDM multiple access systems. *See* Tong '798 at Abstract, 4:11-22. Tong '798 further discloses channel/resource allocation for pilot signals. *See* Tong '798 at 6:8-28, and Fig. 6. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Tong '798 at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Tong '798) in order to carry out channel estimation. In addition, Krishnan '123 and Tong '798 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Tong '798 at Abstract, 6:62-9:38, 10:25-65, and Figs. 6-12. A POSITA would

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have been motivated to combine Krishnan '123 with Tong '798 because Tong '798 provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Tong '798 at Abstract, 6:62-9:38, 10:25-65, and Figs. 6-12.

- **Krishnan '123 and Ketchum '627**: Ketchum '627 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ketchum '627 teaches and describes "[p]ilots suitable for use in MIMO systems and capable of supporting various function", e.g. a "MIMO pilot" and a "steering reference" "may be used for channel estimation" Ketchum '627 at Abstract. Ketchum '627 further discloses pilot structure and transmission schemes in an exemplary MIMO-OFDM system. *See* Ketchum '627 at [0032], [0034]-[0035], [0214]-[0221]. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Ketchum '627 at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ketchum '627) in order to carry out channel estimation. In addition, Krishnan '123 and Ketchum '627 identify the common

problem of providing enhancements to pilot transmission and channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Ketchum '627 at [0043], [0047], [0103], and [0219]-[0221]. A POSITA would have been motivated to combine Krishnan '123 with Ketchum '627 because Ketchum '627 provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Ketchum '627 at [0043], [0047], [0103], and [0219]-[0221]. A POSITA would have combined the system of Krishnan '123 with the teachings of Ketchum '627 by known methods and the results of the combination would have been predictable to a POSITA (e.g., subband multiplexing for various pilot signals in the MIMO-OFDM system). *See* Ketchum '627, FIGS. 4, 6A-6B, 7A-7B. Finally, the proposed combination of Krishnan '123 and Ketchum '627 would involve nothing more than incorporating well-known concepts (i.e., using Ketchum's various pilot signals) into a well-known system (i.e., Krishnan '123's MIMO-OFDM system). Ketchum '627, Abstract; Krishnan '123, Abstract.

- **Krishnan '123 and Ketchum '291**: Ketchum '291 teaches and describes using physical layer feedback for efficient use of high throughput systems, such as an OFDM system. *See* Ketchum '291 at Abstract, [0071], [0073]. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe

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specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Ketchum '291 at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ketchum '291) in order to carry out channel estimation. In addition, Krishnan '123 and Ketchum '291 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Ketchum '291 at [0058], [0075], [0121]-[0122], [0129]-[0134] and [0146]-[0147]. A POSITA would have been motivated to combine Krishnan '123 with Ketchum '291 because Ketchum '291 provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Ketchum '291 at [0058], [0075], [0121]-[0122], [0129]-[0134] and [0146]-[0147].

- **Krishnan '123 and Uesugi '133**: Uesugi '133 teaches and describes a multi-carrier transmission method of an OFDM system capable of improving the frequency utilization efficiency at both ends of a band, resistant to multi-paths. *See* Uesugi '133 at Abstract, 3:24-36, 4:31-36. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references

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were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Uesugi '133 at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Uesugi '133) in order to carry out channel estimation. In addition, Krishnan '123 and Uesugi '133 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Uesugi '133 at 1:38-45, 3:24-36, 6:19-29, 7:7-37 and Fig. 13. Abstract, 2-3 and Fig. 5. A POSITA would have been motivated to combine Krishnan '123 with Uesugi '133 because Uesugi '133 provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Uesugi '133 at 1:38-45, 3:24-36, 6:19-29, 7:7-37 and Fig. 13.

- **Krishnan '123 and Sudo '141**: Sudo '141 teaches and describes "an OFDM-CDMA radio transmitting apparatus and radio transmission method that make it possible to make spectral efficiency compatible with error rate characteristics.." Sudo '141 at 2:66-3:9. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the

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same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Sudo '141 at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Sudo '141) in order to carry out channel estimation. In addition, Krishnan '123 and Sudo '141 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Sudo '141 at 9:4-10, 10:19-46, Fig. 10 and Fig. 12. A POSITA would have been motivated to combine Krishnan '123 with Sudo '141 because Sudo '141 provides pilot and control information transmission and channel estimation implementation details to the problem identified by Krishnan '123. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Sudo '141 at 9:4-10, 10:19-46, Fig. 10 and Fig. 12.

- **Krishnan '123 and Harel**: Harel is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Harel teaches and describes "[a] system and method for using a group of pilot signals to enhance a data signal within an orthogonal frequency division multiplexing (OFDM) multiple-access scheme" Harel at Abstract. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the

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uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Harel at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Harel) in order to carry out channel estimation. In addition, Krishnan '123 and Harel identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Harel at Abstract, [0029], [0033], [0037]-[0041] and Fig. 3. A POSITA would have been motivated to combine Krishnan '123 with Harel because Harel provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Harel at Abstract, [0029], [0033], [0037]-[0041] and Fig. 3.

- **Krishnan '123 and Baum '478**: Baum '478 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Baum '478 teaches and describes a pilot code scheme used in an OFDM system which could improve system synchronization. *See* Baum '478 at Abstract. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract.

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Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Baum '478 at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Baum '478) in order to carry out channel estimation. In addition, Krishnan '123 and Baum '478 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Baum '478 at 10:5-23, 11:48-56, 13:7-26, 21:60-22;10, and Figs. 5, 7, 9. A POSITA would have been motivated to combine Krishnan '123 with Baum '478 because Baum '478 provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Baum '478 at 10:5-23, 11:48-56, 13:7-26, 21:60-22;10, and Figs. 5, 7, 9.

- **Krishnan '123 and Ma '858**: Ma '858 teaches and describes performing soft handoff using pilot signals of an OFDM system." *See* Ma '858 at Abstract. Ma '858 further discloses a pilot channel "used for synchronization, initial channel estimation, base station identification, and carrier-to-interference ratio (CIR) measurements for cell (or base station) selection." *See* Ma '858 at 9:11-20.

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Similarly, Krishnan ’123 teaches and describes the “[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system” Krishnan ’123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan ’123 with Ma ’858 at least because Krishnan ’123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ma ’858) in order to carry out channel estimation. In addition, Krishnan ’123 and Ma ’858 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Ma ’858 at 5:39-62, 8:62-9:54, and 11:9-12. A POSITA would have been motivated to combine Krishnan ’123 with Ma ’858 because Ma ’858 provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan ’123 . *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Ma ’858 at 5:39-62, 8:62-9:54, and 11:9-12.

- **Krishnan ’123 and Ma ’429**: Ma ’429 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma ’429 teaches and describes a new uplink OFDM protocol having two different operation modes. *See* Ma ’429 at Abstract. Ma ’429 further discloses a pilot structure to “support

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uplink transmit power measurement" *See* Ma '429 at [0134]. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Ma '429 at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ma '429) in order to carry out channel estimation. In addition, Krishnan '123 and Ma '429 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Ma '429 at [0131]-[0134], [0241]-[0242], [0248], [0257]-[0258] and Figs. 2, 4-6, 12. A POSITA would have been motivated to combine Krishnan '123 with Ma '429 because Ma '429 provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Ma '429 at Ma '429 at [0131]-[0134], [0241]-[0242], [0248], [0257]-[0258] and Figs. 2, 4-6, 12.

- **Krishnan '123 and Auer**: Auer teaches and describes a two-stage channel estimation process using pilot signals in an OFDM-based system. See Auer at

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Abstract, 1-4. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Auer at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Auer) in order to carry out channel estimation. In addition, Krishnan '123 and Auer identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Auer at Abstract, 3-5, 22 and Figs. 8, 9. A POSITA would have been motivated to combine Krishnan '123 with Auer because Auer provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Auer at Abstract, 3-5, 22 and Figs. 8, 9.

- **Krishnan '123 and Nee**: Nee teaches and describes OFDM design guidance for wireless multimedia communications. *See* Nee at Preface. Nee further discloses using pilot signals to perform channel estimation. *See* Nee at 96 and Fig. 5.2. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more

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efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Nee at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Nee) in order to carry out channel estimation. In addition, Krishnan '123 and Nee identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Nee at 96 and Fig. 5.2. A POSITA would have been motivated to combine Krishnan '123 with Nee because Nee provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Nee at 96 and Fig. 5.2.

- **Krishnan '123 and Jacobsen:** Jacobsen teaches and describes a wireless OFDM communication system which could compensate for in-band interference, noise and channel effects. Jacobsen at Abstract. *See* Jacobsen at Abstract, [0002], [0003], [0016]-[0017]. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of

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endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with Jacobsen at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Jacobsen) in order to carry out channel estimation. In addition, Krishnan '123 and Jacobsen identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Jacobsen at Abstract and [0017]. A POSITA would have been motivated to combine Krishnan '123 with Jacobsen because Jacobsen provides pilot transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Jacobsen at Abstract and [0017].

- **Krishnan '123 and WiMAX**: WiMAX is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Defendants incorporate by reference the citations in the Wi-Max Invalidity Chart into the invalidity chart for Krishnan '123. WiMAX teaches and describes an OFDM based communication system which could use ranging signal as pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure. *See* WiMAX Source 2

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at 37, 50, 51, 93 and 94. Similarly, Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Krishnan '123 with WiMAX at least because Krishnan '123 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in WiMAX) in order to carry out channel estimation. In addition, Krishnan '123 and WiMAX identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* WiMAX Source 2 at 50, 96, 107, 157 and 246. A POSITA would have been motivated to combine Krishnan '123 with WiMAX because WiMAX provides pilot (e.g. initial access and ranging signals) transmission and channel estimation implementation details to the problem identified by Krishnan '123 . *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* WiMAX Source 2 at 37, 50, 51, 96, 107, 157 and 246.

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(ix) Smee ’007 in combination with the knowledge of a skilled artisan, Krishnan ’123, Krishnan ’062, Sumasu ’776, Sumasu ’634, Engstrom, Wahlqvist, Cudak, Walton ’538, Walton ’301, Walton ’131, Walton ’609, Tong ’798, Ketchum ’627, Ketchum ’291, Uesugi ’133, Sudo ’141, Harel, Baum ’478, Ma ’858, Ma ’429, Auer, Nee, Jacobsen, and/or WiMAX.

In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Smee ’007 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Smee ’007 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’302 patent was filed. Specifically:

- Krishnan ’123 / Krishnan ’062, Sumasu ’776 / Sumasu ’634, Engstrom, Wahlqvist, Cudak, Walton ’538, Walton ’301, Walton ’131, Walton ’609, Tong ’798, Ketchum ’627, Ketchum ’291, Uesugi ’133, Sudo ’141, Harel, Baum ’478, Ma ’858, Ma ’429, Auer, Nee, Jacobsen and/or WiMAX are all directed to systems and methods for a broadband wireless communication using OFDM transmission. For example, they relate to broadband wireless communication between a mobile station and a base station using OFDM transmission, and in particular to uplink and

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probing signal (e.g. pilot signal) protocols. They involve same or similar communication protocols, standards, OFDM transmission methods, and access schemes that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Smee '007 and Krishnan '123 / Krishnan '062**: Krishnan '123 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Krishnan '123 at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Krishnan '123) in order to carry out channel estimation. In addition, Both

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Smee ’007 and Krishnan ’123 are assigned to Qualcomm. They are based on the same or similar system architecture and use the same subband structure supporting subband multiplexing and pilot transmission. *See*, Figs. 2A and 7 of Smee ’007; *See*, Figs. 4 and 7 of Krishnan ’123. Smee ’007 and Krishnan ’123 identify the common problem of providing enhancements to pilot transmission and channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095], Fig. 6A and Fig. 6B. A POSITA would have been motivated to combine Smee ’007 with Krishnan ’123 because Krishnan ’123 provides pilot transmission and channel estimation implementation details to the problem identified by Smee ’007. *See* Krishnan ’123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]. Krishnan ’062 is the granted patent of Krishnan ’123 with identical specification. For the same reason above, a POSITA would been motivated to combine Smee ’007 with Krishnan ’062.

- **Smee ’007 and Sumasu ’776 / Sumasu ’634**: Sumasu ’634 is a WIPO counterpart of Sumasu ’776. Sumasu ’776 / Sumasu ’634 are charted separately, and the citations in that charts for each limitation are incorporated herein by reference. Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method

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of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 address to an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Sumasu '776 / Sumasu '634 at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Sumasu '776 / Sumasu '634) in order to carry out channel estimation. In addition, Smee '007 and Sumasu '776 / Sumasu '634 identify the common problem of providing enhancements to pilot transmission and channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; *see* Translation of Sumasu '634

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at Abstract, 6-8, 13-14 and Fig. 2. A POSITA would have been motivated to combine Smee '007 with Sumasu '776 / Sumasu '634 because Sumasu '776 / Sumasu '634 provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; *see* Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2.

- **Smee '007 and Engstrom**: Engstrom teaches and describes "a random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital communication system . . . ." Engstrom at Abstract. Engstrom further describes a channel timing estimation method using an uplink signal in an OFDM system. *See* Engstrom at 1:8-13, 2:51-3:8, 7:38-54. Engstrom further discloses using dedicated channels for the uplink signal to improve channel estimation performance. *See* Engstrom at 6:36-7:4, 7:17-67 and Fig. 8. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile

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stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Engstrom at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Engstrom) in order to carry out channel estimation. In addition, Smee '007 and Engstrom identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Engstrom at Abstract, 6:36-7:4, 7:17-67 and Fig. 8. A POSITA would have been motivated to combine Smee '007 with Engstrom because Engstrom provides pilot (e.g. initial access and ranging signals) transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Engstrom at Abstract, 6:36-7:4, 7:17-67.

- **Smee '007 and Wahlqvist**: Wahlqvist teaches and describes "[the] use of orthogonal frequency division multiplex[ing] [OFDM] in a cellular system requir[ing] that the base station and the mobile station are time and frequency synchronized in order to preserve orthogonality between the subcarriers." Wahlqvist at Abstract. Wahlqvist further discloses "an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol" and related estimation algorithms. *See* Wahlqvist at 1, 3. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010].

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Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Wahlqvist at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Wahlqvist) in order to carry out channel estimation. In addition, Smee '007 and Wahlqvist identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Wahlqvist at Abstract, 2-3 and Fig. 5. A POSITA would have been motivated to combine Smee '007 with Wahlqvist because Wahlqvist provides pilot (e.g. initial access and ranging signals) transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Wahlqvist at Abstract, 2-3 and Fig. 5.

- **Smee '007 and Cudak**: Cudak teaches and describes channel quality feedback procedures within a communication system, e.g. OFDM. *See* Cudak at [0001],

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[0038], [0057], [0058], [0071]. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Cudak at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Cudak) in order to carry out channel estimation. In addition, Smee '007 and Cudak identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Cudak at [0013], [0015], [0020]-[0022], [0066]-[0067], Fig. 6 and Fig. 7. A POSITA would have been motivated to combine Smee '007 with Cudak because Cudak provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Cudak at [0013], [0015], [0020]-[0022], [0066]-[0067], Fig. 6 and Fig. 7.

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- **Smee ’007 and Walton ’538**: Walton ’538 teaches and describes “a multiple-access OFDM-CDMA system” in which “[a] pilot may be transmitted by each transmitter unit to assist the receiver units perform acquisition, timing synchronization, carrier recovery, handoff, channel estimation, coherent data demodulation, and so on” Walton ’538 at Abstract. Similarly, Smee ’007 teaches and describes “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems” Smee ’007 at Abstract, [0010]. Further, Smee ’007 discloses “pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink.” *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee ’007 with Walton ’538 at least because Smee ’007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton ’538) in order to carry out channel estimation. In addition, Smee ’007 and Walton ’538 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Walton ’538 at [0117]-[0123]. A POSITA would have been motivated to combine

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Smee ’007 with Walton ’538 because Walton ’538 provides pilot transmission and channel estimation implementation details to the problem identified by Smee ’007 . *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Walton ’538 at [0117]-[0123].

- **Smee ’007 and Walton ’301**: Walton ’301 teaches and describes an OFDM-based wireless local area network communication which a pilot structure is employed for different. *See* Walton ’301 at Abstract. Similarly, Smee ’007 teaches and describes “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems” Smee ’007 at Abstract, [0010]. Further, Smee ’007 discloses “pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink.” *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee ’007 with Walton ’301 at least because Smee ’007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton ’301) in order to carry out channel estimation. In addition, Smee ’007 and Walton ’301 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee ’007 at [0036],

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[0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Walton '301 at 69:17-77:12. A POSITA would have been motivated to combine Smee '007 with Walton '301 because Walton '301 provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Walton '301 at 69:17-77:12.

- **Smee '007 and Walton '131**: Walton '131 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton '131 teaches and describes using "OFDM symbols of different sizes to achieve greater efficiency for OFDM systems" and "pilot data may be transmitted using OFDM symbols of a third size or the first size" Walton '131 at Abstract. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Walton '131 at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication

system (such as that disclosed in Walton ’131) in order to carry out channel estimation. In addition, Smee ‘007 and Walton ’131 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Walton ’131 at [0041], [0051]-[0052], [0102]-[0104], [0131]-[0133]. A POSITA would have been motivated to combine Smee ’007 with Walton ’131 because Walton ’131 provides pilot transmission and channel estimation implementation details to the problem identified by Smee ’007 . *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Walton ’131 at [0041], [0051]-[0052], [0102]-[0104], [0131]-[0133].

- **Smee ’007 and Walton ’609**: Walton ’609 teaches and describes “[a]n inner loop estimates the channel conditions for a communication link and selects a suitable data rate for each of the multiple parallel channels based on the channel estimates.” in an MIMO-OFDM system, Walton ’609 at Abstract. Similarly, Smee ’007 teaches and describes “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems” Smee ’007 at Abstract, [0010]. Further, Smee ’007 discloses “pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink.” *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal

communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee ’007 with Walton ’609 at least because Smee ’007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton ’609) in order to carry out channel estimation. In addition, Smee ‘007 and Walton ’609 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Walton ’609 at 9:18-28, 10:23-33, 21:10-30, 24:42-51, 26:6-31, 26:39-52, and Fig. 7. A POSITA would have been motivated to combine Smee ’007 with Walton ’609 because Walton ’609 provides pilot transmission and channel estimation implementation details to the problem identified by Smee ’007 . *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Walton ’609 at 9:18-28, 10:23-33, 21:10-30, 24:42-51, 26:6-31, 26:39-52, and Fig. 7.

- **Smee ’007 and Tong ’798**: Tong ’798 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Tong ’798 teaches and describes a virtual MIMO transmission system which is applicable to OFDM multiple access systems. *See* Tong ’798 at Abstract, 4:11-22. Tong ’798 further discloses channel/resource allocation for pilot signals. *See* Tong ’798 at 6:8-28, and Fig. 6. Similarly, Smee ’007 teaches and describes “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM)

communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Tong '798 at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Tong '798) in order to carry out channel estimation. In addition, Smee '007 and Tong '798 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Tong '798 at Abstract, 6:62-9:38, 10:25-65, and Figs. 6-12. A POSITA would have been motivated to combine Smee '007 with Tong '798 because Tong '798 provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Tong '798 at Abstract, 6:62-9:38, 10:25-65, and Figs. 6-12.

- **Smee '007 and Ketchum '627**: Ketchum '627 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference.

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Ketchum ’627 teaches and describes “[p]ilots suitable for use in MIMO systems and capable of supporting various function”, e.g. a “MIMO pilot” and a “steering reference” “may be used for channel estimation” Ketchum ’627 at Abstract. Ketchum ’627 further discloses pilot structure and transmission schemes in an exemplary MIMO-OFDM system. *See* Ketchum ’627 at [0032], [0034]-[0035], [0214]-[0221]. Similarly, Smee ’007 teaches and describes “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems” Smee ’007 at Abstract, [0010]. Further, Smee ’007 discloses “pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink.” *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee ’007 with Ketchum ’627 at least because Smee ’007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ketchum ’627) in order to carry out channel estimation. In addition, Smee ‘007 and Ketchum ’627 identify the common problem of providing enhancements to pilot transmission and channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Ketchum ’627 at [0043], [0047], [0103], and [0219]-

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[0221]. A POSITA would have been motivated to combine Smee '007 with Ketchum '627 because Ketchum '627 provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Ketchum '627 at [0043], [0047], [0103], and [0219]-[0221].

- **Smee '007 and Ketchum '291**: Ketchum '291 teaches and describes using physical layer feedback for efficient use of high throughput systems, such as an OFDM system. *See* Ketchum '291 at Abstract, [0071], [0073]. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Ketchum '291 at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ketchum '291) in order to carry out channel estimation. In addition, Smee '007 and Ketchum '291 identify the common problem of providing enhancements to pilot transmission and/or channel estimation

in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Ketchum '291 at [0058], [0075], [0121]-[0122], [0129]-[0134] and [0146]-[0147]. A POSITA would have been motivated to combine Smee '007 with Ketchum '291 because Ketchum '291 provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Ketchum '291 at [0058], [0075], [0121]-[0122], [0129]-[0134] and [0146]-[0147].

- **Smee '007 and Uesugi '133**: Uesugi '133 teaches and describes a multi-carrier transmission method of an OFDM system capable of improving the frequency utilization efficiency at both ends of a band, resistant to multi-paths. *See* Uesugi '133 at Abstract, 3:24-36, 4:31-36. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Uesugi '133 at least because Smee '007 provides details of a pilot transmission and channel allocation

in an OFDM-based wireless communication system (such as that disclosed in Uesugi ’133) in order to carry out channel estimation. In addition, Smee ‘007 and Uesugi ’133 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Uesugi ’133 at 1:38-45, 3:24-36, 6:19-29, 7:7-37 and Fig. 13. Abstract, 2-3 and Fig. 5. A POSITA would have been motivated to combine Smee ’007 with Uesugi ’133 because Uesugi ’133 provides pilot transmission and channel estimation implementation details to the problem identified by Smee ’007 . *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Uesugi ’133 at 1:38-45, 3:24-36, 6:19-29, 7:7-37 and Fig. 13.

- **Smee ’007 and Sudo ’141**: Sudo ’141 teaches and describes “an OFDM-CDMA radio transmitting apparatus and radio transmission method that make it possible to make spectral efficiency compatible with error rate characteristics..” Sudo ’141 at 2:66-3:9. Similarly, Smee ’007 teaches and describes “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems” Smee ’007 at Abstract, [0010]. Further, Smee ’007 discloses “pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink.” *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical

layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Sudo '141 at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Sudo '141) in order to carry out channel estimation. In addition, Smee '007 and Sudo '141 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Sudo '141 at 9:4-10, 10:19-46, Fig. 10 and Fig. 12. A POSITA would have been motivated to combine Smee '007 with Sudo '141 because Sudo '141 provides pilot and control information transmission and channel estimation implementation details to the problem identified by Smee '007. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Sudo '141 at 9:4-10, 10:19-46, Fig. 10 and Fig. 12.

- **Smee '007 and Harel**: Harel is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Harel teaches and describes "[a] system and method for using a group of pilot signals to enhance a data signal within an orthogonal frequency division multiplexing (OFDM) multiple-access scheme" Harel at Abstract. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such

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as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Harel at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Harel) in order to carry out channel estimation. In addition, Smee '007 and Harel identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Harel at Abstract, [0029], [0033], [0037]-[0041] and Fig. 3. A POSITA would have been motivated to combine Smee '007 with Harel because Harel provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Harel at Abstract, [0029], [0033], [0037]-[0041] and Fig. 3.

- **Smee '007 and Baum '478**: Baum '478 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Baum '478 teaches and describes a pilot code scheme used in an OFDM system which could improve system synchronization. *See* Baum '478 at Abstract. Similarly, Smee '007

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teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Baum '478 at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Baum '478) in order to carry out channel estimation. In addition, Smee '007 and Baum '478 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Baum '478 at 10:5-23, 11:48-56, 13:7-26, 21:60-22;10, and Figs. 5, 7, 9. A POSITA would have been motivated to combine Smee '007 with Baum '478 because Baum '478 provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Baum '478 at 10:5-23, 11:48-56, 13:7-26, 21:60-22;10, and Figs. 5, 7, 9.

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- **Smee ’007 and Ma ’858**: Ma ’858 teaches and describes performing soft handoff using pilot signals of an OFDM system.” *See* Ma ’858 at Abstract. Ma ’858 further discloses a pilot channel “used for synchronization, initial channel estimation, base station identification, and carrier-to-interference ratio (CIR) measurements for cell (or base station) selection.” *See* Ma ’858 at 9:11-20. Similarly, Smee ’007 teaches and describes “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems” Smee ’007 at Abstract, [0010]. Further, Smee ’007 discloses “pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink.” *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee ’007 with Ma ’858 at least because Smee ’007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ma ’858) in order to carry out channel estimation. In addition, Smee ‘007 and Ma ’858 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Ma ’858 at 5:39-62, 8:62-9:54, and 11:9-12. A POSITA would have been motivated to combine

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Smee ’007 with Ma ’858 because Ma ’858 provides pilot transmission and channel estimation implementation details to the problem identified by Smee ’007 . *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Ma ’858 at 5:39-62, 8:62-9:54, and 11:9-12.

- **Smee ’007 and Ma ’429**: Ma ’429 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma ’429 teaches and describes a new uplink OFDM protocol having two different operation modes. *See* Ma ’429 at Abstract. Ma ’429 further discloses a pilot structure to “support uplink transmit power measurement” *See* Ma ’429 at [0134]. Similarly, Smee ’007 teaches and describes “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems” Smee ’007 at Abstract, [0010]. Further, Smee ’007 discloses “pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink.” *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee ’007 with Ma ’429 at least because Smee ’007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ma ’429) in order to carry out channel estimation. In addition, Smee ‘007 and Ma ’429 identify the common problem of providing enhancements

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to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Ma '429 at [0131]-[0134], [0241]-[0242], [0248], [0257]-[0258] and Figs. 2, 4-6, 12. A POSITA would have been motivated to combine Smee '007 with Ma '429 because Ma '429 provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Ma '429 at Ma '429 at [0131]-[0134], [0241]-[0242], [0248], [0257]-[0258] and Figs. 2, 4-6, 12.

- **Smee '007 and Auer**: Auer teaches and describes a two-stage channel estimation process using pilot signals in an OFDM-based system. See Auer at Abstract, 1-4. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Auer at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that

disclosed in Auer) in order to carry out channel estimation. In addition, Smee '007 and Auer identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Auer at Abstract, 3-5, 22 and Figs. 8, 9. A POSITA would have been motivated to combine Smee '007 with Auer because Auer provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Auer at Abstract, 3-5, 22 and Figs. 8, 9.

- **Smee '007 and Nee**: Nee teaches and describes OFDM design guidance for wireless multimedia communications. *See* Nee at Preface. Nee further discloses using pilot signals to perform channel estimation. *See* Nee at 96 and Fig. 5.2. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007 discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007

with Nee at least because Smee ’007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Nee) in order to carry out channel estimation. In addition, Smee ‘007 and Nee identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Nee at 96 and Fig. 5.2. A POSITA would have been motivated to combine Smee ’007 with Nee because Nee provides pilot transmission and channel estimation implementation details to the problem identified by Smee ’007 . *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Nee at 96 and Fig. 5.2.

- **Smee ’007 and Jacobsen:** Jacobsen teaches and describes a wireless OFDM communication system which could compensate for in-band interference, noise and channel effects. Jacobsen at Abstract. *See* Jacobsen at Abstract, [0002], [0003], [0016]-[0017]. Similarly, Smee ’007 teaches and describes “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems” Smee ’007 at Abstract, [0010]. Further, Smee ’007 discloses “pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink.” *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between

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mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with Jacobsen at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Jacobsen) in order to carry out channel estimation. In addition, Smee '007 and Jacobsen identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Jacobsen at Abstract and [0017]. A POSITA would have been motivated to combine Smee '007 with Jacobsen because Jacobsen provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Jacobsen at Abstract and [0017].

- **Smee '007 and WiMAX**: WiMAX is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Defendants incorporate by reference the citations in the Wi-Max Invalidity Chart into the invalidity chart for Smee '007. WiMAX teaches and describes an OFDM based communication system which could use a ranging signal as pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure" *See* WiMAX Source 2 at 37, 50, 51, 93 and 94. Similarly, Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. Further, Smee '007

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discloses "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink." *Id.* at [0036]. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Smee '007 with WiMAX at least because Smee '007 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in WiMAX) in order to carry out channel estimation. In addition, Smee '007 and WiMAX identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* WiMAX Source 2 at 50, 96, 107, 157 and 246. A POSITA would have been motivated to combine Smee '007 with WiMAX because WiMAX provides pilot (e.g. initial access and ranging signals) transmission and channel estimation implementation details to the problem identified by Smee '007 . *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* WiMAX Source 2 at 37, 50, 51, 96, 107, 157 and 246.

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(x) Sumasu ’776 / Sumasu ’634 in combination with the knowledge of a skilled artisan, Krishnan ’123, Krishnan ’062, Smee ’007, Engstrom, Wahlqvist, Cudak, Walton ’538, Walton ’301, Walton ’131, Walton ’609, Tong ’798, Ketchum ’627, Ketchum ’291, Uesugi ’133, Sudo ’141, Harel, Baum ’478, Ma ’858, Ma ’429, Auer, Nee, and/or Jacobsen.

Sumasu ’634 is a WIPO counterpart of Sumasu ’776. In addition to the motivations identified above and in the relevant charts, a person of ordinary skill in the art would have had ample reason to combine Sumasu ’776 / Sumasu ’634 with each of these references. A person of ordinary skill in the art would have found it obvious to combine Sumasu ’776 / Sumasu ’634 with, or modify it based on, the disclosures of one or more of the other references because, for example, the references come from the same field of endeavor, use known techniques to improve similar devices in the same way, and represent a choice among a finite number of identified, predictable solutions. Such a modification or substitution would have been both obvious to try and simple, requiring nothing more than a simple substitution of one known element for another to obtain predictable results. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success for the combination or substitution, because the claimed disclosures were well-known at the time the application leading to the ’302 patent was filed. Specifically:

- Krishnan ’123 / Krishnan ’062, Smee ’007, Engstrom, Wahlqvist, Cudak, Walton ’538, Walton ’301, Walton ’131, Walton ’609, Tong ’798, Ketchum ’627, Ketchum ’291, Uesugi ’133, Sudo ’141, Harel, Baum ’478, Ma ’858, Ma ’429, Auer, Nee, and/or Jacobsen are all directed to systems and methods for a broadband wireless communication using OFDM transmission. For example, they relate to broadband wireless communication between a mobile station and a base station using OFDM transmission, and in particular to uplink and probing signal (e.g. pilot

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signal) protocols. They involve same or similar communication protocols, standards, OFDM transmission methods, and access schemes that were common and easily understood and were also well adapted to integration with each other using common building blocks that would be known to a person of ordinary skill in the art.

- **Sumasu '776 / Sumasu '634 and Krishnan '123 / Krishnan '062**: Krishnan '123 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Krishnan '123 teaches and describes the "[t]echniques to more efficiently transmit pilot and signaling on the uplink in an OFDM system" Krishnan '123 at Abstract. Similarly, Sumasu '776 / Sumasu '634 teaches and describes "a transmission apparatus, reception apparatus and radio communication method" "capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 address to an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Krishnan '123 at least because Sumasu '776 / Sumasu '634 provides details

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of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Krishnan '123) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Krishnan '123 identify the common problem of providing enhancements to pilot transmission and channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056] and Fig. 5; *see* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; *see* Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2. A POSITA would have been motivated to combine Smee '007 with Krishnan '123 because Krishnan '123 provides pilot transmission and channel estimation implementation details to the problem identified by Smee '007. *See* Krishnan '123 at Abstract, [0042], [0047]-[0048], [0054]-[0056]; *see* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; *see* Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2. Krishnan '062 is the granted patent of Krishnan '123 with identical specification. For the same reason above, a POSITA would been motivated to combine Smee '007 with Krishnan '062.

- **Sumasu '776 / Sumasu '634 and Smee '007**: Smee '007 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Smee '007 teaches and describes "[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems" Smee '007 at Abstract, [0010]. "pilots are transmitted to support various functions …, such as … channel estimation, …. The multiple carriers may be provided by OFDM … The pilot transmission schemes described herein … may also be used for the uplink."

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Id. at [0036]. Similarly, Sumasu '776 / Sumasu '634 teaches and describes "a transmission apparatus, reception apparatus and radio communication method" "capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 address to an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Smee '007 at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Smee '007) in order to carry out channel estimation. In addition, Smee '007 and Sumasu '776 / Sumasu '634 identify the common problem of providing enhancements to pilot transmission and channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Smee '007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; *see* Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Smee '007

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because Smee ’007 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu ’776 / Sumasu ’634. *See* Smee ’007 at [0036], [0046]-[0048], [0063]-[0065], [0071], [0091]-[0095]; *see* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; *see* Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2.

- **Sumasu ’776 / Sumasu ’634 and Engstrom**: Engstrom teaches and describes “a random access protocol system and method for communicating between a mobile station and a base station in a multi-access digital communication system . . . .” Engstrom at Abstract. Engstrom further describes a channel timing estimation method using an uplink signal in an OFDM system. *See* Engstrom at 1:8-13, 2:51-3:8, 7:38-54. Engstrom further discloses using dedicated channels for the uplink signal to improve channel estimation performance. *See* Engstrom at 6:36-7:4, 7:17-67 and Fig. 8. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation

processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Engstrom at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Engstrom) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Engstrom identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; *see* Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Engstrom at Abstract, 6:36-7:4, 7:17-67 and Fig. 8. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Engstrom because Engstrom provides pilot (e.g. initial access and ranging signals) transmission and channel estimation implementation details to the problem identified by Sumasu '776 / Sumasu '634. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2 *see* Engstrom at Abstract, 6:36-7:4, 7:17-67.

- **Sumasu '776 / Sumasu '634 and Wahlqvist**: Wahlqvist teaches and describes "[the] use of orthogonal frequency division multiplex[ing] [OFDM] in a cellular system requir[ing] that the base station and the mobile station are time and frequency synchronized in order to preserve orthogonality between the subcarriers." Wahlqvist at Abstract. Wahlqvist further discloses "an initial time synchronization scheme for the uplink that can be used as a part in a random access protocol" and

related estimation algorithms. *See* Wahlqvist at 1, 3. Similarly, Sumasu '776 / Sumasu '634 teaches and describes "a transmission apparatus, reception apparatus and radio communication method" "capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 address to an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Wahlqvist at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Wahlqvist) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Wahlqvist identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Wahlqvist at Abstract, 2-3 and Fig. 5. A POSITA would have been motivated to combine Sumasu '776 /

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Sumasu ’634 with Wahlqvist because Wahlqvist provides pilot (e.g. initial access and ranging signals) transmission and channel estimation implementation details to the problem identified by Sumasu ’776 / Sumasu ’634. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2;; *see* Wahlqvist at Abstract, 2-3 and Fig. 5.

- **Sumasu ’776 / Sumasu ’634 and Cudak**: Cudak teaches and describes channel quality feedback procedures within a communication system, e.g. OFDM. *See* Cudak at [0001], [0038], [0057], [0058], [0071]. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu ’776 / Sumasu ’634 with Cudak at least because Sumasu ’776 / Sumasu ’634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless

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communication system (such as that disclosed in Cudak) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Cudak identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Cudak at [0013], [0015], [0020]-[0022], [0066]-[0067], Fig. 6 and Fig. 7. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Cudak because Cudak provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu '776 / Sumasu '634. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Cudak at [0013], [0015], [0020]-[0022], [0066]-[0067], Fig. 6 and Fig. 7.

- **Sumasu '776 / Sumasu '634 and Walton '538**: Walton '538 teaches and describes "a multiple-access OFDM-CDMA system" in which "[a] pilot may be transmitted by each transmitter unit to assist the receiver units perform acquisition, timing synchronization, carrier recovery, handoff, channel estimation, coherent data demodulation, and so on" Walton '538 at Abstract. Similarly, Sumasu '776 / Sumasu '634 teaches and describes "a transmission apparatus, reception apparatus and radio communication method" "capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of

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Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu ’776 / Sumasu ’634 with Walton ’538 at least because Sumasu ’776 / Sumasu ’634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton ’538) in order to carry out channel estimation. In addition, Sumasu ’776 / Sumasu ’634 and Walton ’538 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Walton ’538 at [0117]-[0123]. A POSITA would have been motivated to combine Sumasu ’776 / Sumasu ’634 with Walton ’538 because Walton ’538 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu ’776 / Sumasu ’634. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Walton ’538 at [0117]-[0123].

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- **Sumasu ’776 / Sumasu ’634 and Walton ’301**: Walton ’301 teaches and describes an OFDM-based wireless local area network communication which a pilot structure is employed for different. *See* Walton ’301 at Abstract. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu ’776 / Sumasu ’634 with Walton ’301 at least because Sumasu ’776 / Sumasu ’634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton ’301) in order to carry out channel estimation. In addition, Sumasu ’776 / Sumasu ’634 and Walton ’301 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see

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Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Walton ’301 at 69:17-77:12. A POSITA would have been motivated to combine Sumasu ’776 / Sumasu ’634 with Walton ’301 because Walton ’301 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu ’776 / Sumasu ’634. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Walton ’301 at 69:17-77:12.

- **Sumasu ’776 / Sumasu ’634 and Walton ’131**: Walton ’131 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Walton ’131 teaches and describes using “OFDM symbols of different sizes to achieve greater efficiency for OFDM systems” and “pilot data may be transmitted using OFDM symbols of a third size or the first size” Walton ’131 at Abstract. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation

processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Walton '131 at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton '131) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Walton '131 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Walton '131 at [0041], [0051]-[0052], [0102]-[0104], [0131]-[0133]. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Walton '131 because Walton '131 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu '776 / Sumasu '634. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Walton '131 at [0041], [0051]-[0052], [0102]-[0104], [0131]-[0133].

- **Sumasu '776 / Sumasu '634 and Walton '609**: Walton '609 teaches and describes "[a]n inner loop estimates the channel conditions for a communication link and selects a suitable data rate for each of the multiple parallel channels based on the channel estimates." in an MIMO-OFDM system, Walton '609 at Abstract. Similarly, Sumasu '776 / Sumasu '634 teaches and describes "a transmission apparatus, reception apparatus and radio communication method" "capable of

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improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 address to an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Walton '609 at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Walton '609) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Walton '609 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Walton '609 at 9:18-28, 10:23-33, 21:10-30, 24:42-51, 26:6-31, 26:39-52, and Fig. 7. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Walton '609 because Walton '609 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu '776 /

Sumasu ’634. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Walton ’609 at 9:18-28, 10:23-33, 21:10-30, 24:42-51, 26:6-31, 26:39-52, and Fig. 7.

- **Sumasu ’776 / Sumasu ’634 and Tong ’798**: Tong ’798 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Tong ’798 teaches and describes a virtual MIMO transmission system which is applicable to OFDM multiple access systems. *See* Tong ’798 at Abstract, 4:11-22. Tong ’798 further discloses channel/resource allocation for pilot signals. *See* Tong ’798 at 6:8-28, and Fig. 6. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu ’776 / Sumasu ’634 with Tong ’798 at least because Sumasu ’776 / Sumasu ’634 provides details of a

pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Tong '798) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Tong '798 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Tong '798 at Abstract, 6:62-9:38, 10:25-65, and Figs. 6-12. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Tong '798 because Tong '798 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu '776 / Sumasu '634. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Tong '798 at Abstract, 6:62-9:38, 10:25-65, and Figs. 6-12.

- **Sumasu '776 / Sumasu '634 and Ketchum '627**: Ketchum '627 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ketchum '627 teaches and describes "[p]ilots suitable for use in MIMO systems and capable of supporting various function", e.g. a "MIMO pilot" and a "steering reference" "may be used for channel estimation" Ketchum '627 at Abstract. Ketchum '627 further discloses pilot structure and transmission schemes in an exemplary MIMO-OFDM system. *See* Ketchum '627 at [0032], [0034]-[0035], [0214]-[0221]. Similarly, Sumasu '776 / Sumasu '634 teaches and describes "a transmission apparatus, reception apparatus and radio communication

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method" "capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 address to an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Ketchum '627 at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ketchum '627) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Ketchum '627 identify the common problem of providing enhancements to pilot transmission and channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Ketchum '627 at [0043], [0047], [0103], and [0219]-[0221]. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Ketchum '627 because Ketchum '627 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu '776 /

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Sumasu ’634. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Ketchum ’627 at [0043], [0047], [0103], and [0219]-[0221].

- **Sumasu ’776 / Sumasu ’634 and Ketchum ’291**: Ketchum ’291 teaches and describes using physical layer feedback for efficient use of high throughput systems, such as an OFDM system. *See* Ketchum ’291 at Abstract, [0071], [0073]. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu ’776 / Sumasu ’634 with Ketchum ’291 at least because Sumasu ’776 / Sumasu ’634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ketchum ’291) in order to carry out channel estimation. In addition, Sumasu ’776 / Sumasu ’634 and Ketchum ’291 identify the common problem of providing

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enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Ketchum '291 at [0058], [0075], [0121]-[0122], [0129]-[0134] and [0146]-[0147]. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Ketchum '291 because Ketchum '291 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu '776 / Sumasu '634. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Ketchum '291 at [0058], [0075], [0121]-[0122], [0129]-[0134] and [0146]-[0147].

- **Sumasu '776 / Sumasu '634 and Uesugi '133**: Uesugi '133 teaches and describes a multi-carrier transmission method of an OFDM system capable of improving the frequency utilization efficiency at both ends of a band, resistant to multi-paths. *See* Uesugi '133 at Abstract, 3:24-36, 4:31-36. Similarly, Sumasu '776 / Sumasu '634 teaches and describes "a transmission apparatus, reception apparatus and radio communication method" "capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 address to an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of

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endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Uesugi '133 at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Uesugi '133) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Uesugi '133 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Uesugi '133 at 1:38-45, 3:24-36, 6:19-29, 7:7-37 and Fig. 13. Abstract, 2-3 and Fig. 5. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Uesugi '133 because Uesugi '133 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu '776 / Sumasu '634. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Uesugi '133 at 1:38-45, 3:24-36, 6:19-29, 7:7-37 and Fig. 13.

- **Sumasu '776 / Sumasu '634 and Sudo '141**: Sudo '141 teaches and describes "an OFDM-CDMA radio transmitting apparatus and radio transmission method that make it possible to make spectral efficiency compatible with error rate

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characteristics..” Sudo ’141 at 2:66-3:9. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu ’776 / Sumasu ’634 with Sudo ’141 at least because Sumasu ’776 / Sumasu ’634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Sudo ’141) in order to carry out channel estimation. In addition, Sumasu ’776 / Sumasu ’634 and Sudo ’141 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Sudo ’141 at 9:4-10, 10:19-46, Fig. 10 and Fig. 12. A POSITA would have been motivated to combine Sumasu ’776 / Sumasu ’634

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with Sudo ’141 because Sudo ’141 provides pilot and control information transmission and channel estimation implementation details to the problem identified by Sumasu ’776 / Sumasu ’634. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Sudo ’141 at 9:4-10, 10:19-46, Fig. 10 and Fig. 12.

- **Sumasu ’776 / Sumasu ’634 and Harel**: Harel is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Harel teaches and describes “[a] system and method for using a group of pilot signals to enhance a data signal within an orthogonal frequency division multiplexing (OFDM) multiple-access scheme” Harel at Abstract. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine

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Sumasu ’776 / Sumasu ’634 with Harel at least because Sumasu ’776 / Sumasu ’634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Harel) in order to carry out channel estimation. In addition, Sumasu ’776 / Sumasu ’634 and Harel identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Harel at Abstract, [0029], [0033], [0037]-[0041] and Fig. 3. A POSITA would have been motivated to combine Sumasu ’776 / Sumasu ’634 with Harel because Harel provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu ’776 / Sumasu ’634. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Harel at Abstract, [0029], [0033], [0037]-[0041] and Fig. 3.

- **Sumasu ’776 / Sumasu ’634 and Baum ’478**: Baum ’478 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Baum ’478 teaches and describes a pilot code scheme used in an OFDM system which could improve system synchronization. *See* Baum ’478 at Abstract. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and

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improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 address to an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Baum '478 at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Baum '478) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Baum '478 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Baum '478 at 10:5-23, 11:48-56, 13:7-26, 21:60-22;10, and Figs. 5, 7, 9. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Baum '478 because Baum '478 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu '776 / Sumasu '634. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of

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Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Baum ’478 at 10:5-23, 11:48-56, 13:7-26, 21:60-22;10, and Figs. 5, 7, 9.

- **Sumasu ’776 / Sumasu ’634 and Ma ’858**: Ma ’858 teaches and describes performing soft handoff using pilot signals of an OFDM system.” *See* Ma ’858 at Abstract. Ma ’858 further discloses a pilot channel “used for synchronization, initial channel estimation, base station identification, and carrier-to-interference ratio (CIR) measurements for cell (or base station) selection.” *See* Ma ’858 at 9:11-20. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu ’776 / Sumasu ’634 with Ma ’858 at least because Sumasu ’776 / Sumasu ’634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ma ’858) in order to carry out channel estimation. In addition, Sumasu ’776 / Sumasu ’634

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and Ma ’858 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Ma ’858 at 5:39-62, 8:62-9:54, and 11:9-12. A POSITA would have been motivated to combine Sumasu ’776 / Sumasu ’634 with Ma ’858 because Ma ’858 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu ’776 / Sumasu ’634. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Ma ’858 at 5:39-62, 8:62-9:54, and 11:9-12.

- **Sumasu ’776 / Sumasu ’634 and Ma ’429**: Ma ’429 is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Ma ’429 teaches and describes a new uplink OFDM protocol having two different operation modes. *See* Ma ’429 at Abstract. Ma ’429 further discloses a pilot structure to “support uplink transmit power measurement” *See* Ma ’429 at [0134]. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-

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[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Ma '429 at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Ma '429) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Ma '429 identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Ma '429 at [0131]-[0134], [0241]-[0242], [0248], [0257]-[0258] and Figs. 2, 4-6, 12. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Ma '429 because Ma '429 provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu '776 / Sumasu '634. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Ma '429 at Ma '429 at [0131]-[0134], [0241]-[0242], [0248], [0257]-[0258] and Figs. 2, 4-6, 12.

- **Sumasu '776 / Sumasu '634 and Auer**: Auer teaches and describes a two-stage channel estimation process using pilot signals in an OFDM-based system. See Auer

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at Abstract, 1-4. Similarly, Sumasu '776 / Sumasu '634 teaches and describes "a transmission apparatus, reception apparatus and radio communication method" "capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 address to an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Auer at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Auer) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Auer identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Auer at Abstract, 3-5, 22 and Figs. 8, 9. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Auer because Auer provides pilot transmission

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and channel estimation implementation details to the problem identified by Sumasu '776 / Sumasu '634. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Auer at Abstract, 3-5, 22 and Figs. 8, 9.

- **Sumasu '776 / Sumasu '634 and Nee**: Nee teaches and describes OFDM design guidance for wireless multimedia communications. *See* Nee at Preface. Nee further discloses using pilot signals to perform channel estimation. *See* Nee at 96 and Fig. 5.2. Similarly, Sumasu '776 / Sumasu '634 teaches and describes "a transmission apparatus, reception apparatus and radio communication method" "capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 address to an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Nee at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Nee) in order to carry out channel estimation. In addition, Sumasu '776

/ Sumasu ’634 and Nee identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Nee at 96 and Fig. 5.2. A POSITA would have been motivated to combine Sumasu ’776 / Sumasu ’634 with Nee because Nee provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu ’776 / Sumasu ’634. *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Nee at 96 and Fig. 5.2.

- **Sumasu ’776 / Sumasu ’634 and Jacobsen:** Jacobsen teaches and describes a wireless OFDM communication system which could compensate in-band interference, noise and channel effects. Jacobsen at Abstract. *See* Jacobsen at Abstract, [0002], [0003], [0016]-[0017]. Similarly, Sumasu ’776 / Sumasu ’634 teaches and describes “a transmission apparatus, reception apparatus and radio communication method” “capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation” Sumasu ’776 at [0008]; Translation of Sumasu ’634 at 2. Sumasu ’776 / Sumasu ’634 address to an OFDM-based MC modulation system. *See* Sumasu ’776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu ’634 at 1, 6-7, 10, 11. Thus, these references were in the same field of

endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with Jacobsen at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in Jacobsen) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and Jacobsen identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Jacobsen at Abstract and [0017]. A POSITA would have been motivated to combine Sumasu '776 / Sumasu '634 with Jacobsen because Jacobsen provides pilot transmission and channel estimation implementation details to the problem identified by Sumasu '776 / Sumasu '634. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu '634 at Abstract, 6-8, 13-14 and Fig. 2; *see* Jacobsen at Abstract and [0017].

- **Sumasu '776 / Sumasu '634 and WiMAX**: WiMAX is charted separately, and the citations in that chart for each limitation are incorporated herein by reference. Defendants incorporate by reference the citations in the Wi-Max Invalidity Chart into the invalidity charts for Sumasu '776 and Sumasu '634. WiMAX teaches and describes an OFDM based communication system which could use a ranging signal

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as a pilot signal to perform channel estimation on timing . *See* WiMAX Source 1 at 66, 179, 180. WiMAX further discloses a ranging signal structure and procedure" *See* WiMAX Source 2 at 37, 50, 51, 93 and 94. Similarly, Sumasu '776 / Sumasu '634 teaches and describes "a transmission apparatus, reception apparatus and radio communication method" "capable of improving the transmission efficiency in radio communications based on the MC modulation system by improving a method of transmitting pilot signals and improving a method of carrying out channel estimation" Sumasu '776 at [0008]; Translation of Sumasu '634 at 2. Sumasu '776 / Sumasu '634 addresses an OFDM-based MC modulation system. *See* Sumasu '776 at [0001], [0004]-[0005], [0034]-[0037], [0054], [0057]; Translation of Sumasu '634 at 1, 6-7, 10, 11. Thus, these references were in the same field of endeavor, and describe specifications of wireless communication systems using OFDM transmission, including the physical layer and pilot signal communication and channel estimation processes, between mobile stations and base stations. It would have been obvious for a POSITA to combine Sumasu '776 / Sumasu '634 with WiMAX at least because Sumasu '776 / Sumasu '634 provides details of a pilot transmission and channel allocation in an OFDM-based wireless communication system (such as that disclosed in WiMAX) in order to carry out channel estimation. In addition, Sumasu '776 / Sumasu '634 and WiMAX identify the common problem of providing enhancements to pilot transmission and/or channel estimation in wireless communication systems to accommodate more demanding physical environments. *See* Sumasu '776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of

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Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* WiMAX Source 2 at 50, 96, 107, 157 and 246. A POSITA would have been motivated to combine Sumasu ’776 / Sumasu ’634 with WiMAX because WiMAX provides pilot (e.g. initial access and ranging signals) transmission and channel estimation implementation details to the problem identified by Sumasu ’776 / Sumasu ’634 . *See* Sumasu ’776 at Abstract, [0034]-[0037], [0041], [0080]-[0081] and Fig. 2; see Translation of Sumasu ’634 at Abstract, 6-8, 13-14 and Fig. 2; *see* WiMAX Source 2 at 37, 50, 51, 96, 107, 157 and 246.

2. Lack of Secondary Indicia of Nonobviousness

Defendants are not aware of any evidence that would tend to establish any secondary considerations of non-obviousness. This lack of evidence further renders the Asserted Claims obvious. Proving any such secondary considerations is Neo Wireless’s burden. *See, e.g.*, *ZUP, LLC v. Nach Mfg., Inc.*, 896 F.3d 1365, 1373 (Fed. Cir. 2018) (“[A] patentee bears the burden of production with respect to evidence of secondary considerations of nonobviousness.”). Accordingly, Defendants reserve all rights regarding their full contention in this respect until after Neo Wireless completes its final and binding disclosure of any such evidence and contentions. In the meantime, Defendants note the complete lack of any such evidence in the record.

Neo Wireless has disclosed no evidence of, and Defendants know of no viable evidence to suggest:

- **The alleged invention’s commercial success**. The alleged inventions are applied to wireless standards. There is no evidence to suggest that the inventions made any material contribution to the success of the standards (as opposed to standardization itself driving any alleged commercial success). Further, Defendants know of no nexus

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between any commercial success Neo Wireless has argued before and the Asserted Claims. *See, e.g., Windsurfing Int'l Inc. v. AMF* , 782 F.2d 995 (Fed. Cir. 1986) (considerations such as intervening, non-covered technological innovations, popularity of accessories, and advertising expense are all relevant to the nexus determination). If any commercial success is due to any of the concepts discussed in the Asserted Patents, those concepts are also present in the prior art, as described above, and thus do not support any commercial success that is relevant to the question of obviousness. *See Tokai Corp. v. Easton Enters, Inc.* , 632 F.3d 1358, 1369–70 (Fed. Cir. 2011) ("If commercial success is due to an element in the prior art, no nexus exists."); *In re Huai-Hung Kao* , 639 F.3d 1057, 1068 (Fed. Cir. 2011) ("Where the offered secondary consideration actually results from something other than what is both claimed and *novel* in the claim, there is no nexus to the merits of the claimed invention."); *Ormco Corp. v. Align Tech., Inc.* , 463 F.3d 1299, 1312 (Fed. Cir. 2006) ("[I]f the feature that creates the commercial success was known in the prior art, the success is not pertinent.").

- **Long felt but unresolved needs**. No such long felt and unresolved need existed. Indeed, to the extent that the asserted patents, which are asserted against standards alone, are used in the standard, they were incorporated into the standard at the same time the standard was established.
- **No industry praise.** There is also no evidence of industry praise for the alleged invention of the Asserted Patents or any functionality that allegedly practices the Asserted Patents. Neo Wireless has presented no evidence that there was any praise for the Asserted Patents or its alleged inventions. To the extent any praise is related to any functionality that allegedly practices the Asserted Patents, that praise is not due to the

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allegedly novel features of the Asserted Patents, but instead only to features present in the prior art, which is not a sufficient nexus to be relevant to the question of industry praise for purposes of obviousness. *See Muniauction, Inc. v. Thomson Corp.*, 532 F.3d 1318, 1328 (Fed. Cir. 2008). Praise for the standards is not praise for any particular alleged invention.

- **Unexpected results**: No evidence of any such unexpected results is known. As discussed above, the concepts contained in the Asserted Claims were already combined in the same manner as the asserted. These prior art references and systems, as described in the above-referenced exhibits, disclosed the same combination of elements, and the same result of that combination, that is recited in the Asserted Claims. Thus, there were no unexpected results that arose from combining the well-known elements in the Asserted Claims.
- **The failure of others**. No evidence of any such failure is known.
- **Skepticism by experts**. No experts or person of skill expressed skepticism about implementing the alleged inventions.
- **Teaching away by others**. No evidence of any such teaching is known.
- **Recognition of a problem**. Solutions to the problem already existed in the prior art as discussed above.
- **Copying of the alleged invention by competitors**. No evidence of any such copying is known. *See Amazon.com, Inc. v. Barnesandnoble.com, Inc* ., 239 F.3d 1343, 1366 (Fed. Cir. 2001) (allegedly copied feature must be an embodiment of the patented claims).

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V. INVALIDITY UNDER 35 U.S.C. § 112

Defendants contend that, at least under Neo Wireless's actual and/or apparent application of the claims, the Asserted Claims are invalid based on inadequate written description and/or a lack of enablement under 35 U.S.C. § 112 ¶ 1, and/or based on indefiniteness under 35 U.S.C. § 112 ¶ 2. Defendants further contend that a person of ordinary skill in the art would not understand what is encompassed by certain limitations in the Asserted Claims because certain terms are means-plus-function terms under 35 U.S.C. § 112, ¶ 6 without sufficient disclosure of supporting structure in the specification and are therefore indefinite. *See, e.g., Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1349 (Fed. Cir. 2015).

Defendants' aforementioned identification of prior art that anticipates and/or renders obvious particular claim elements, including the attached claim charts, should not be deemed as an admission that any claim element satisfies the requirements of 35 U.S.C. § 112. While Defendants assert below that a claim is invalid under 35 U.S.C. § 112 (such as because of a failure to particularly point out and distinctly claim the alleged invention, failure to provide written description support in the specification, and/or failure to enable one of ordinary skill in the art to make and use the alleged invention), Defendants have nonetheless provided prior art disclosures that anticipate or render obvious the claim on the assumption that Neo Wireless will contend those claims are definite, are supported by an adequate written description, and are adequately enabled.

A. Lack of Written Description and Enablement Under 35 U.S.C. § 112 ¶ 1

Certain claims in the Asserted Patents are invalid for lack of written description. Section 112 requires that a patent specification "contain a written description . . . of the manner and process of making and using [the invention] in such full, clear, concise and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same." 35 U.S.C. § 112 ¶ 1. A patent's written description "must clearly allow persons

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of ordinary skill in the art to recognize that [the inventor] invented what is claimed." *Ariad Pharms., Inc. v. Eli Lilly & Co*., 598 F.3d 1336, 1351 (Fed. Cir. 2010) (en banc). The disclosure must "convey to those skilled in the art that the inventor had possession of the claimed subject matter as of the filing date." *Id.* The level of detail required to satisfy the written description requirement varies depending on the nature and scope of the claims and on the complexity and predictability of the relevant technology, but a "mere wish or plan" for obtaining the alleged invention does not satisfy the written description requirement. *Novozymes A/S v. DuPont Nutrition Biosciences APS*, 723 F.3d 1336, 1344 (Fed. Cir. 2013). Put another way, "a description that merely renders the invention obvious does not satisfy the requirement." *Ariad*, 598 F.3d at 1351. Instead, "all the limitations must appear in the specification." *Lockwood v. Am. Airlines, Inc*., 107 F.3d 1565, 1572 (Fed. Cir. 1997). Defendants contend that, at least under Neo Wireless's actual and/or apparent application of the claims, the specifications of at least one or more of the Asserted Patents do not include a sufficient written description supporting the claims.

Section 112 likewise requires that the specification "enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the" alleged invention. 35 U.S.C. § 112 ¶ 1. A claim is not enabled if, "at the effective filing date of the patent, one of ordinary skill in the art could not practice their full scope without undue experimentation." *Wyeth and Cordis Corp. v. Abbott Labs.*, 720 F.3d 1380, 1384 (Fed. Cir. 2013). "This important doctrine prevents both inadequate disclosure of an invention and overbroad claiming that might otherwise attempt to cover more than was actually invented." *MagSil Corp. v. Hitachi Global Storage Techs., Inc.*, 687 F.3d 1377, 1381 (Fed. Cir. 2012). Defendants contend that, at least under Neo Wireless's actual and/or apparent application of the claims, the specifications of at least one or

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more of the Asserted Patents do not enable any person skilled in the relevant art to make and use the alleged inventions of the Asserted Claims without undue experimentation.

Furthermore, under Neo Wireless's actual and/or apparent application of the claims, the specifications of at least one or more of the Asserted Patents do not enable the broad scope of the Asserted Claims as Neo Wireless asserts. Defendants contend that Neo Wireless's actual and/or apparent application of the Asserted Claims covers a broader scope than is justified, and certainly broader than is enabled in the specifications. As explained in detail below, the specifications of at least one or more of the Asserted Patents have not enabled a person of ordinary skill in the art at the time of the alleged invention to perform the full scope of all Asserted Claims.

Defendants' investigation of grounds of invalidity based upon failure to meet the written description and/or enablement requirements is ongoing, and Defendants reserve the right to supplement these Contentions.

1. The '366 Patent

The asserted claims of the '366 Patent, at least under Neo Wireless's actual and/or apparent application of the claims, are invalid under 35 U.S.C. § 112 ¶ 1 because the specification lacks an adequate written description of the alleged invention and fails to enable the full scope of the alleged invention.

For example, independent claims 1 and 17 require that "the ranging signal exhibits a low peak-to-average power ratio in the time domain." *E.g.*, '366 pat. at claims 1, 17. In its infringement contentions, Neo Wireless relies on Zadoff-Chu sequences as having a low peak-to-average power ratio. *E.g.*, Infring. Cont. for '366 Pat. at claim 1(f). The '366 patent does not disclose, describe, or teach sequences with low peak to average power ratio in the time domain, much less Zadoff-Chu sequences. Instead, the '366 patent specification discusses Hadamard sequences as ranging sequences. *Id.* at 4:15-48. As the specification notes, Hadamard sequences

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are characterized by "a narrow main peak and low sidelobes." *Id.* at 4:49-59. But Hadamard sequences do not exhibit low peak to average power ratio, which is a specific characteristic of CAZAC (constant amplitude zero autocorrelation) sequences. Accordingly, the '366 patent specification fails to adequately describe any signal with low peak to average power ratio, as required by the asserted independent claims. Thus, to the extent the claims are stretch to cover anything beyond the Hadamard sequences disclosed in the '366 patent specification (such as trying to cover signals based on Zadoff-Chu sequences), the specification does not enable or provide sufficient written description support for independent claim 1 and 17, and the claims which depend therefrom.

Further, independent claims 1 and 17 require that the "mobile station" comprises two apparatuses: "an apparatus configured to transmit a data signal to the serving base station in the cell over a data subchannel," and "an apparatus configured to transmit a ranging signal to the serving base station in the cell over a ranging subchannel for random access." *E.g.*, '366 pat. at claims 1, 17. Yet, the specification of the '366 patent does not disclose, describe, or teach such apparatuses having the required configurations. At best, the '366 patent specification mentions operations and processes, but without the required disclosure of apparatuses configured as claimed. Therefore, the specification does not enable or provide sufficient written description support for independent claim 1 and 17, and the claims which depend therefrom.

In addition, dependent claims 5 and 21 of the '366 patent each recite "setting the transmission power of the ranging signal based on the path loss." *E.g.*, '366 pat. at claims 5, 21. The '366 patent specification's lone disclosure of "path loss," '366 pat. at 5:9-18 (discussing Fig. 8), which relates to "a mobile station estimate[ing] that path loss from a base station," fails to

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disclose setting the transmission power of the ranging signal based on the path loss, as required by the claims.

2. The ’908 Patent

The asserted claims of the ’908 Patent, at least under Neo Wireless’s actual and/or apparent application of the claims, are invalid under 35 U.S.C. § 112 ¶ 1 because the specification lacks an adequate written description of the alleged invention and fails to enable the full scope of the alleged invention.

For example, independent claim 1 of the ’908 patent recites “[a] mobile station comprising[] a transmitter configured to[] transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols[.]” ’908 pat. at claim 1. The only OFDM uplink signals disclosed in the specification are multi-carrier (MC) uplink control signals. *See, e.g.*, ’908 pat at 8:15-29 (“uplink MC control signals”); 9:2-4 (“uplink MC control channel”). Thus, to the extent the claimed “first uplink signal” is interpreted to cover anything beyond the “uplink MC control signals/channel” disclosed in the ’908 patent specification, the specification does not enable or provide sufficient written description support for independent claim 1, and dependent claims 2-10, which depend therefrom. Similarly, independent claims 11 and 21 (and all claims dependent therefrom) must also fail for lack of enablement or written description. *See* ’908 pat. at claim 11 (“A method performed by a mobile station, the method comprising[] transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols[.]”); ’908 pat. at claim 21 (“A mobile station comprising[] a first type of transmitter signal processing circuit configured to[]

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generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols[.]").

In addition, independent claim 1 recites "[a] mobile station comprising[] a transmitter configured to . . . transmit, to the base station, a random access signal . . . , wherein the random access signal includes a sequence associated with the base station[.]" '908 pat. at claim 1. The specification discloses only that the "initial random access signal [is sent] over the DSSS channel with a certain signature code or sequence that is designated to the corresponding base station and is broadcasted to all the mobile stations by each base station." '908 pat. at 8:52-55. Thus, to the extent the "sequence associated with the base station" is interpreted to cover anything beyond the "signature code or sequence that is designated to the corresponding base station and is broadcasted to all the mobile stations by each base station" disclosed in the '908 patent specification, the specification does not enable or provide sufficient written description support for independent claim 1, and dependent claims 2-10, which depend therefrom. Similarly, independent claims 11 and 21 (and all claims dependent therefrom) must also fail for lack of enablement or written description. *See* '908 pat. at claim 11 ("A method performed by a mobile station, the method comprising . . . transmitting, to the base station, an random access signal . . . , wherein the random access signal includes a sequence associated with the base station[.]"); '908 pat. at claim 21 ("A mobile station comprising . . . a second type of transmitter signal processing circuit configured to generate an random access signal . . ., wherein the random access signal includes a sequence associated with a base station[.]").

Moreover, independent claims 1, 11, and 21 (and any claims depending therefrom) require a "random access signal." The only "random access signal" disclosed in the specification is a

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direct sequence spread spectrum (DSSS) signal. *See, e.g.*, '908 pat. at 8:34-9:19. Thus, to the extent the claimed "random access signal" is interpreted to cover anything beyond the "DSSS signal" disclosed in the '908 patent specification, the specification does not enable or provide sufficient written description support for independent claims 1, 11, and 21, or the dependent claims that depend therefrom.

Further, claims 1, 2, 9, 11, 12, 19, 21, 22, 29 (and any claims depending therefrom) require a "sequence associated with the base station" being included or used in forming a random access signal. *E.g.*, '908 pat. at claims 1, 2, 9, 11, 12, 19, 21, 22, 29. The '908 patent specification only describes random access operations in a section titled "initial random access using the overlay scheme" appearing in column 8 line 31 to column 9 line 19 of the specification. *Id.* at 8:31-9:19. Nowhere in this passage is there a description, disclosure, or teaching of a sequence "associated" with the base station. *Id.* The specification, at best, states that the "initial random access signal" is sent over the "DSSS channel with a certain signature code or sequence that is designated to the corresponding base station and is broadcasted to all the mobile stations by each base station." *Id.* at 8:52-55. The specification thus states that the "signature code or sequence" is being sent to the base station over the DSSS channel, but there is no description that the signature code or sequence is specific or associated with the base station, much less that it identifies a base station. Instead, the patent states that the signature code or sequence "is broadcasted to all the mobile stations by each base station." *Id.* Accordingly, the specification does not enable or provide sufficient written description support for independent claims 1, 11, and 21, and claims depend therefrom.

3. The '941 Patent

The asserted claims of the '941 Patent, at least under Neo Wireless's actual and/or apparent application of the claims, are invalid under 35 U.S.C. § 112 ¶ 1 because the specification lacks an

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adequate written description of the alleged invention and fails to enable the full scope of the alleged invention.

For example, asserted independent claims 8 and 13 of the '941 Patent recite that "the corresponding subchannel configuration [is] characterized by distributed subcarriers or localized subcarriers in the frequency domain." '941 Pat. at claims 8 and 13. The '941 Patent specification only discloses "that different configurations of subchannel compositions are suitable for different scenarios or user profiles." '941 Pat. at 7:10-13. The '941 Patent specification does not disclose what subchannel configurations are suitable. In particular, the '941 Patent does not disclose "distributed subcarriers" or "localized subcarriers" regardless of whether or not they are suitable for different scenarios or user profiles. By way of example only, Neo Wireless added the "distributed subcarriers" and "localized subcarriers" in response to the patent examiner's anticipation rejection based on U.S. Patent No. 9,301,296 to Wilson. The only support provided by the applicant for this amendment is paragraph [0025] of the specification, which by its plain language does not mention these terms or their concepts:

> **[0025]** The basic structure of a multi-carrier signal in the time domain is made up of time slots to support multiple-access. The resource division in both the frequency and time domains is depicted in Figure 3, which is the radio resource divided into small units in both the frequency and time domains (subchannels and time slots). The basic structure of a multi-carrier signal in the time domain is made up of time slots.

Further, Neo Wireless's infringement contentions alleges that "localized subcarriers" corresponds to a situation where adjacent resource block groups are used and "distributed subcarriers" corresponds to another situation where non-adjacent resource block groups are used. *See* Infring. Contentions for '941 Pat. for Limitations 8(e), 13(e). But the '941 patent specification does not disclose, describe, or teach these situations with adjacent or non-adjacent resource block groups.

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Accordingly, claims 8 and 13, and the claims depending therefrom, are invalid for lack of enablement and lack of written description. On the same basis, because there is no support "the corresponding subchannel configuration characterized by distributed subcarriers or localized subcarriers in the frequency domain," a POSITA would understand that the April 12, 2018 Amendment adding this limitation introduced new matter into the claims that expressly changed the scope of what was being claimed.

4. The '450 Patent

The asserted claims of the '450 Patent, at least under Neo Wireless's actual and/or apparent application of the claims, are invalid under 35 U.S.C. § 112 ¶ 1 because the specification lacks an adequate written description of the alleged invention and fails to enable the full scope of the alleged invention.

For example, asserted independent claim 7 of the '450 patent recites that "the mobile device configured to . . . receive an identifier from a base station in a cell in which the mobile device is operating." '450 pat. at claim 7. The '450 patent specification only discloses "connection IDs" (CID), including a "basic connection identification (BCID)," an "application connection-specific identifier (ACID)," and a "voice connection ID (VCID)." *See, e.g.*, '450 pat. at 1:51-55 ("each connection is identified by a 16 bits connection ID (CID)"), 2:58-64 ("An application connection-specific identifier (ACID) may also be assigned to a packet stream."), 8:20-26, 8:36-9:67 (section titled "Application Connection IDs"), 10:8-26 ("the IE for a voice packet may include the VCID (indicative of the packet destination)"), 11:49-12:9, Figs. 10A, 10B, 10C. The '450 patent specification does not disclose any radio network identifier, user equipment identifier, or anything other than a connection identifier—let alone the use of any such other identifiers. *See generally id.* Thus, to the extent the claimed "identifier" is interpreted to cover anything beyond the "connection IDs" disclosed in the '450 patent specification, the specification does not enable or

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provide sufficient written description support for independent claim 7, and dependent claims 8, 10, and 11, which depend therefrom. *Tronzo v. Biomet, Inc.*, 156 F.3d 1154, 1159 (Fed. Cir. 1998); *LizardTech, Inc. v. Earth Res. Mapping, Inc*., 424 F.3d 1336, 1346 (Fed. Cir. 2005); *ICU Med., Inc. v. Alaris Med. Sys., Inc*., 558 F.3d 1368 (Fed. Cir. 2009); *Certain Beverage Brewing Capsules,* Inv. No. 337-TA-929, Comm'n Op. (Apr. 5, 2016); *Certain Multimedia Display*, Inv. No. 337-TA-694, Comm'n Op. (July 22, 2011); *Certain UV Curable Coatings for Optical Fibers*, Inv. No. 337-TA-1031, Comm'n Op. (June 7, 2018).

Moreover, asserted independent claim 7 of the '450 patent recites, "starting time-frequency coordinate." '450 pat. at claim 7. However, the '450 patent specification fails to disclose any embodiment or teaching in which the starting time-frequency coordinate is a time-frequency index pair, or a first OFMD symbol in an index. *See generally id.* Instead, as noted by Neo Wireless in its Patent Owner Preliminary Response in IPR2021-01486, the '450 patent transformed "two independent dimensions of time and frequency into one time-frequency dimension measured by a basic resource unit having a fixed number of symbols in a fixed number of subcarriers that fits the resource requirements of a given application" in order to reduce "the amount of data required to allocate resources." Thus, to the extent the claimed "starting time-frequency coordinate" is interpreted to cover anything beyond a singular one-dimensional time-frequency coordinate as disclosed in the '450 patent specification, the specification does not enable or provide sufficient written description support for independent claim 7, and dependent claims 8, 10, and 11, which depend therefrom. *Tronzo v. Biomet, Inc.*, 156 F.3d 1154, 1159 (Fed. Cir. 1998); *LizardTech, Inc. v. Earth Res. Mapping, Inc*., 424 F.3d 1336, 1346 (Fed. Cir. 2005); *ICU Med., Inc. v. Alaris Med. Sys., Inc*., 558 F.3d 1368 (Fed. Cir. 2009); *Certain Beverage Brewing Capsules,* Inv. No. 337-TA-929, Comm'n Op. (Apr. 5, 2016); *Certain Multimedia Display*, Inv. No. 337-TA-694, Comm'n

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Op. (July 22, 2011); *Certain UV Curable Coatings for Optical Fibers*, Inv. No. 337-TA-1031, Comm'n Op. (June 7, 2018).

Further, asserted independent claim 7 of the '450 patent recites, "a signal containing information." '450 pat. at claim 7. However, the '450 patent specification fails to teach the receipt or recovery of control channel information. Thus, to the extent the claimed "signal containing information" is interpreted to cover a signal containing control channel information, the specification does not enable or provide sufficient written description support for independent claim 7, and dependent claims 8, 10, and 11, which depend therefrom. *Tronzo v. Biomet, Inc.*, 156 F.3d 1154, 1159 (Fed. Cir. 1998); *LizardTech, Inc. v. Earth Res. Mapping, Inc*., 424 F.3d 1336, 1346 (Fed. Cir. 2005); *ICU Med., Inc. v. Alaris Med. Sys., Inc*., 558 F.3d 1368 (Fed. Cir. 2009); *Certain Beverage Brewing Capsules,* Inv. No. 337-TA-929, Comm'n Op. (Apr. 5, 2016); *Certain Multimedia Display*, Inv. No. 337-TA-694, Comm'n Op. (July 22, 2011); *Certain UV Curable Coatings for Optical Fibers*, Inv. No. 337-TA-1031, Comm'n Op. (June 7, 2018).

Additionally, asserted independent claim 7 of the '450 patent recites, "recover the information from the received signal using the starting time-frequency coordinate and N in conjunction with the received identifier." '450 pat. at claim 7. However, the '450 patent specification fails to teach that the "time-frequency coordinate and N" are used in conjunction with a received identifier (e.g., CID, BCID, ACID, and/or VCID) in order to recover information.

5. The '512 Patent

The asserted claims of the '512 Patent, at least under Neo Wireless's actual and/or apparent application of the claims, are invalid under 35 U.S.C. § 112 ¶ 1 because the specification lacks an adequate written description of the alleged invention and fails to enable the full scope of the alleged invention.

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For example, asserted independent claims 15 and 23 of the '512 patent recite "wherein the first pilots do not interfere with the second pilots." '512 pat. at claims 15, 23. However, the '512 patent specification fails to disclose any embodiment or teaching in which "first pilots," i.e., "cell-specific pilots," and "second pilots," e.g., "common pilots," do not interfere with each other. Instead, the '512 patent specification focuses on mitigating inter-cell interference. *See, e.g.*, 1:54-61 ("signals originated from the base stations at different cells interfere with each other"), 1:62-2:2 ("One approach to deal with the interference problem has been to have each cell transmit a particular pattern of pilot subcarriers based on a certain type of cell-dependent random process. This approach, to a certain degree, has mitigated the impact of the mutual interference between the pilot subcarriers from adjacent cells[.]"), 3:17-24 ("For these pilot subcarriers [i.e., cell-specific pilots], counter-interference methods are necessary."), 3:25-36 ("Thus, every receiver 104 within the system is able to exploit these common pilot subcarriers to perform necessary functions without interference problem."), 7:31 ("reduce interference between cells or groups of cells"), 8:11-55 ("Mobile stations 1004 covered by these two base stations do not experience interference when receiving the common pilot subcarriers."). In other words, while the asserted claims focus on intra-cell inference between cell-specific pilots and "second pilots" (e.g., common pilots), the '512 patent specification focuses on inter-cell interference between pilot signals.

Moreover, asserted independent claims 15 and 23 of the '512 patent recite "first pilots of a first type . . . wherein the first pilots are cell-specific pilots," and "second pilots of a second type . . . wherein the second type is different than the first type." *E.g.*, '512 pat. at claims 15, 23. The '512 patent specification only discloses two forms of pilot signals: cell-specific pilots and common pilots. *See, e.g.*, '512 pat. at title, abstract, 1:49-53, 2:16-17, 2:22-23, 2:37-44, 3:17-36, 3:37-40, 5:33-7:23, 7:31, 7:58-8:55, 8:65-9:5, Figs. 5, 7, 12, 13. Thus, to the extent the claimed "second

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pilots of a second type" are interpreted to cover anything beyond the "common pilots" disclosed in the specification, the specification does not enable or provide sufficient written description support for independent claims 15 and 23, and dependent claims 20, 21, 28, and 29, which depend therefrom. *Tronzo v. Biomet, Inc.*, 156 F.3d 1154, 1159 (Fed. Cir. 1998); *LizardTech, Inc. v. Earth Res. Mapping, Inc*., 424 F.3d 1336, 1346 (Fed. Cir. 2005); *ICU Med., Inc. v. Alaris Med. Sys., Inc*., 558 F.3d 1368 (Fed. Cir. 2009); *Certain Beverage Brewing Capsules,* Inv. No. 337-TA-929, Comm'n Op. (Apr. 5, 2016); *Certain Multimedia Display*, Inv. No. 337-TA-694, Comm'n Op. (July 22, 2011); *Certain UV Curable Coatings for Optical Fibers*, Inv. No. 337-TA-1031, Comm'n Op. (June 7, 2018).

Further, asserted independent claims 15 and 23 of the '512 patent require "second pilots of a second type" in addition to cell-specific pilots. *E.g.*, '512 pat. at claims 15, 23. In its contentions, Neo Wireless reads the claimed "second pilots" on "UE-specific reference signals." *See* Infring. Contentions for '512 Pat. at cl. 15(b), cl. 23(b). Under this read of the "second pilots," the '512 patent specification fails to enable and adequately describe the full scope of claims, as Neo Wireless reads its claims, because—as discussed above—the patent specification only discloses a common pilot with characteristics common to all base stations in the system. There is no disclosure, description, or teaching of a pilot signal that is specific to a particular mobile device/user equipment, as Neo Wireless now reads its claims.

Also, asserted independent claims 15 and 23 of the '512 patent require that the "second pilots of a second type" be used to recover "the data using channel estimates from at least the second pilots." *E.g.*, '512 pat. at claims 15, 23. In its contentions, Neo Wireless reads the claimed recovered data as data sent to a specific UE over the PDSCH channel. *See* Infring. Contentions for '512 Pat. at cl. 15(b), cl. 23(b). Under this read of the recovered "data," the '512 patent

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specification fails to enable and adequately describe to the full scope of claims, as Neo Wireless reads its claims, because the patent specification only discloses a common pilot with characteristics common to all base stations in the system. There is no disclosure, description, or teaching of a common pilot being used to recover data specific to particular mobile device/user equipment, as Neo Wireless now reads its claims.

Finally, asserted independent claims 15 and 23, and dependent claims 20 and 28, of the '512 patent each recite "the second plurality of subcarriers are beam-formed." *E.g.*, '512 pat. at claims 15, 20, 23, 28. The '512 patent specification's lone disclosure of "beam forming," '512 pat. at 7:44-57 (discussing Fig. 9), which relates to "beam-forming" a "matrix," fails to disclose beam-forming a second plurality of subcarriers, and fails to explain how one would beam-form the second plurality of subcarriers, as required.

6. The '302 Patent

The asserted claims of the '302 Patent, at least under Neo Wireless's actual and/or apparent application of the claims, are invalid under 35 U.S.C. § 112 ¶ 1 because the specification lacks an adequate written description of the alleged invention and fails to enable the full scope of the alleged invention.

For example, claims 1-2, 4-7, 23-24, 26-29 of the '302 patent recite the term "probing signal." However, the '302 patent does not explain what a "probing signal" is. Indeed, the '302 patent never even uses the term "probing signal." For at least this reason, the specification does not enable or provide sufficient written description support for claims 1-2, 4-7, 23-24, 26-29 of the '302 patent.

In addition, claims 1 and 23 recite "the probing signal is configured to occupy a portion of spectrum in the uplink frequency band not designated for transmission of uplink control signals in the system." The '302 patent does not explain how "the probing signal is configured to occupy a

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portion of spectrum in the uplink frequency band not designated for transmission of uplink control signals in the system." Indeed, the '302 patent implies that the "probing signal" is an "uplink control signal." For at least this reason, the specification does not enable or provide sufficient written description support for claims 1 and 23 of the '302 patent.

Moreover, claims 1 and 23 recite a generic "probing signal." The '302 patent specification only discloses one form of probing signal—a direct sequence spread spectrum (DSSS) probing signal. *See, e.g.,* '302 patent at Abstract, 2:39-54, 5:9-26, 8:63-64, 8:65-9:52, Figs. 5-7, 8, 15-18. Thus, to the extent the claimed "probing signal" is interpreted to cover anything beyond the DSSS probing signal disclosed in the specification, the specification does not enable or provide sufficient written description support for independent claims 1 or 23, or dependent claims 2, 4-7, 24, or 26-29, which depend therefrom. *Tronzo v. Biomet, Inc.*, 156 F.3d 1154, 1159 (Fed. Cir. 1998); *LizardTech, Inc. v. Earth Res. Mapping, Inc*., 424 F.3d 1336, 1346 (Fed. Cir. 2005); *ICU Med., Inc. v. Alaris Med. Sys., Inc*., 558 F.3d 1368 (Fed. Cir. 2009); *Synthes USA, LLC v. Spinal Kinetics, Inc.*, 734 F.3d 1332, 1341-1345 (Fed. Cir. 2013); *Rivera v. Int'l Trade Comm'n*, 857 F.3d 1315, 1322 (Fed. Cir. 2017); *Certain Beverage Brewing Capsules,* Inv. No. 337-TA-929, Comm'n Op. (Apr. 5, 2016); *Certain Multimedia Display*, Inv. No. 337-TA-694, Comm'n Op. (July 22, 2011); *Certain UV Curable Coatings for Optical Fibers*, Inv. No. 337-TA-1031, Comm'n Op. (June 7, 2018).

Similarly, asserted independent claim 23 recites "a transmitter configured to form and transmit… the probing signal." The '302 patent specification does not disclose any embodiment or teaching of a transmitter configured to form and transmit a generic probing signal, as claimed. Rather, the '302 patent specification merely discloses a "spread spectrum transmitter" configured to form and transmit a "DSSS signal," which can be used as a probing signal. '302 patent, 4:50-

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5:8. Thus, to the extent the claimed "transmitter" is interpreted to cover anything beyond the spread spectrum transmitter disclosed in the specification, the specification does not enable or provide sufficient written description support for independent claims 1 or 23, or dependent claims 2, 4-7, 24, or 26-29, which depend therefrom.

Moreover, claims 1 and 23 recite "[transmitting/transmit]… the probing signal with a code sequence modulated in the frequency domain." The '302 patent specification discloses only one form of code sequence associated with the DSSS probing signal—a "DSSS sequence" that is "used to spread the DSSS signal." '302 patent, 4:61-65, 7:38-47. Thus, to the extent the claimed "code sequence" is interpreted to cover anything beyond the DSSS sequence disclosed in the specification, the specification does not enable or provide sufficient written description support for independent claims 1 or 23, or dependent claims 2, 4-7, 24, or 26-29, which depend therefrom.

Further, the '302 patent does not disclose any embodiment or teaching in which a probing signal is transmitted with a code sequence. Rather, the '302 patent specification discloses that an "*initial random access signal* [is transmitted] over the DSSS channel with a certain signature code or sequence." '302 patent, 8:31-34 (emphasis added); *see also* 5:22-26. But the '302 patent discloses the initial random access signal separately from the claimed probing signal. The '302 patent specification does not disclose that a probing signal is transmitted with such a "certain signature code or sequence." The '302 patent specification also discloses that a "DSSS sequence is modulated by the information bits or symbols" to form "modulated signals." '302 patent, 4:61-5:8. The modulated signals are then transmitted. *Id*. But the transmitted modulation signals are not the DSSS sequence (code sequence). The DSSS sequence itself is not transmitted.

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Moreover, claims 1 and 23 of the ’302 patent recite “the probing signal is configured to overlap, in the time domain, with uplink signals transmitted over an uplink frequency band by other mobile devices in the system.” However, the ’302 patent specification fails to disclose any embodiment or teaching in which the probing signal overlaps in the time domain with uplink signals transmitted over an uplink frequency band by other mobile devices as claimed. Rather, the ’302 patent specification merely discloses a mobile station that “transmit[s] its *initial access DSSS signal* simultaneously with the MC signals from other mobile stations.” ’302 patent, 8:20-23. But the ’302 patent discloses the initial access DSSS signal separately from the claimed probing signal. The ’302 patent specification does not disclose that the probing signal is transmitted *simultaneously* (i.e., overlapping in the time domain) with other uplink signals transmitted over an uplink frequency band by other mobile devices in the system. *See*, ’302 patent, 9:5-16.

In addition, claims 1 and 23 recite “[receiving/receive] a request for a probing signal from a base station in the system.” However, the ’302 patent does not disclose any embodiment or teaching in which a mobile station receives a request for a probing signal. Rather, the ’302 patent specification merely discloses that the base station “dictates the mobile station to transmit the channel probing DSSS.” ’302 patent, 9:35-42.

In addition, dependent claims 6 and 28 of the ’302 patent recite “the portion of spectrum is available for transmission of uplink data signals by other mobile devices in the system during a time period when the portion of the spectrum is not occupied by the probing signal.” *E.g.*, ’302 pat. at claims 6, 28. The ’302 patent specification only discloses an embodiment where “[t]he initial access DSSS signal arrives at the base station *together* with MC signals from other mobile stations, each carrying data and control information.” *Id.* at 8:35-37 (emphasis added); *see also*

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id. at 4:38-44, 9:5-17, Fig. 6. The '302 patent specification does not disclose any embodiment or teaching where supposed uplink data signals, such as MC signals, are transmitted while the supposed probing signal, such as the DSSS signal, is not transmitted.

B. Indefiniteness Under 35 U.S.C. § 112 ¶ 2 and/or ¶ 6

Section 112 also requires that the specification "conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention." 35 U.S.C. § 112 ¶ 2. As the Supreme Court clarified, this provision requires that the "claims, viewed in light of the specification and the prosecution history, inform those skilled in the art about the scope of the invention with reasonable certainty." *Nautilus, Inc. v. Biosig Instruments, Inc.*, 134 S. Ct. 2120, 2129 (2014). Defendants contend that, at least under Neo Wireless's actual and/or apparent application of the claims, the Asserted Claims of the Asserted Patents fail to distinctly claim what the inventors claim as their alleged invention.

1. The '366 Patent

At least under Neo Wireless's actual and/or apparent application of the claims, the asserted claims of the '366 Patent are invalid under 35 U.S.C. § 112 ¶ 2 for indefiniteness because the specification and prosecution history of the '366 Patent would not inform those skilled in the art about the scope of the alleged invention with reasonable certainty. Further, the asserted claims of the '366 Patent are invalid for indefiniteness because the specification does not disclose adequate corresponding structure, material, or acts for several claim terms reciting functional language subject to 35 U.S.C. § 112 ¶ 6.

For example, independent claims 1 and 17 require "exhibits a low peak-to-average power ratio in the time domain." *E.g.*, '366 pat. at claims 1, 17. The term "low" is a term of degree, and there is no indication in the claims or the patent specification about any objective boundaries for this term of degree. Federal Circuit "case law is clear that the objective boundaries requirement

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[of § 112 ¶ 2] applies to terms of degree." *Berkheimer v. HP Inc.*, 881 F.3d 1360, 1364 (Fed. Cir. 2018). A "term of degree fails to provide sufficient notice of its scope," and is thus indefinite, "if it depends on the unpredictable vagaries of any one person's opinion." *Interval Licensing LLC v. AOL, Inc.*, 766 F.3d 1364, 1370-71 (Fed. Cir. 2014) (internal quotation omitted) (holding term "unobtrusive manner" indefinite, because the "phrase is highly subjective and, on its face, provides little guidance to one of skill in the art"). Thus, when using terms of degree, the patent "must provide some standard for measuring that degree such that the claim language provides enough certainty to one of skill in the art when read in the context of the invention." *GE Lighting Solutions, LLC v. Lights of Am., Inc.*, 663 F. App'x 938, 940 (Fed. Cir. 2016) (internal quotation marks omitted). But the '366 patent's intrinsic evidence fails to provide the required objective boundaries. As a result, independent claims 1 and 17, and the claims depending therefrom, are indefinite.

In addition, independent claim 1 and recites "an apparatus configured to transmit a data signal to the serving base station in the cell over a data subchannel wherein the data subchannel comprises a plurality of adjacent or non-adjacent subcarriers within the communication channel" and "an apparatus configured to transmit a ranging signal to the serving base station in the cell over a ranging subchannel for random access, wherein: the ranging signal is formed from a ranging sequence selected from a set of ranging sequences associated with the cell for identifying the mobile station; the ranging signal lasts over a period of one or multiple orthogonal frequency division multiplexing (OFDM) symbols and the ranging signal exhibits a low peak-to-average power ratio in the time domain." Both of these terms are subject to 35 U.S.C. § 112 ¶ 6 and are indefinite because the specification does not disclose adequate corresponding structure, material, or acts for performing the recited functions.

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2. The ’908 Patent

At least under Neo Wireless’s actual and/or apparent application of the claims, the asserted claims of the ’908 Patent are invalid under 35 U.S.C. § 112 ¶ 2 for indefiniteness because the specification and prosecution history of the ’908 Patent would not inform those skilled in the art about the scope of the alleged invention with reasonable certainty. Further, the asserted claims of the ’908 Patent are invalid for indefiniteness because the specification does not disclose adequate corresponding structure, material, or acts for several claim terms reciting functional language subject to 35 U.S.C. § 112 ¶ 6.

For example, independent claims 1 and 11 require a “random access signal followed by a guard period in only a portion of the frequency band.” *E.g.*, ’908 pat. at claims 1, 11. The claimed “guard period” is in the time domain, as the word “period” indicates. Yet, the claims requires that the signal and its guard period be “in only a portion of the frequency band,” thus indicating that they must be “in only” the frequency domain. The claim language therefore requires the guard period to be in the frequency domain. The inconsistent and contradictory requirement in the claim language would not inform a person skilled in the art about the scope of these independent claims, and the claims depending therefrom, with reasonable certainty.

In addition, independent claims 1, 11, and 21 (and their dependent claims) recite “a first uplink signal” and a “random access signal.” Based on the specification of the ’908 patent, a “random access signal” is an “uplink signal.” *See, e.g.*, ’908 pat. at 8:34-9:19. A person of ordinary skill in the art would not understand the scope of the terms “first uplink signal” and “random access signal” with reasonable certainty and would not be able to determine whether the claimed “first uplink signal” includes a “random access signal.” Similarly, claims 2-3, 12-13, and 22-23 recite a “second uplink signal.” A person of ordinary skill in the art would not understand the scope of the terms “second uplink signal” and “random access signal” with reasonable certainty

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and would not be able to determine whether the claimed "second uplink signal" includes a "random access signal." Thus, for at least these reasons, the terms "first uplink signal," "second uplink signal," and "random access signal" are indefinite under 35 U.S.C. § 112 ¶ 2.

Similarly, claim 7 recites "wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion." Based on the specification of the '908 patent, a "random access signal" is an "uplink control signal." Thus, a person of ordinary skill would not understand, with reasonable certainty, whether a "random access signal" or an "uplink control signal" can be both in the "center portion" and in the "outer portion" and still fall within the scope of claim 7. Thus, for at least these reasons, claim 7 is indefinite under 35 U.S.C. § 112 ¶ 2. Claims 17 and 27 recite similar features and are indefinite under 35 U.S.C. § 112 ¶ 2 for at least similar reasons.

Similarly, claim 4 recites "wherein the portion of the frequency band used for transmission of the random access signal does not include control channels." Based on the specification of the '908 patent, a "random access signal" is transported on a "control channel." *See, e.g.*, '908 pat. at 8:34-9:19. Therefore, a person of ordinary skill would not understand, with reasonable certainty, how "the portion of the frequency band used for transmission of the random access signal does not include control channels." Thus, for at least these reasons, claim 4 is indefinite under 35 U.S.C. § 112 ¶ 2. Claims 14 and 24 recite similar features and are indefinite under 35 U.S.C. § 112 ¶ 2 for at least similar reasons.

In addition, independent claim 1 of the '908 patent recites "a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format

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comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols." Claim 1 further recites "a transmitter configured to: . . . transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station, wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols." Both of these terms are subject to 35 U.S.C. § 112 ¶ 6 and are indefinite because the specification does not disclose adequate corresponding structure, material, or acts for performing the recited functions. Independent claims 11 and 21 recite similar limitations that are similarly indefinite because the specification does not disclose adequate corresponding structure, material, or acts for performing the recited functions. *See* '908 pat. at claim 11 ("transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"; transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station, wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"); '908 pat. at claim 21 ("a first type of transmitter signal processing circuit configured to: generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a first set of OFDM subcarriers"; a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random

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access signal includes a sequence associated with a base station, wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols")

Other terms from the asserted claims of the '908 patent are also subject to 35 U.S.C. § 112 ¶ 6 and are indefinite because the specification does not disclose adequate corresponding structure, material, or acts for performing the recited functions, including (but not limited to) "the receiver is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal" (claim 2), "the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal" (claim 9), "determining if the response message identifies the sequence associated with the base station in the random access signal; and on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal" (claim 12), "receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal" (claim 19), "the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and on a condition that the response message identifies the sequence associated with the base station in the random access signal, the first type of transmitter signal processing circuit is configured to transmit a second uplink signal" (claim 22), and "the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one

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sequence associated with the base station for use in producing the random access signal" (claim 29).

3. The '941 Patent

At least under Neo Wireless's actual and/or apparent application of the claims, the asserted claims of the '941 Patent are invalid under 35 U.S.C. § 112 ¶ 2 for indefiniteness because the specification and prosecution history of the '941 Patent would not inform those skilled in the art about the scope of the alleged invention with reasonable certainty. Further, the asserted claims of the '941 Patent are invalid for indefiniteness because the specification does not disclose adequate corresponding structure, material, or acts for several claim terms reciting functional language subject to 35 U.S.C. § 112 ¶ 6.

For example, independent claims 8 and 13 require "localized subcarriers" and "distributed subcarriers." *E.g.*, '941 pat. at claims 8, 13. The terms "localized" and "distributed" are terms of degree, and there is no indication in the claims or the patent specification about any objective boundaries for these terms of degrees. Federal Circuit "case law is clear that the objective boundaries requirement [of § 112 ¶ 2] applies to terms of degree." *Berkheimer v. HP Inc.*, 881 F.3d 1360, 1364 (Fed. Cir. 2018). A "term of degree fails to provide sufficient notice of its scope," and is thus indefinite, "if it depends on the unpredictable vagaries of any one person's opinion." *Interval Licensing LLC v. AOL, Inc.*, 766 F.3d 1364, 1370-71 (Fed. Cir. 2014) (internal quotation omitted) (holding term "unobtrusive manner" indefinite, because the "phrase is highly subjective and, on its face, provides little guidance to one of skill in the art"). Thus, when using terms of degree, the patent "must provide some standard for measuring that degree such that the claim language provides enough certainty to one of skill in the art when read in the context of the invention." *GE Lighting Solutions, LLC v. Lights of Am., Inc.*, 663 F. App'x 938, 940 (Fed. Cir. 2016) (internal quotation marks omitted). But the '941 patent's intrinsic evidence fails to provide

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the required objective boundaries. As a result, independent claims 8 and 13, and the claims depending therefrom, are indefinite.

Further, claim 8 recites "receiving a control message from the serving base station over a control channel, wherein: the control message contains transmission parameters specific to the mobile station for a subsequent transmission by the serving base station over a frequency subchannel to the mobile station in a time slot; and the mobile station-specific transmission parameters indicate an antenna transmission scheme and a corresponding subchannel configuration, the antenna transmission scheme comprising a transmission diversity scheme or a multiple-input multiple-output (MIMO) scheme and the corresponding subchannel configuration characterized by distributed subcarriers or localized subcarriers in the frequency domain." This term is subject to 35 U.S.C. § 112 ¶ 6 and is indefinite because the specification does not disclose adequate corresponding structure, material, or acts for performing the recited function. Claim 13 recites a similar limitation that is subject to 35 U.S.C. § 112 ¶ 6 and is indefinite because the specification does not disclose adequate corresponding structure, material, or acts for performing the recited function. *See* '941 pat. at claim 13 ("a receiver configured to: receive a control message from the serving base station over a control channel, wherein: the control message contains transmission parameters specific to the mobile station for a subsequent transmission by the serving base station over a frequency subchannel to the mobile station in a time slot; and the mobile station-specific transmission parameters indicate an antenna transmission scheme and a corresponding subchannel configuration, the antenna transmission scheme comprising a transmission diversity scheme or a multiple-input multiple-output (MIMO) scheme and the corresponding subchannel configuration characterized by distributed subcarriers or localized subcarriers in the frequency domain").

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4. The ’450 Patent

At least under Neo Wireless’s actual and/or apparent application of the claims, the asserted claims of the ’450 Patent are invalid under 35 U.S.C. § 112 ¶ 2 and/or ¶ 6 for indefiniteness because the specification and prosecution history of the ’366 Patent would not inform those skilled in the art about the scope of the alleged invention with reasonable certainty.

For example, asserted independent claim 7 of the ’450 patent recites that “the mobile device configured to . . . receive an identifier from a base station in a cell in which the mobile device is operating.” ’450 pat. at claim 7. The term “identifier” is indefinite because a person of ordinary skill in the art, reading the patent’s claims in light of the specification, would be unable to determine the appropriate scope of the invention with reasonable certainty. *Nautilus, Inc. v. Biosig Instruments, Inc.*, 572 U.S. 898, 910 (2014). “Identifier” has no ordinary and customary meaning to a person of ordinary skill in the art, and while the ’450 patent specification discusses the existence of certain “connection IDs” (CID), including a “basic connection identification (BCID),” an “application connection-specific identifier (ACID),” and a “voice connection ID (VCID),” *see, e.g.*, ’450 pat. at 1:51-55, 2:58-64, 8:20-26, 8:36-9:67, 10:8-26, 11:49-12:9, Figs. 10A, 10B, 10C, independent claim 7 does not appear to be so limited. To the extent that the claimed “identifier” is interpreted to cover anything beyond the “connection IDs” disclosed in the ’450 patent specification, a person of ordinary skill in the art would not be able to determine the scope of the invention with reasonable certainty in light of both the specification and the prosecution history.

5. The ’512 Patent

At least under Neo Wireless’s actual and/or apparent application of the claims, the asserted claims of the ’512 Patent are invalid under 35 U.S.C. § 112 ¶ 2 for indefiniteness because the specification and prosecution history of the ’512 Patent would not inform those skilled in the art about the scope of the alleged invention with reasonable certainty. Further, the asserted claims of

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the ’512 Patent are invalid for indefiniteness because the specification does not disclose adequate corresponding structure, material, or acts for several claim terms reciting functional language subject to 35 U.S.C. § 112 ¶ 6.

For example, asserted independent claims 15 and 23 of the ’512 patent recite “wherein the first pilots do not interfere with the second pilots.” ’512 pat. at claims 15, 23. However, in real-life systems with channel distortions and multi-path effects, zero interference is impossible to achieve. *See* 1:54-61 (“In [a multi-cell] environment, carrying out the pilot-dependent functions becomes a challenging task in that, in addition to the degradation due to multipath propagation channels, signals originated from the base stations at different cells interfere with each other.”). Indeed, the ’512 patent specifications describe a single situation in which pilot signals do not interfere with one another – i.e., common pilots sent by different base stations. *See* 3:25-36 (“The second group is termed ‘common pilot sub-carriers,’ and are designed to possess a set of characteristics common to all base stations of the system. Thus, every receiver 104 within the system is able to exploit these common pilot subcarriers to perform necessary functions without interference problem.”); 5:34-47 (“The common pilot subcarriers for different cells may be aligned in frequency, and possess a set of attributes common to all base stations within the network. Thus, every receiver within the system is able to exploit these common pilot subcarriers without interference problem.”); 8:11-55 (“Mobile stations 1004 covered by these two base stations do not experience interference when receiving the common pilot subcarriers.”). Thus, to the extent “wherein the first pilots do not interfere with the second pilots” is not construed to require the first and second pilots to be “aligned in frequency” and “possess a set of attributes common to all base stations within the network,” this term would be rendered indefinite because the ’512 Patent does

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not inform one skilled in the art with reasonable certainty how little the interference must be to constitute no (i.e., zero) interference.

Further, the asserted claims of the ’512 Patent are invalid under for indefiniteness because the specification does not disclose adequate corresponding structure, material, or acts for terms subject to 35 U.S.C. § 112 ¶ 6. For example, claim 15 of the ’512 Patent recites “the receiver is further configured to recover the data using channel estimates from at least the second pilots; and recover cell-specific information using the cell-specific pilots.” This term is subject to 35 U.S.C. § 112 ¶ 6 and is indefinite because the specification does not disclose adequate corresponding structure, material, or acts for performing the recited function.

6. The ’302 Patent

At least under Neo Wireless’s actual and/or apparent application of the claims, the asserted claims of the ’302 Patent are invalid under 35 U.S.C. § 112 ¶ 2 indefiniteness because the specification and prosecution history of the ’302 Patent would not inform those skilled in the art about the scope of the alleged invention with reasonable certainty. Further, the asserted claims of the ’302 Patent are invalid for indefiniteness because the specification does not disclose adequate corresponding structure, material, or acts for several claim terms reciting functional language subject to 35 U.S.C. § 112 ¶ 6.

For example, claims 1-2, 4-7, 23-24, 26-29 of the ’302 patent recite the term “probing signal.” However, a person of ordinary skill would not understand, with reasonable certainty, the scope of the term “probing signal” and the specification of the ’302 patent never even uses that term. Nor does the specification of the ’302 patent explain what is meant by that term. Thus, for at least these reasons, the term “probing signal” is indefinite under 35 U.S.C. § 112 ¶ 2.

Moreover, claims 1 and 23 recite “the probing signal is configured to occupy a portion of spectrum in the uplink frequency band not designated for transmission of uplink control signals in

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the system." However, a person of ordinary skill would not understand, with reasonable certainty, the scope of this term at least because the '302 patent implies that the "probing signal" is an "uplink control signal." *See* '302 Patent at 8:65-9:52. Thus, a person of ordinary skill would not understand how a "probing signal is configured to occupy a portion of spectrum in the uplink frequency band ***not*** designated for transmission of uplink control signals in the system." Thus, for at least these reasons, the following phrase is indefinite under 35 U.S.C. § 112 ¶ 2: "probing signal is configured to occupy a portion of spectrum in the uplink frequency band not designated for transmission of uplink control signals in the system."

Further, claims 1 and 23 recite a "probing signal ***with a code sequence modulated in the frequency domain***." However, a person of ordinary skill would not understand, with reasonable certainty, the scope of the phrase "code sequence modulated in the frequency domain." Nor does the '302 patent explain what is meant by a "code sequence modulated in the frequency domain." Further, this claim element is ambiguous and does not inform a POSITA as to whether the transmission must include a probing signal and a separate code sequence. The specification does not provide clarity. For instance, the '302 patent discloses that "an initial random access signal"—not a probing signal—is transmitted "with a certain signature code or sequence." '302 patent, 8:31-34. The '302 patent specification also discloses that a "DSSS sequence is modulated by the information bits or symbols" to form "modulated signals." '302 patent, 4:61-5:8. The modulated signals are then transmitted. *Id*. But the transmitted modulation signals are not the DSSS sequence (code sequence). The DSSS sequence itself is not transmitted.Thus, for at least these reasons, the following phrase is indefinite under 35 U.S.C. § 112 ¶ 2: "code sequence modulated in the frequency domain."

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In addition, dependent claims 6 and 28 require that "the portion of the spectrum is not occupied by the probing signal." '302 patent at claims 6, 28. These two dependent claims, however, depend from claims 1 and 23, respectively, that require that "the probing signal is configured to occupy a portion of spectrum in the uplink frequency band not designated for transmission of uplink control signals in the system." *Id.* at claims 1, 23. The dependent claims 6 and 28 therefore require that the probing signal does not occupy a portion of the spectrum while incorporating by reference from their independent claim a requirement that the same probing signal occupies the portion of the spectrum. Because of this inconsistent and contradictory requirement, these dependent claims fail to inform one skilled in the art with reasonable certainty how the probing signal can occupy and not occupy the portion of the spectrum.

Moreover, claims 7 and 29 recite "wherein the portion of spectrum is within a center portion of the uplink frequency band and subcarriers for the transmission of uplink control signals are within an outer portion of the uplink frequency band." A person of ordinary skill in the art would not understand, with reasonable certainty, the scope of this phrase at least because the specification of the '302 patent implies that a probing signal is an "uplink control signal." *See* '302 Patent at 8:65-9:52. Therefore, a person of ordinary skill would not understand, with reasonable certainty, whether a "probing signal" or an "uplink control signal" can be both in the "center portion" and in the "outer portion" and still fall within the scope of claims 7 and 29. Thus, for at least these reasons, claims 7 and 29 are indefinite under 35 U.S.C. § 112 ¶ 2.

Also, independent claim 1 of the '302 patent recites "transmitting, in response to the received request, the probing signal with a code sequence modulated in the frequency domain, wherein: the probing signal is configured to overlap, in the time domain, with uplink signals transmitted over an uplink frequency band by other mobile devices in the system; and the probing

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signal is configured to occupy a portion of spectrum in the uplink frequency band not designated for transmission of uplink control signals in the system." This term is subject to 35 U.S.C. § 112 ¶ 6 and is indefinite because the specification does not disclose adequate corresponding structure, material, or acts for performing the recited function. Independent claim 23 recites similar limitations that are similarly indefinite because the specification does not disclose adequate corresponding structure, material, or acts for performing the recited function. *See* '302 pat. at claim 23 ("a transmitter configured to form and transmit, in response to the received request, the probing signal with a code sequence modulated in the frequency domain, wherein: the probing signal is configured to overlap, in the time domain, with uplink signals transmitted over an uplink frequency band by other mobile devices in the system; and the probing signal is configured to occupy a portion of spectrum in the uplink frequency band not designated for transmission of uplink control signals in the system").

VI. OBVIOUSNESS TYPE DOUBLE PATENTING

Double patenting renders claims directed towards the same invention invalid. There are two kinds of double patenting—statutory double patenting under 35 U.S.C. § 101 and non-statutory double patenting or obvious-type double patenting ("ODP"). *In re Lonardo*, 119 F.3d 960, 965 (Fed. Cir. 1997). ODP may be applied where the patents are commonly owned or share common inventors. *See e.g., In re Hubbell,* 709 F.3d 1140, 1146-48 (Fed. Cir. 2013). ODP is evaluated using a "one-way test"—"i.e., whether the invention claimed in the application would have been anticipated by, or an obvious variation of, the invention claimed in the patent." MPEP § 8.32(B)(2)(b) (citing *In re Berg*, 140 F.3d 1438, 46 (Fed. Cir. 1998)); *see also In re Fallaux,* 564 F.3d 1313, 1316 (Fed. Cir. 2009).

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The Asserted Claims of the ’941 patent are obvious under the judicially established doctrine of obviousness-type double patenting. For example, at least claims 1-5, 7-12, 14-16, 18, 20-24, 26 of U.S. Patent No. 8,934,445 to Li et al. disclose, and/or render obvious the Asserted Claims of the ’941 patent either alone or in combination with “IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems Amendment 2: Medium Access Control Modifications and Additional Physical Layer Specifications for 2-11 GHz,” U.S. Patent No. 6,937,592 to Heath et al., U.S. Patent No. 6,802,035 to Catreux et al., U.S. Patent Application Publication No. 2003/0125040 to Walton et al., U.S. Patent No. 7,020,110 to Walton et al., U.S. Patent No. 6,473,467 to Wallace et al., U.S. Patent No. 6,952,454 to Jalali et al., and/or U.S. Patent No. 6,985,434 to Wu et al. As such, the subject matter of claims 1-5, 7-12, 14-16, 18, 20-24, 26 in the ’445 patent is patentably indistinct from the subject matter of the Asserted Claims of the ’941 patent, except for minor differences that are mere obvious modifications of the ’941 patent.

In this matter, the application that issued as the ’445 patent was filed on May 23, 2014, claims priority at least to U.S. Patent Appl. No. 09/837,701, filed April 17, 2001 (now U.S. Patent No. 7,146,172), and issued on January 13, 2015. The application that issued as the ’941 patent claims was filed March 28, 2016, claims priority to U.S. Prov. Appl. No. 60/544,521, and issued on September 11, 2018. The ’445 patent was thus filed approximately two years before the filing of the application that issued as the ’941 patent and claims priority to an application filed three years before the earliest possible priority date of the ’941 patent. The ’941 patent issued over three years after the ’445 patent. As such, the ’941 patent is invalid under the doctrine of obviousness-type double patenting. *See In re Hitachi Metals, Ltd.*, 603 Fed.Appx. 976, 978 (Fed. Cir. 2015) (under the doctrine of obviousness-type double patenting, “a patent is invalid when it is merely an

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obvious variation of an invention disclosed and claimed in an earlier patent by the same inventor.") And because the '445 patent has expired, a terminal disclaimer of the '941 patent would be ineffective to overcome this obviousness-type double patenting.

VII. UNENFORCEABILITY

A. Unclean Hands

1. The Named Inventors

Upon information and belief, the named inventors of the Asserted Patents (Xiaodong Li, Titus Lo, Ruifeng Wang, Kemin Li, and Haiming Huang) were formerly employed by AT&T (or a subsidiary of AT&T) and/or Broadstorm Telecommunications, Inc. ("Broadstorm"). As discussed further below, upon information and belief, one or more of the named inventors incorporated into the Asserted Patents information misappropriated from AT&T.

Xiaodong Li (also known as Xiaodong (Alex) Li) is listed as a co-inventor of each Asserted Patent. Upon information and belief, in 1996 Xiaodong Li was employed by a subsidiary of AT&T in the Wireless Systems Research Department.[9] As discussed further below, by 2000, Xiaodong Li was a founding employee of Broadstorm. In 2002-2003, while employed by Broadstorm, or shortly thereafter, Xiaodong Li and another named inventor, Titus Lo, founded Walbell Technologies, Inc. ("Walbell"), a predecessor-in-interest to Neo Wireless.

Titus Lo (also known as Titus Kwok-Yeung Lo) is listed as a co-inventor of each Asserted Patent. Upon information and belief, Titus Lo was employed by an AT&T subsidiary from 1997

[9] Xiaodong Li was employed by Lucent Technologies from 1998 to 2000 in the Wireless Technology Research Department. Lucent Technologies was formerly owned by AT&T. *See* https://www.britannica.com/topic/Bell-Laboratories (Nov. 18, 2019).

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to 2001 "developing OFDMA wireless technology."[10] In 2002-2003, Titus Lo co-founded Walbell, a predecessor-in-interest to Neo Wireless along with Xiaodong Li.

Ruifeng Wang is listed as a co-inventor of the '450 patent. Ruifeng Wang was employed by an AT&T subsidiary from at least July 2000 to January 2003, working on "[s]ystem design and technology innovation for broadband wireless systems (AT&T Angel Project)." *See* Ruifeng Wang LinkedIn Profile. Upon information and belief, Ruifeng Wang worked at a predecessor-in-interest to Neo Wireless from at least June 2004 to August 2008.

Kemin Li is listed as a co-inventor of the asserted '941 patent, '302 patent, '908 patent, '512 patent, and the '366 patent (five of the six Asserted Patents). Kemin Li worked as a system engineer at Broadstorm from at least August 2000 to June 2003 and then a predecessor-in-interest to Neo Wireless from January 2004 to July 2005. *See* Kemin Li LinkedIn Profile.

Haiming Huang is listed as a co-inventor of each Asserted Patent. Upon information and belief, Haiming Huang worked at Broadstorm from at least December 2000 to June 2003 and began working for a predecessor-in-interest to Neo Wireless in 2003.

2. AT&T's Project Angel

Upon information and belief, McCaw Cellular Communications, Inc. ("McCaw") began developing a wireless system project called "Project Angel" in the 1990s.[11] AT&T purchased McCaw in 1994, including Project Angel. In the mid to late 1990s, AT&T further developed Project Angel—a wireless system incorporating orthogonal frequency-division multiple access ("OFDMA") technology that used a base station and remote units to communicate data through

[10] *See* "Seattle Communications (COM-19) Society Chapter," https://labs.ece.uw.edu/ieee-comm/event_sep_30_2010.htm (last accessed Aug. 24, 2022).

[11] *See* https://www.rcrwireless.com/19970303/carriers/mccaws-project-angel-given-life-by-at-t-wireless-services (last accessed August 15, 2022).

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the wireless system.[12]

During AT&T's work on Project Angel, AT&T created a number of confidential documents, data, and source code related to Project Angel and OFDMA wireless communication systems. AT&T took measures to ensure the confidentiality of Project Angel and to prevent its disclosure, including, upon information and belief, marking related documents, data, and source code "proprietary" and/or "confidential," covering windows in buildings with metalized film to prevent non-authorized personnel from electronically eavesdropping on AT&T personnel associated with Project Angel, and requiring employees working on Project Angel to sign a non-disclosure agreement ("NDA"). AT&T also applied for and obtained several patents related to Project Angel and OFDMA technology. AT&T offered Project Angel for sale as early as August 1999.

Upon information and belief, several named inventors of the Asserted Patents, including at least Xiaodong Li, Titus Lo, and Ruifeng Wang, were employed by AT&T or one of its subsidiaries, worked on Project Angel, and/or had access to AT&T's wireless technology research and documentation.

3. Broadstorm

Upon information and belief, named inventor Xiaodong Li was employed by or interned with AT&T, and worked on Project Angel, and/or OFDMA wireless communication systems. In the early 2000s, Xiaodong Li co-founded a Broadstorm, and later formed Walbell, a predecessor-in-interest to Neo Wireless, in 2002-2003.

Upon information and belief, Xiaodong Li "proposed to strategically hire key Project

[12] *See* "First Amended Answer, Defenses & Counterclaims of Cellco Partnership d/b/a Verizon Wireless," *Adaptix, Inc. v. Apple, Inc.*, Civ. No. 5:13-cv-01776-PSG, Docket No. 229-2 at 5-6 (N.D. Cal. Jun. 4, 2014).

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Angel engineers from AT&T." *See* Order Denying Summary Judgment, *Adaptix, Inc. v. Apple, Inc. et al*, Civ. No. 5:13-cv-01776-PSG, Doc. No. 404 at 4 (N.D. Cal. Jan. 15, 2015).

Other patents listing Xiaodong Li as a co-inventor have been litigated in federal cases. Fact discovery in these cases established a record that Broadstorm had "pretty much . . . everything . . . on [AT&T's] engineering side" and "several AT&T technical documents related to Project Angel." *Id*.

Upon information and belief, several named inventors of the Asserted Patents, including at least Xiaodong Li and two additional named inventors (Kemin Li and Haiming Huang), were employed by Broadstorm and had access to or knowledge of AT&T's wireless technology research and documentation, including Project Angel.

4. Neo Wireless

Upon information and belief, Neo Wireless has previously operated under several names and/or identifiers, including without limitation Walbell Technologies, Inc. ("Walbell"), Waltical Solutions, Inc. ("Waltical"), CFIP NCF Holdings LLC ("CFIP), and Neocific, Inc. ("Neocific").

Upon information and belief, named inventors Xiaodong Li and Titus Lo founded Walbell in 2002-2003. Upon information and belief, Xiaodong Li, Kemin Li, and Haiming Huang possessed and continued to use AT&T documentation, information, and research that Broadstorm improperly obtained from former AT&T employees.

Upon information and belief, Titus Lo and Ruifeng Wang possessed and continued to use AT&T documentation, information, and research from their former employment at AT&T.

Upon information and belief, one or more of the named inventors incorporated into the Asserted Patents misappropriated information from AT&T's wireless technology research, including Project Angel.

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5. Failure to Disclose

Upon information and belief, the claimed inventions of the Asserted Patents were developed fully or in-part while one or more of the named inventors was employed by AT&T and/or were developed using information illegally gained from former AT&T employees.

Upon information and belief, each named inventor failed to disclose AT&T as an owner-in-interest, and failed to disclose Project Angel and other related wireless research they misappropriated from AWS and Project Angel to the United States Patent and Trademark Office ("USPTO") while prosecuting the Asserted Patents.

Upon information and belief, one or more of the named inventors, including at least Xiaodong Li, Titus Lo, and Ruifeng Wang, were aware that Project Angel and AT&T's wireless communication research was material to the patentability of the claims of the Asserted Patents.

a. The '366 patent

Upon information and belief, Xiaodong Li, Titus Lo, Haiming Huang, and Kemin Li signed an assignment agreement on April 8, 2005 warranting that "Assignors own the Rights, and that the Rights are encumbered" to US05/08169, a related predecessor application of the '366 patent.

Upon information and belief, at least Xiaodong Li and Titus Lo knew that materials filed in the '366 patent were derived wholly or in-part from AT&T's Project Angel and/or AT&T's proprietary and confidential materials without permission and that their ownership and right to assign such ideas, information, or materials was absent or questionable. Upon information and belief, Xiaodong Li and Titus Lo were aware of this at the time of the April 8, 2005 assignment and no later than December 5, 2014.[13]

[13] *See, e.g.,* Amended Answer and Counterclaims of ZTE (USA) Inc., *Adaptix, Inc. v. ZTE Corporation*, Civ. No. 6:13-cv-00443, Doc. No. 111 at 15 (E.D. Tex. Dec. 5, 2014) (asserting that patents naming Dr. Li as co-inventor were substantially derived from AT&T which was not

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Upon information and belief, Neo Wireless and/or one of its predecessors-in-interest recorded the April 8, 2005 assignment record on December 12, 2019 as Reel/Frame 015258/0162. This document purported to convey ownership to Neocific. Recordation of this document was an intentional act. Upon information and belief, this act intended to deceive the public of the true ownership of the ’366 patent.

b. The ’941 patent

Upon information and belief, Xiaodong Li, Titus Lo, Haiming Huang, and Kemin Li signed an assignment agreement on April 8, 2005 warranting that “Assignors own the Rights, and that the Rights are encumbered” to US05/04601, a related application of the ’941 patent.

Upon information and belief, at least Xiaodong Li and Titus Lo knew that materials filed in the ’941 patent were derived wholly or in-part from AT&T’s Project Angel and/or AT&T’s proprietary and confidential materials without permission and that their ownership and right to assign such ideas, information, or materials was absent or questionable. Upon information and belief, Xiaodong Li and Titus Lo were aware of this at the time of the April 8, 2005 assignment and no later than December 5, 2014.[14]

Upon information and belief, Neo Wireless and/or one of its predecessors-in-interest recorded the April 8, 2005 assignment record on December 12, 2019 as Reel/Frame 051261/0382. This document purported to convey ownership to Waltical. Recordation of this document was an intentional act. Upon information and belief, this act intended to deceive the public of the true

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disclosed to the USPTO); *see also* Order Denying Summary Judgment, *Adaptix, Inc. v. Apple, Inc. et al*, Civ. No. 5:13-cv-01776-PSG, Doc. No. 404 at 4 (N.D. Cal. Jan. 15, 2015) (“Along with *Xiandong Li*, another one of Adaptix’s co-founders, Liu proposed to strategically hire key Project Angel engineers from AT&T.”) (emphasis added).

[14] *Id.*

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ownership of the ’941 patent.

c. The ’450 patent

Upon information and belief, Xiaodong Li, Titus Lo, Haiming Huang, and Ruifeng Wang signed an assignment agreement on October 2, 2007 warranting that “Assignors own the Rights, and that the Rights are encumbered” to PCT/US06/38149, a related predecessor application of the ’450 patent.

Upon information and belief, at least Xiaodong Li, Titus Lo, and Ruifeng Wang knew that materials filed in the ’450 patent were derived wholly or in-part from AT&T’s Project Angel and/or AT&T’s proprietary and confidential materials without permission and that their ownership and right to assign such ideas, information, or materials was absent or questionable. Upon information and belief, Xiaodong Li, Titus Lo, and Ruifeng Wang were aware of this at the time of the October 2, 2007 assignment and no later than December 5, 2014.[15]

Upon information and belief, Neo Wireless and/or one of its predecessors-in-interest recorded the October 2, 2007 assignment record on December 12, 2019 as Reel/Frame 051256/0932. This document purported to convey ownership to Neocific. Recordation of this document was an intentional act. Upon information and belief, this act intended to deceive the public of the true ownership of the ’450 patent.

d. The ’302 patent

Upon information and belief, Xiaodong Li, Titus Lo, Haiming Huang, and Kemin Li signed an assignment agreement on December 14, 2005 warranting that “Assignors own the Rights, and that the Rights are encumbered” to a related predecessor application of the ’302 patent.

Upon information and belief, at least Xiaodong Li and Titus Lo knew that materials filed

[15] *Id*.

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in the ’302 patent were derived wholly or in-part from AT&T’s Project Angel and/or AT&T’s proprietary and confidential materials without permission and that their ownership and right to assign such ideas, information, or materials was absent or questionable. Upon information and belief, Xiaodong Li and Titus Lo were aware of this at the time of the December 14, 2005 assignment and no later than December 5, 2014.[16]

Upon information and belief, Neo Wireless and/or one of its predecessors-in-interest recorded the December 14, 2005 assignment record on December 12, 2019 as Reel/Frame 051261/0382. This document purported to convey ownership to Waltical. Recordation of this document was an intentional act. Upon information and belief, this act intended to deceive the public of the true ownership of the ’302 patent.

e. The ’908 patent

Upon information and belief, Titus Lo and Haiming Huang signed an inventor declaration form for U.S. Patent Application 13/861,942 on April 12, 2013. Upon information and belief, Xiaodong Li and Kemin Li signed an inventor declaration form for U.S. Patent Application 13/861,942 on June 5, 2013. Each signed inventor declaration stated, “The above-identified application was made or authorized to be made by me. I believe that I am the original inventor or an original joint inventor of a claimed invention in the application. . . . I acknowledge the duty to disclose information material to patentability[.]”

Upon information and belief, at least Xiaodong Li, Titus Lo, and Ruifeng Wang knew that materials filed in the ’908 patent were derived wholly or in-part from AT&T’s Project Angel and/or AT&T’s proprietary and confidential materials without permission and that their ownership and right to assign such ideas, information, or materials was absent or questionable. Upon

[16] *Id.*

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information and belief, Titus Lo was aware of this at the time of his April 12, 2013 inventor declaration. Upon information and belief, Xiaodong Li was aware of this at the time of his June 5, 2013 inventor declaration and no later than December 5, 2014.[17]

Upon information and belief, Neo Wireless and/or one of its predecessors-in-interest recorded the April 12, 2013 and June 5, 2013 inventor declaration forms on June 16, 2020. Recordation of these documents was an intentional act. Upon information and belief, this act intended to deceive the public of the true inventorship and/or ownership of the '908 patent.

f. The '512 patent

Upon information and belief, Xiaodong Li, Titus Lo, Haiming Huang, and Kemin Li signed an inventor declaration form for U.S. Patent Application 13/874,278 on June 5, 2013. Each signed inventor declaration stated, "The above-identified application was made or authorized to be made by me. I believe that I am the original inventor or an original joint inventor of a claimed invention in the application. . . . I hereby acknowledge the duty to disclose information material to patentability[.]"

Upon information and belief, at least Xiaodong Li and Titus Lo knew that materials filed in the '908 patent were derived wholly or in-part from AT&T's Project Angel and/or AT&T's proprietary and confidential materials without permission and that their ownership and right to assign such ideas, information, or materials was absent or questionable. Upon information and belief, Xiaodong Li and Titus Lo were aware of this at the time of the June 5, 2013 inventor declaration and no later than December 5, 2014.[18]

Upon information and belief, Neo Wireless and/or one of its predecessors-in-interest

[17] *Id.*

[18] *Id.*

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recorded the June 5, 2013 inventor declaration forms on September 4, 2020. Recordation of this document was an intentional act. Upon information and belief, this act intended to deceive the public of the true inventorship and/or ownership of the '908 patent.

* * * * *

Neo Wireless is therefore barred by the doctrine of unclean hands from enforcing the Asserted Patents against Defendants. *Gilead Scis., Inc. v. Merck & Co., Inc.*, 888 F.3d 1239 (Fed. Cir. 2018) (quoting *Keystone Driller Co. v. Gen. Excavator Co.*, 290 U.S. 240, 245 (1933)) ("a determination of unclean hands may be reached when 'misconduct' of a party seeking relief 'has immediate and necessary relation to the equity that he seeks'").

B. Inequitable Conduct

Upon information and belief, one or more of the named inventors intentionally chose not to disclose Project Angel and AT&T's contribution to the claims to the USPTO. Upon information and belief, this was done with an intent to deceive the USPTO.

Upon information and belief, but for the inventors' intentional failure to disclose Project Angel and AT&T's contributions to the claims, the USPTO would not have issued the Asserted Patents. *See Exergen Corp. v. Wal-Mart Stores, Inc.*, 575 F.3d 1312, 1327 (Fed. Cir. 2009) (Inequitable conduct requires showing by clear and convincing evidence that "(1) an individual associated with the filing and prosecution of a patent application made an affirmative misrepresentation of a material fact, failed to disclose material information, or submitted false material information; and (2) the individual did so with a specific intent to deceive the PTO."); *Bd. of Educ. ex rel. Bd. Of Trustees of Fla. State Univ. v. Am. Bioscience, Inc.,* 333 F.3d 1330, 1344 (Fed. Cir. 2003) (failure to disclose inventorship is material omission of fact).

Neo Wireless is therefore barred by the doctrine of inequitable conduct from enforcing the Asserted Patents. *Therasense, Inc. v. Becton, Dickinson & Co.*, 649 F.3d 1276, 1285 (Fed. Cir.

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2011) (en banc) ("Inequitable conduct is an equitable defense to patent infringement that, if proved, bars enforcement of a patent."). Neo Wireless is further barred from asserting "related patents" against Defendants pursuant to the doctrine of infectious unenforceability. *See, e.g., Consolidated Aluminum Corp. v. Foseco Intern. Ltd.,* 910 F.2d 804, 812 (Fed. Cir. 1990) (finding patent unenforceable due to inequitable conduct during prosecution of a related patent).

Neo Wireless is barred by the doctrine of inequitable conduct from enforcing the Asserted Patents for the additional reason that Neo Wireless failed to disclose to the USPTO numerous prior-art references that are material to the patentability of the Asserted Patents, and that were known or should have been known to Neo Wireless at the time.

For example, upon information and belief, inventors Xiaodong Li, Titus Lo, Kemin Li, and Haiming Huang participated in development of the 802.16 standard for several years prior to the earliest possible priority date of the '941 patent. In particular, the first named inventor Xiadong Li participated in the IEEE 802.16 Working Group on Broadband Wireless Access since at least 2001 and voted on proposals related to the development of the 802.16 standard. Li specifically provided a vote for the 802.16a-2003 version of the standard (IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems—Amendment 2: Medium Access Control Modification and Additional Physical Layer Specifications for 2-11 GHz, IEEE 802.16a-2003, referred to herein as "802.16a-2003"). 802.16a-2003 was published and publically available on April 1, 2003, which is prior to the provisional application filing date cited by the '941 patent (U.S. Provisional Appl. No. 60/544,521 filed February 13, 2004). In view of Li's vote to adopt 802.16a-2003 and participation in the working group, Li would have also been aware of the existence and its publication. During the USPTO's examination of the '941 patent, however, Li never disclosed 802.16a-2003 for the USPTO's consideration. 802.16a-2003

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is not duplicative of any art that was cited during prosecution of the ’941 patent. Only U.S. Patent 7,436,757 was cired during prosecution, which does not reflect the state of the 802.16 standard. In fact, 802.16a-2003 was disclosd to the USPTO for the first time in a child application two years after the ’941 patent had already issued. This would have been 17 years after 802.16a-2003 was already adopted and published. Therefore, upon information and belief, Li intentionally chose not to disclose 802.16a-2003 to the USPTO during the pendency of the ’941 patent. Upon information and belief, this was done with an intent to deceive the USPTO. Upon information and belief, but for the inventors’ intentional failure to disclose 802.16a-2003, the USPTO would not have issued the ’941 patent. The “but for” materiality of 802.16a-2003 to the asserted claims of the ’941 has been demonstrated in Exhibit C-01. Neo Wireless is therefore barred by the doctrine of inequitable conduct from enforcing the ’941 patent.

C. Derivation/Lack of Inventorship

Upon information and belief, the Asserted Patents are invalid due to derivation pursuant to pre-AIA 35 U.S.C. § 102(f) and lack of inventorship pursuant to 35 U.S.C. § 101. *See Creative Compounds, LLC v. Starmark Labs.,* 651 F.3d 1303, 1313 (Fed. Cir. 2011) (patents are rendered invalid if the claimed invention was derived from someone other than the named inventor(s)). As described above, Neo Wireless, its predecessors-in-interest, and/or one or more of the named inventors had access to confidential AT&T wireless communications prior to filing the Asserted Patents. Thus, the claimed invention(s) of the Asserted Patents were derived from someone other than the named inventors and are rendered invalid and unenforceable.

D. Implied Waiver

Upon information and belief, Neo Wireless’ claims are barred, in whole or in part, or their remedies limited, by the doctrines of implied waiver.

The European Telecommunications Standards Institute (“ETSI”) is a standards-setting

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organization ("SSO") for various communication systems, including the LTE technology at issue in the present case. ETSI requires members to disclose standard essential patents and patent applications. Members that breach their duty to disclose "have impliedly waived [their] right to assert infringement claims against standard-compliant products." *Hynix Semiconductor Inc. v. Rambus Inc.*, 645 F.3d 1336, 1347-48 (Fed. Cir. 2011) (quoting *Qualcomm Inc. v. Broadcom Corp. ("Qualcomm II")*, 548 F.3d 1004, 1019 (Fed. Cir. 2008)).

ESTI Rule, Clause 4.1 states:

> [1] Subject to Clause 4.2 below, each MEMBER shall use its reasonable endeavours, in particular during the development of a STANDARD or TECHNICAL SPECIFICATION where it participates, to inform ETSI of ESSENTIAL IPRs in a timely fashion.
>
> [2] In particular, a MEMBER submitting a technical proposal for a STANDARD or TECHNICAL SPECIFICATION shall, on a bona fide basis, draw the attention of ETSI to any of that MEMBER's IPR which might be ESSENTIAL if that proposal is adopted.

The 3rd Generation Partnership Project ("3GPP") "unites seven telecommunications standard development organizations," including ETSI and ATIS (Alliance for Telecommunications Industry Solutions).[19] *See* Amended Complaint ¶ 40.

ATIS requires members prior to approval of a standard to make "(a) assurance in the form of a general disclaimer to the effect that such party does not hold and does not currently intend to hold any essential patent claim(s); or (b) assurance that a license to such essential patent claim(s) will be made available to applicants desiring" to implement the standard on fair reasonable and non-discriminatory ("FRAND") terms. *See* ATIS Operating Procedures, 10.4 "Patents" at 10 (version 5.6); *see also Apple, Inc. v. Motorola Mobility, Inc.,* 886 F. Supp. 2d 1061, 1086-88 (W.D.

[19] *See* https://www.3gpp.org/about-3gpp.

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Wis. 2012) (patent owner had a duty to disclose before the adoption of standard).

Upon information and belief, AT&T and related entities were members of 3GPP, ETSI, and/or ATIS. As a member of 3GPP, ETSI, and/or ATIS, AT&T and related entities were obligated to declare any patent applications and/or patents that they believed to be essential to the LTE standard.

Upon information and belief, at least named inventors Xiaodong Li, Titus Lo, and Ruifeng Wang were employed by AT&T during the development of the LTE standard in the mid to late 1990s. Upon information and belief, as employees of AT&T, Xiaodong Li, Titus Lo, and Ruifeng Wang had an obligation to disclose and assign intellectual property rights to AT&T. Upon information and belief, the alleged inventions were developed entirely or in part while Xiaodong Li, Titus Lo, and Ruifeng Wang were employed by AT&T. Upon information and belief, AT&T owns the Asserted Patents in part or in whole. As such, the Asserted Patents are subject to the disclosure standards of 3GPP, ETSI, and/or ATIS.

Upon information and belief, the Asserted Patents are also subject to the disclosure standards of Institute of Electrical and Electronics Engineers ("IEEE"). Under the IEEE-SA Standards Board Bylaws, "[i]n order for IEEE's patent policy to function efficiently, *individuals participating in the standards development process: (a) shall inform the IEEE* (or cause the IEEE to be informed) of the holder *of any potential Essential Patent Claims of which they are personally aware* and that are not already the subject of an Accepted Letter of Assurance, that are owned or controlled by the participant or the entity the participant is from, employed by, or otherwise represents; and (b) should inform the IEEE (or cause the IEEE to be informed) of any other holders of potential Essential Patent Claims that are not already the subject of an Accepted Letter of Assurance." IEEE-SA Standards Board Bylaws, Section 6.2 (emphasis added); *see also Chrimar*

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Sys., Inc. v. Alcatel-Lucent Enter. USA Inc., No. 6:15-CV-00163-JDL, 2017 WL 345991 at *2 (E.D. Tex. Jan. 24, 2017) (expert testimony that IEEE's bylaws govern at least the "board itself, the staff, and any officers of the organization, such as committee chairs").

Upon information and belief, at least named inventors Xiaodong Li, Haiming Huang, Kemin Li, and Titus Lo were involved in IEEE's efforts to develop the WiMax standard. For example:

- The aforementioned inventors are listed as attendees for IEEE 802.16 Session #38 on July 18-21, 2005;[20]
- Xiaodong Li has been a member of IEEE since at least 2002, and is listed as a contributor to the project IEEE 802.156 Broadband Wireless Access Working Group in a document submitted to IEEE on May 7, 2002;[21] and as a participant "in the Working Group Letter Ballot in which the draft IEEE Std 802.16c-2002 was prepared and finalized for IEEE Ballot[;]"[22]
- Kemin Li co-authored several IEEE Conference Papers between 1996 and 1999;[23] and
- As of September 30, 2010, Titus Lo was described as a "senior member of IEEE."[24] Titus Lo is an active participate in IEEE to this day and holds the title of "Publicity

[20] *See* https://ieee802.org/16/meetings/mtg38/reglist.html.

[21] *See* https://www.ieee802.org/20/Dot16_Ar/C80216sgm-02_06.pdf.

[22] *See* "802.16-2017 - IEEE Standard for Air Interface for Broadband Wireless Access Systems," IEEE-SA at 11.

[23] *See* https://ieeexplore.ieee.org/author/37087298721.

[24] *See* https://labs.ece.uw.edu/ieee-comm/event_sep_30_2010.htm.

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Chair-Americas."[25]

As documented IEEE members and contributors to IEEE working groups involving WiMax technology before, during, and/or after prosecution of the Asserted Patents and related applications, at least Xiaodong Li, Haiming Huang, Kemin Li, and Titus Lo had a duty to disclose the Asserted Patents and/or related patent applications to IEEE. Upon information and belief, they failed to do so.

Upon information and belief, equitable estoppel, including without limitation implied waiver of enforceability, attaches to the original holder of a standard essential patent application and/or patent and any successor-in-interest, including any named inventor of an alleged standard essential patent that was employed by a SSO member during any time of the claimed invention. *Cf. Core Wireless Licensing S.A.R.L. v. Apple Inc.,* 899 F.3d 1356, 1368 (Fed. Cir. 2018) (indicating that Nokia's duty to disclose potential standard essential patent applications and patents and any resulting implied waiver attached to successor-in interest to prevent "any unjust advantage").

Applying the duty to disclose to named inventors employed by SSO members is consistent with SSO policies which already attributes actions by employees to the SSO member company employing them. *See* 64 (ETSI Directives) at § 4.6.3.5 ("'reasonable endeavors' that are to be taken to disclose patents that are essential to a particular ETSI deliverable should be measured in terms of the knowledge of representatives of an ETSI members who are actively involved in the work of the body developing that ETSI deliverable"). For example, the ETSI Directive Clause 4.1 was revised to clarify that "this Clause should be adhered to . . . in which an employee (or otherwise authorised representative) of such member . . . performs at least one of the following: i)

[25] *See* https://wcnc2022.ieee-wcnc.org/committees/organizing-committee.

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attends a meeting of; ii) participates in or contributes, directly or indirectly, to the work of; iii) votes on any matter raised within[.]" *See* ETSI Directives § 4.6.3.3 at 74 (Sep. 19, 2013); *see also In re Certain UMTS and LTE Cellular Communication Modules and Products Containing the Same*, Inv. No. 337-TA-1240, Final Initial Determination at 275-78 (ITC April 1, 2022). Additionally, SSOs already determine lack of disclosure based on the member employee's knowledge. *See* ETSI Directives § 4.6.3.2 ("Intention disclosure" occurs "when a representative participating in a Technical Body . . . has actual knowledge of [Essential Patents], and . . . holds back notification.").

The purpose of equitable estoppel is to prevent a party from gaining an inequitable benefit. *See Conversant Wireless Licensing S.A.R.L. v. Apple, Inc.,* No. 15-CV-05008-NC, 2019 WL 4038419, at *5 (N.D. Cal. May 10, 2019) (implied waiver "should only be applied in instances where the patentee's misconduct resulted in [an] unfair benefit") (internal citations and quotations omitted). By failing to disclose the Asserted Patents and related patent applications to 3GPP, ETSI, ATIS, and/or IEEE, Neo Wireless's predecessors-in-interest gained an inequitable benefit: (1) fraudulent conveyance of the Asserted Patents and (2) depriving "[ATIS and IEEE] members the opportunity to make a fully informed decision as to the technical solution for the [LTE or WiMAX] standard." *See In re Certain UMTS and LTE Cellular Communication Modules and Products Containing the Same*, Inv. No. 337-TA-1240, Final Initial Determination at 280 (ITC April 1, 2022).

LTE and WiMax were developed as competing wireless technologies in the early to mid-2000s for the 4G standard. Failure to disclose the Asserted Patents to either IEEE, which was responsible the development of WiMAX specifications, or ATIS, which was responsible for the development of LTE specifications, deprived IEEE and ATIS members of information necessary

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to make a fully informed decision as to whether to implement LTE or WiMAX technology for the 4G standard. As a result of at least Xiaodong Li, Titus Lo, and Ruifeng Wang's failure to disclose the Asserted Patents and related patent applications to ATIS during development of the LTE standard, Neo Wireless and its predecessors-in-interest have waived any right to enforce the Asserted Patents.

Likewise, as a result of at least Xiaodong Li, Kemin Li, Titus Lo, and Haiming Huang's failure to disclose the Asserted Patents and related patent applications to IEEE as working members involved in developing the WiMax standard, Neo Wireless and its predecessors-in-interest have waived any right to enforce the Asserted Patents.

E. Patent Misuse/Breach of FRAND

1. Neo Wireless' Assertion that the Asserted Patents are Standard Essential

Pursuant to ATIS's Operating Procedure 10.4.2, ATIS requires patent holders of standard essential patents to offer licenses on "reasonable terms and conditions that are demonstrably free of any unfair discrimination" or "without compensation." ATIS Operating Procedures, § 10.4.2(a)-(b) at 10 (version 5.6). This is often referred to as a requirement to offer a license on fair reasonable and non-discriminatory ("FRAND") terms.

Similarly, pursuant to IEEE's Bylaws, patent holders of standard essential patents are required to "make available a license for Essential Patent Claims to an unrestricted number of Applicants on a worldwide basis without compensation or under Reasonable Rates, with other reasonable terms and conditions that are demonstrably free of any unfair discrimination[.]" IEEE-SA Standards Board Bylaws, Section 6.2 "Policy." This is another example of a FRAND requirement.

Based on the named inventors' involvement with IEEE (discussed above), Neo Wireless

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had a duty to disclose the Asserted Patents and offer licensing on FRAND terms. Similarly, if Neo Wireless intended to claim the Asserted Patents as essential to the 4G/LTE standard, which was developed and codified by 3GPP (including its US entity ATIS), this again conferred an obligation on Neo Wireless to disclose the Asserted Patents and offer licensing on FRAND terms pursuant to at least ATIS's Operating Procedure 10.4.2. Neo Wireless failed to provide notice of the infringement allegations to Defendants prior to filing the Complaint or offer a license on FRAND terms. Therefore, Neo Wireless has breached its obligation to offer a license on FRAND terms.

Neo Wireless is barred from asserting infringement of the asserted patents based on the doctrine of patent misuse because Neo Wireless has not offered to grant irrevocable licenses to the asserted standard essential patents on FRAND terms.

2. Neo Wireless Assignment of Patents to Oppo

a. The Assignment and OPPO's Declaration

Guangdong OPPO Mobile Telecommunications Corp., Ltd ("OPPO") is a Chinese consumer electronics manufacturer headquartered in Dongguan, Guangdong. OPPO's major product lines include smartphones, smart devices, audio devices, power banks, and other electronic products. On April 28, 2018, Neo Wireless assigned several patent families to OPPO. One such patent family includes U.S. Patent No. 9,198,179 ("the '179 patent").[26] Shortly after the assignment, OPPO declared the patents that it received from Neo Wireless as essential to the 4G LTE standard. Specifically, on May 28, 2018, OPPO submitted an IPR information statement and licensing declaration ("declaration") to ETSI, which is the European standard organization within

[26] Four assignments were filed on April 28, 2018, which assigned the '179 Patent (1) from inventors Xiaodong Li, Titus Lo, Haiming Huang, and Li Kemin to Waltical Solution, Inc.; (2) from Waltical Solution, Inc. to Neocific, Inc.; (3) from Neocific, Inc. to Golden Valley Holdings Limited; and (4) from Golden Valley Holdings Limited to OPPO.

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3GPP, and is responsible for the 4G standard. The declaration indicated that multiple patents owned by OPPO—including those assigned from Neo Wireless—are essential to "ETSI Work Item, STANDARD and/or TECHNICAL SPECIFICATION." Declaration, p. 1. OPPO's declaration also stated that "the Declarant and/or its AFFILIATES are (1) prepared to grant irrevocable licences under this/these IPR(s) on terms and conditions which are in accordance with Clause 6.1 of the ETSI IPR Policy; and (2) will comply with Clause 6.1 bis of the ETSI IPR Policy." Declaration, p. 1.

b. The '179 Patent Incorporates Five Asserted Patents by Reference

The '179 patent claims to be related to (1) PCT application No. PCT/US2005/008169 ("the '169 PCT"), which is a parent application of the asserted U.S. Patent No. 8,467,366 ("the '366 patent"), (2) PCT application No. PCT/US2005/004601 ("the '601 PCT"), which is a parent application of asserted U.S. Patent No. 10,075,941 ("the '941 patent"), and (3) U.S. Provisional Application No. 60/540,032 ("the '032 application") (collectively, "the parent applications"), which is a parent application of asserted U.S. Patent Nos. 10,771,302 ("the '302 patent"), 10,833,908 ("the '908 patent"), and 10,965,512 ("the '512 patent").'179 Patent, 1:18-29. The '179 patent also states that "[a]ll of the above patents and applications and other references, including any that may be listed in accompanying filing papers, **are incorporated herein by reference**."[27] *Id.*, 7:65-8:1.

[27] The '366 and '941 patents are almost identical to the '169 and '601 PCTs, respectively. The '512 patent is substantially similar to the '032 application. But, the '908 and '302 patents are fairly different from the '032 application.

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c. ETSI IPR Policy

The ETSI intellectual property rights (IPR) policy ("ETSI IPR Policy") states that "each MEMBER shall use its reasonable endeavours, in particular during the development of a STANDARD or TECHNICAL SPECIFICATION where it participates, to inform ETSI of ESSENTIAL IPRs in a timely fashion." ETSI IPR Policy, Clause 4.1. The ETSI IPR Policy indicates that a declared IPR is bounded by FRAND terms. *See* ETSI IPR Policy, Clause 6.1. In addition, the ETSI IPR Policy recites that "[a]n undertaking pursuant to Clause 6.1 with regard to a specified member of a PATENT FAMILY shall apply to **all existing and future ESSENTIAL IPRs[28] of that PATENT FAMILY** unless there is an explicit written exclusion of specified IPRs at the time the undertaking is made." ETSI IPR Policy, Clause 6.2, *emphasis added*. The ETSI IPR Policy defines PATENT FAMILY to mean "all the documents having at least one priority in common, including the priority document(s) themselves." ETSI IPR Policy, Clause 15. Here the recited "undertaking pursuant to Clause 6.1" corresponds to "an irrevocable undertaking in writing that it is prepared to grant irrevocable licences on fair, reasonable and non-discriminatory ('FRAND') terms." *See* ETSI IPR Policy, Clause 6.1.

d. OPPO's Declaration Bounds Five of the Asserted Patents

Five of the six asserted patents should be bounded by FRAND and subject to clause 6.1 of the ETSI IPR Policy because of OPPO's declaration.

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[28] The ETSI IPR Policy defines essential IPRs to mean "that it is not possible on technical (but not commercial) grounds, taking into account normal technical practice and the state of the art generally available at the time of standardization, to make, sell, lease, otherwise dispose of, repair, use or operate EQUIPMENT or METHODS which comply with a STANDARD without infringing that IPR." ETSI IPR Policy, Clause 15. The ETSI IPR Policy further explains that "[f]or the avoidance of doubt in exceptional cases where a STANDARD can only be implemented by technical solutions, all of which are infringements of IPRs, all such IPRs shall be considered ESSENTIAL." *Id.*

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As discussed above, the parent applications of five out of the six asserted patents are related to, and incorporated by reference into the ’179 patent. Therefore, the parent applications are part of the ’179 patent. Because the ’179 patent was declared to be essential, and thus subject to clause 6.1 of the ETSI IPR policy, the parent applications were in essence also declared to be essential to the ETSI standard and subject to the clause 6.1. Additionally, clause 6.2 of the ETSI IPR policy states that the FRAND obligations of clause 6.1 also apply to “all existing and future ESSENTIAL IPRs of that PATENT FAMILY” of the declared patent/application. Because the ’169 PCT is a parent application of the ’366 patent, the ’601 PCT is a parent application of the ’941 patent, and the ’032 application is a parent application of the ’302, ’908, and ’512 patents, the ’366, ’941, ’302, ’908, and ’512 patents are “of that PATENT FAMILY” of at least the parent applications incorporated by reference into the declared ’179 patent.[29]

Moreover, Neo Wireless has stated that the ’366, ’941, ’302, ’908, and ’512 patents are essential to the 4G LTE standard. *See* Complaint, at 46, 51, 63, 69, 75, 87, and 93. Therefore, if the Court sides with Neo Wireless, and agrees that these patents are essential to the 4G LTE standard, then the ’366, ’941, ’302, ’908, and ’512 patents would necessarily constitute “ESSENTIAL IPRs” under clause 6.2 of the ETSI IPR policy. As such, the ’366, ’941, ’302, ’908, and ’512 patents should be subject to the FRAND obligations of clause 6.1 of the ETSI policy due to the fact that these patents are “future ESSENTIAL IPRs of that PATENT FAMILY” that was declared as essential by Oppo.

Neo Wireless is barred from asserting infringement of the asserted patents based on the doctrine of patent misuse because Neo Wireless has not offered to grant irrevocable licenses to the

[29] The ETSI IPR Policy defines PATENT FAMILY to mean “all the documents having at least one priority in common, including the priority document(s) themselves.” ETSI IPR Policy, Clause 15.

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asserted standard essential patents on FRAND terms.

VIII. DOCUMENT PRODUCTION

Defendants have produced copies of the invalidating references (*e.g.*, publications and patents) before and with service of these Contentions, including the documents labeled with Bates Nos. NEO-MDL_PA000001- NEO-MDL_019859.

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CERTIFICATE OF SERVICE

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