

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Xiaodong Li, et al.	
U.S. Patent No.:	10,447,450	Attorney Docket No.: 18768-0206IP3
Issue Date:	October 15, 2019	
Appl. Serial No.:	15/676,421	
Filing Date:	August 14, 2017	
Title:	METHOD AND SYSTEM FOR MULTI-CARRIER PACKET COMMUNICATION WITH REDUCED OVERHEAD	

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**PETITION FOR *INTER PARTES* REVIEW OF
UNITED STATES PATENT NO. 10,447,450
PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

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EXHIBITS

<i>Exhibit No.</i>	<i>Description</i>
GM-1001	U.S. Patent No. 10,447,450 to Li <i>et al.</i> (“’450 patent”).
GM-1002	Prosecution History of U.S. Patent No. 10,447,450 (“Prosecution History”).
GM-1003	Declaration of Sarah Kate Wilson, Ph.D.
GM-1004	<i>Curriculum Vitae</i> of Dr. Sarah Kate Wilson
GM-1005	U.S. Patent Pub. No. 2005/0058089 to Vijayan <i>et al.</i> (“Vijayan089”)
GM-1006	U.S. Patent Pub. No. 2005/0141475 to Vijayan <i>et al.</i> (“Vijayan475”)
GM-1007	U.S. Patent Pub. No. 2005/0277429 to Laroia <i>et al.</i> (“Laroia”)
GM-1008	U.S. Patent Pub. No. 2005/0063345 to Wu <i>et al.</i> (“Wu”)
GM-1009	U.S. Patent Pub. No. 2005/0243774 to Choi <i>et al.</i> (“Choi”)
GM-1010	Petition (Paper 3), <i>Dell Inc. v. Neo Wireless LLC</i> , IPR2021-01486, filed September 16, 2021
GM-1011	Ding Declaration (EX1003), <i>Dell Inc. v. Neo Wireless LLC</i> , IPR2021-01486, filed September 16, 2021
GM-1012	Patent Owner’s Preliminary Response (Paper 7), <i>Dell Inc. v. Neo Wireless LLC</i> , IPR2021-01486, filed December 20, 2021
GM-1013	Alberth Declaration (EX2001), <i>Dell Inc. v. Neo Wireless LLC</i> , IPR2021-01486, filed December 20, 2021
GM-1014	Decision Denying Institution (Paper 10), <i>Dell Inc. v. Neo Wireless LLC</i> , IPR2021-01486, issued March 16, 2022
GM-1015	U.S. Patent Pub. No. 2005/0157803 to Kim <i>et al.</i> (“Kim”)
GM-1016	IEEE 802.16-2004 Standard, entitled “IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems” (“IEEE802.16-2004”)
GM-1017	<i>Intentionally Left Blank</i>
GM-1018	<i>Intentionally Left Blank</i>
GM-1019	<i>Intentionally Left Blank</i>
GM-1020	Joint Claim Construction Statement, <i>Neo Wireless, LLC v. Dell Technologies Inc. et al.</i> , Case No. 6:21-cv-00024-ADA (W.D. Tex.), filed December 21, 2021 (ECF No. 56)
GM-1021	U.S. Patent Pub. No. 2005/0073973 to Laroia <i>et al.</i> (“Laroia973”)

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GM-1022	U.S. Patent Pub. No. 2008/0192851 to Golitschek Edler Elbwart <i>et al.</i> (“Golitschek”)
GM-1023	U.S. Patent Pub. No. 2005/0135324 to Kim <i>et al.</i> (“Kim”)
GM-1024	U.S. Patent Pub. No. 2006/0039274 to Park <i>et al.</i> (“Park274”)
GM-1025	U.S. Patent Pub. No. 2008/0123593 to Fujita <i>et al.</i> (“Fujita”)
GM-1026	U.S. Patent Pub. No. 2006/0285481 to Lane <i>et al.</i> (“Lane”)
GM-1027	U.S. Patent Pub. No. 2006/0046647 to Parikh <i>et al.</i> (“Parikh”)
GM-1028	U.S. Patent No. 6,039,624 to Holmes (“Holmes”)
GM-1029	U.S. Patent Pub. No. 2005/0197123 to Chang <i>et al.</i> (“Chang”)
GM-1030	U.S. Patent Pub. No. 2005/0075148 to Park (“Park148”)
GM-1031	B. Saltzberg, “Performance of an efficient parallel data transmission system,” <i>IEEE Transactions on Communications Technology</i> . Vol. 15, No. 6, 1967 pp. 805-811.
GM-1032	S. Weinstein, P. Ebert, “Data transmission by frequency-division multiplexing using the discrete Fourier Transform,” <i>IEEE Transactions on Communications Technology</i> , Vol. 19, No. 5, 1971, pp. 628-634.
GM-1033	L. Cimini, “Analysis and Simulation of a Digital Mobile Channel Using Orthogonal Frequency Division Multiplexing,” <i>IEEE Transactions on Communications</i> , vol. 33, no. 7, July 1985, pp. 665-675.
GM-1034	J. Bingham, <i>Theory and Practice of Modem Design</i> , John Wiley and Sons, 1988.
GM-1035	P. S. Chow, J. C. Tu and J. M. Cioffi, “A multichannel transceiver system for asymmetric digital subscriber line service,” <i>IEEE Global Telecommunications Conference GLOBECOM '91: Countdown to the New Millennium. Conference Record</i> , 1991, pp. 1992.
GM-1036	B. LeFloch, R. Halbert-Lassalle, D. Castelain, “Digital sound broadcasting to mobile receivers,” <i>IEEE Transactions on Consumer Electronics</i> , Vol. 35, No. 3, 1989, pp. 493-503.
GM-1037	M. Aldinger, “Multicarrier COFDM scheme in high bitrate radio local area networks,” <i>5th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, Wireless Networks - Catching the Mobile Future.</i> , Vol. 3, 1994, pp. 969-973.
GM-1038	C. Reiners and H. Rohling, “Multicarrier transmission technique in cellular mobile communications systems,” <i>Proceedings of IEEE Vehicular Technology Conference</i>

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	(VTC), vol.3, 1994, pp. 1645-1649.
GM-1039	M. Wahlqvist, C. Östberg, J. van de Beek, O. Edfors, and P. O. Börjesson, “A conceptual study of OFDM-based multiple access schemes: Part 1: Air interface requirements,” Telia research AB, Luleå University of Technology, 1996.
GM-1040	Transfer Order, <i>In re: Neo Wireless, LLC, Patent Litigation</i> , Case MDL No. 3034, issued June 14, 2022 (ECF No. 50)
GM-1041	Docket Sheet, <i>Neo Wireless, LLC v. Volkswagen Group of America, Inc. et al.</i> , Case No. 2:22-cv-11404-TGB (E.D. Mich.)
GM-1042	United States District Courts – National Judicial Caseload Profile, June 2022
GM-1043	U.S. Patent No. 7,221,680 to Vijayan <i>et al.</i> (“Vijayan680”).
GM-1044	U.S. Patent No. 7,948,944 to Li <i>et al.</i>
GM-1045	Prosecution History for U.S. Patent Application 11/908,257 corresponding to U.S. Patent No. 7,948,944
GM-1046	U.S. Patent No. 9,735,944 to Li <i>et al.</i>
GM-1047	Prosecution History for U.S. Patent Application 14/720,554 corresponding to U.S. Patent No. 9,735,944
GM-1048	Declaration of Dr. Matthew C. Valenti

LIST OF CHALLENGED CLAIMS

Claim 1	
[1-pre]	An operating method for a wireless network comprising at least a base station and a mobile station, the wireless network employing a frame structure of multiple frames for transmission, each frame comprising a plurality of time intervals, each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and each OFDM symbol containing a plurality of frequency subcarriers, the method comprising:
[1A]	assigning an identifier to the mobile station;
[1B]	transmitting a signal containing information from the base station to the mobile 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; and

[1C]	receiving by the mobile station the transmitted signal; and
[1D]	recovering by the mobile station the information from the received signal based on the starting time-frequency coordinate and N in conjunction with the identifier assigned to the mobile station.
Claim 2	
[2]	The method of claim 1, wherein the starting time-frequency coordinate indicates a starting OFDM symbol of the segment of time-frequency resource.
Claim 3	
[3]	The method of claim 1, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.
Claim 4	
[4]	The method of claim 1, wherein the starting time-frequency coordinate indicates a starting group of subcarriers of the segment of time-frequency resource.

Claim 5	
[5]	The method of claim 1, wherein modular coding is applied to the time-frequency resource units in the segment of time-frequency resource.
Claim 6	
[6]	The method of claim 5, wherein a repetition coding is further applied to the time-frequency resource units.
Claim 7	
[7-pre]	A mobile device in a wireless packet system using a frame structure of multiple frames for transmission, each frame comprising a plurality of time intervals, each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and each OFDM symbol containing a plurality of frequency subcarriers, the mobile device configured to:
[7A]	receive an identifier from a base station in a cell in which the mobile device is operating; and

[7B]	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; and
[7C]	recover the information from the received signal using the starting time-frequency coordinate and N in conjunction with the received identifier.
Claim 8	
[8]	The mobile device of claim 7, wherein the starting time-frequency coordinate indicates a starting OFDM symbol of the segment of time-frequency resource.
Claim 9	
[9]	The mobile device of claim 7, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.

Claim 10	
[10]	The mobile device of claim 7, wherein the starting time-frequency coordinate indicates a starting group of subcarriers of the segment of time-frequency resource.
Claim 11	
[11]	The mobile device of claim 7, wherein modular coding is applied to the time-frequency resource units in the segment of time-frequency resource.
Claim 12	
[12]	The mobile device of claim 11, wherein a repetition coding is further applied to the time-frequency resource units.

Claim 13	
[13-pre]	A base station in a wireless packet system using a frame structure of multiple frames for transmission, each frame comprising a plurality of time intervals, each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and each OFDM symbol containing a plurality of frequency subcarriers, the base station configured to:
[13A]	provide an identifier to a mobile device in the cell;
[13B]	allocate a segment of time-frequency resource for carrying information to the mobile device, 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; and

[13C]	transmit a signal containing the information to the mobile device in a manner that allows the mobile device to recover the information using the starting time-frequency coordinate and N in conjunction with the provided identifier.
Claim 14	
[14]	The base station of claim 13, wherein the starting time-frequency coordinate indicates a starting OFDM symbol of the segment of time-frequency resource.
Claim 15	
[15]	The base station of claim 13, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.
Claim 16	
[16]	The base station of claim 13, wherein the starting time-frequency coordinate indicates a starting group of subcarriers of the segment of time-frequency resource.

Claim 17	
[17]	The base station of claim 13, wherein modular coding is applied to the time-frequency resource units in the segment of time-frequency resource.
Claim 18	
[18]	The base station of claim 17, wherein a repetition coding is further applied to the time-frequency resource units.

I. INTRODUCTION

General Motors LLC, Nissan North America Inc., and Tesla Inc. (“Petitioner”) petitions for *Inter Partes* Review (“IPR”) of claims 1-18 (“the challenged claims”) of U.S. Patent No. 10,447,450 (“the ’450 patent”) assigned to Neo Wireless LLC (“Neo Wireless”), titled “Method and System for Multi-Carrier Packet Communication with Reduced Overhead.” Petitioner is filing a Motion to Join the IPR in *Volkswagen Group of America, Inc. v. Neo Wireless, LLC*, IPR2022-01567 (“the VW IPR”).

The challenged claims are directed to a resource allocation method in a generic orthogonal frequency-division multiplexing (OFDM) communication system. Specifically, the challenged claims recite allocating communication segments in a time-frequency plane using “time-frequency resource units.” These “units” are organized into a communication segment with a “starting time- frequency coordinate” and “N time-frequency resource units.” But before the ’450 patent, using a “time-frequency resource unit” for allocating communication segments was well-known and had been fully developed. Section V.B. The challenged claims are therefore not patentable and should be canceled.

Petitioner’s expert, Dr. Matthew Valenti, who has over 30 years of experience working with wireless communications systems, explains that using a “time-frequency

resource unit” was well-known and publicly disclosed well before the ’450 patent.¹ For example, by 2004, prior to the earliest priority date of the ’450 patent, multiple patents were filed detailing specific systems and methods for allocating communication segments using a “time-frequency resource unit.” A subset of these patents are discussed herein, and include U.S. Patent Application Publication No. 2005/0058089 to Vijayan et al. (“Vijayan089”) and U.S. Patent Application Publication No. 2005/0141475 Vijayan et al. (“Vijayan475”). Vijayan089 discloses time-frequency “transmission slots” and assigns a segment using “two parameters: the start of the segment ... and the length of the segment,” where the length of the segment is specified by the number of slots in the segment. EX1005, Vijayan089, ¶74. Vijayan475 also discloses transmission slots, but in a manner different from Vijayan089. Specifically, Vijayan475 defines a starting coordinate and number of slots using “Start Offset,” “Slot Info,” and “Stream Lengths” parameters. EX1006,

¹ Petitioner retained Matthew C. Valenti, Ph.D. in this proceeding. *See* EX1048. Dr. Valenti has adopted the opinions set forth in EX1003 (the expert declaration of Dr. Sarah Kate Wilson) submitted in IPR2022-01567, as his own. EX1048, ¶18. While Petitioner is not relying directly on Dr. Wilson’s declaration in this Petition, for expediency this Petition cites only to Dr. Wilson’s declaration. EX1003 (IPR2022-01567).

Vijayan475, ¶45. Vijayan475 applies its techniques to multiplexed logical channels (MLCs) while Vijayan089 applies its techniques to physical layer channels (PLCs). In this way, both Vijayan089 and Vijayan475 separately and distinctly disclose “time-frequency resource units.”

Vijayan089 and Vijayan475 used in various combinations disclose the challenged claims of the ’450 patent. Unfortunately, none of the prior art references relied on herein were previously applied against the ’450 patent during prosecution. If they had been, the ’450 patent would not have been allowed. Accordingly, the Board should institute this proceeding and find claims 1-18 of the ’450 patent unpatentable.

II. MANDATORY NOTICES (37 C.F.R. § 42.8(A)(1))

A. Real Parties-in-Interest

General Motors LLC, Nissan North America, Inc., and Tesla, Inc. collectively “Petitioner,” along with General Motors Company and LG Electronics, Inc. (as to General Motors LLC), Nissan Motor Acceptance Corporation a/k/a Nissan Motor Acceptance Company LLC, and Quectel Wireless Solutions Co. Ltd. are the real parties-in-interest.

B. Related Matters

The ’450 Patent is or has been involved in the following civil actions in the district courts:

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Defending Party (all cases asserted by Neo Wireless, LLC)	Case No.	Venue	Date Complaint Filed
Mercedes-Benz USA, LLC	2-22-cv-11769	EDMI (E.D. Mich.)	Aug. 02, 2022
FCA US LLC	2-22-cv-11770	EDMI	Aug. 02, 2022
Mercedes-Benz USA, LLC	3-22-cv-00780	MDFL (M.D. Fl.)	Jul. 15, 2022
FCA US LLC	3-22-cv-01252	NDOH (N.D. Ohio)	Jul. 15, 2022
Nissan North America, Inc. et al	2-22-cv-11405	EDMI	Jun. 29, 2022
Volkswagen Group of America, Inc. et al	2-22-cv-11404	EDMI	Jun. 28, 2022
Toyota Motor North America, Inc.	2-22-cv-11406	EDMI	Jun. 28, 2022
General Motors	2-22-cv-11407	EDMI	Jun. 28, 2022

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Company et al.			
Tesla Inc.	2-22-cv-11408	EDMI	Jun. 28, 2022
Ford Motor Company	2-22-cv-11402	EDMI	Jun. 27, 2022
American Honda Motor Co., Inc.	2-22-cv-11403	EDMI	Jun. 27, 2022
NEO Wireless, LLC Patent Litigation	2-22-md-03034	EDMI	Jun. 23, 2022
Volkswagen Group of America, Inc. et al	1-22-cv-00076	EDTN (E.D. Tenn.)	Mar. 29, 2022
Toyota Motor North America, Inc.	2-22-cv-00093	EDTX (E.D. Tex.)	Mar. 29, 2022
General Motors Company et al.	2-22-cv-00094	EDTX	Mar. 29, 2022
Tesla Inc.	2-22-cv-00095	EDTX	Mar. 29, 2022
Nissan North America, Inc. et al	3-22-cv-00220	MDTN (M.D. Tenn.)	Mar. 29, 2022

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American Honda Motor Co., Inc.	2-22-cv-01824	SDOH (S.D. Ohio)	Mar. 29, 2022
Ford Motor Company	4-22-cv-00210	WDMO (W.D. MO.)	Mar. 29, 2022
LG Electronics, Inc. et al	6-21-cv-00025	WDTX (W.D. Tex.)	Jan. 13, 2021
Apple Inc.	6-21-cv-00026	WDTX	Jan. 13, 2021
Dell Technologies Inc. et al	1-22-cv-00060	WDTX	Jan. 12, 2021
Dell Technologies Inc. et al	6-21-cv-00024	WDTX	Jan. 12, 2021

The '450 Patent is or has been involved in the following IPR proceedings at the PTAB:

Case No.	Parties (all v. Neo Wireless, LLC)	Petition Filing Date	Current Status
IPR2023-00793	American Honda Motor Co., Inc.	Mar. 30, 2023	Pending, pre- institution
IPR2023-00763	Ford Motor	Mar. 29, 2023	Pending, pre-

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	Company		institution
IPR2022-01567	Volkswagen Group of America, Inc.	Sept. 27, 2022	Instituted
IPR2021-01486	Dell Inc. et al	Sept. 16, 2021	Not instituted

Volkswagen, Mercedes Benz, and American Honda also filed IPR petitions for commonly-assigned U.S. Patent Nos. 10,965,512 (IPR2022-01539 and IPR2023-00079) and 10,075,941 (IPR2022-01537 and IPR2023-00791). Petitioners are also filing IPR petitions challenging U.S. Patent Nos. 10,965,512 (IPR2023-00764, IPR2023-00961), 10,075,941 (IPR2023-00766, IPR2023-00964), and a concurrent petition challenging the '450 Patent (IPR2023-00962).

C. Lead and Backup Counsel

Petitioners provide the following designation of counsel.

Lead Counsel	Backup counsel
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D. Service Information

Please address all correspondence and service to the address listed above.

Petitioners consent to electronic service by email at IPR18768-0206IP3@fr.com

(referencing No. 18768-0206IP3 and cc'ing PTABInbound@fr.com,
rhill@jenner.com, and nkeenan@jenner.com).

E. PAYMENT OF FEES

Petitioner authorizes the PTO to charge Deposit Account No. 06-1050 for the fee set forth in 37 C.F.R. § 42.15(a) for this Petition and further authorizes payment for any additional fees to be charged to this Deposit Account.

III. GROUNDS FOR STANDING

The undersigned and Petitioners certify that the '450 patent is available for *inter partes* review. Petitioner is not barred or estopped from requesting *inter partes* review on the grounds herein.

IV. IDENTIFICATION OF CHALLENGE (37 C.F.R. §42.104(B))

A. Citation of Prior Art

The '450 patent was filed on August 14, 2017. EX1001, (22), (60), (63).

Through several continuation applications, the '450 patent claims the benefit of U.S.

Provisional Patent Application No. 60/721,451, filed September 28, 2005. *Id.*, (60), (63). Petitioner does not concede that the challenged claims are entitled to the benefit of this date. Nonetheless, all references relied upon qualify as prior art with respect to September 28, 2005.

Vijayan089 (EX1005) was filed on September 1, 2004 and published on March 17, 2005, more than six months prior to the earliest effective filing date of the '450 patent. Therefore, Vijayan089 is prior at least under 35 U.S.C. §§ 102(a) & (e) (pre-AIA).

Vijayan475 (EX1006) was filed on October 18, 2004 and published on June 30, 2005, more than two months prior to the earliest effective filing date of the '450 patent. Therefore, Vijayan475 is prior at least under 35 U.S.C. §§ 102(a) & (e) (pre-AIA).

U.S. Patent Pub. No. 2005/0277429 (Laroia) (EX1007) was filed on June 10, 2004, more than a year prior to the earliest effective filing date of the '450 patent, and published on December 15, 2005. Therefore, Laroia is prior art at least under 35 U.S.C. § 102(e) (pre-AIA).

U.S. Patent Pub. No. 2005/0063345 (Wu) (EX1008) was filed on August 11, 2004 and published on March 24, 2005, more than six months prior to the earliest effective filing date of the '450 patent. Therefore, Wu is prior at least under 35 U.S.C. §§ 102(a) & (e) (pre-AIA).

U.S. Patent Pub. No. 2005/0243774 (Choi) (EX1009) was filed on September

17, 2003, more than two years prior to the earliest effective filing date of the '450 patent, and published on November 3, 2005. Therefore, Choi is prior art at least under 35 U.S.C. § 102(e) (pre-AIA).

B. Statutory Grounds for the Challenge

Ground	References	Basis	Claims Challenged
1	Vijayan089 + Laroia	§103	1-5, 7-11, and 13-17
2	Vijayan475 + Wu	§103	1-5, 7-11, and 13-17
3	Vijayan089 + Laroia + Choi	§103	6, 12, and 18
4	Vijayan475 + Wu + Choi	§103	6, 12, and 18

V. TECHNICAL BACKGROUND

The '450 patent is directed to a “[m]ethod and system for minimizing the control overhead in a multi-carrier [OFDM] wireless communication network.” EX1001, 2:45-47, 4:63-5:5. To allegedly minimize this overhead, the '450 patent describes defining a zone or segment of communication resources using time- frequency resource “units.” *Id.*, 6:49-51, 7:7-30. A segment is then defined using a starting time-frequency coordinate and a number of units. *Id.*, 6:22-29. But these techniques and alleged benefits were known well before the '450 patent's earliest possible priority date. EX1003, ¶¶70-77. Similarly, the use of a mobile device identifier used to recover information from the segment was also well-known. *Id.*, ¶¶78-80.

A. OFDM Communication Systems Were Well Known

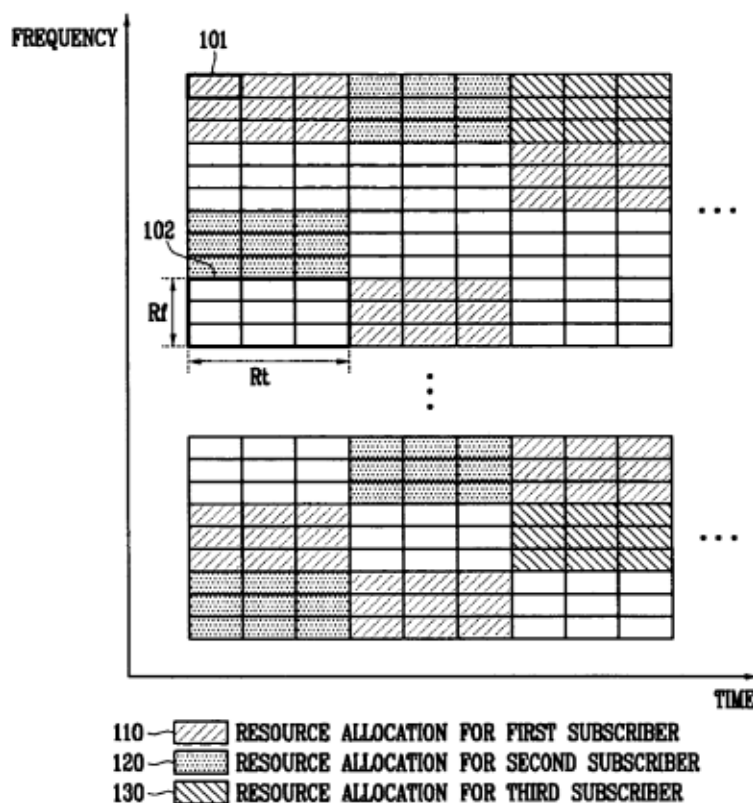
The inventors of the '450 patent did not invent OFDM. Specifically, the '450 patent admits that the IEEE 802.16 (WiMAX) standard was well-known and used to support wireless communications. EX1001, 1:42-45. The WiMAX standard implements OFDM, which the '450 patent adopts for its disclosure. *Id.*, 3:6-12; EX1003, ¶¶61-69. Indeed, Vijayan089, Vijayan475, Laroia, Wu, and Choi are also just a few of the many prior art references that specifically describe OFDM communication systems. EX1003, ¶¶61-69.

B. Using Time-Frequency Units to Allocate a Communication Zone or Segment was Well Known

As discussed below, both Vijayan089 and Vijayan475 disclose using time-frequency units to define a communication segment/zone. *See* Sections VIII.B.3, IX.B.3. Indeed, as explained by Dr. Wilson, this concept was well known in the art and commonly applied to OFDM systems. EX1003, ¶¶70-77.

For example, using a data transmission “resource mapping” with “time-frequency resources of a slot interval including OFDM symbols” was well-known. EX1023, Abstract. As Dr. Wilson explains, it was well-known in the art to allocate “time-frequency resources to multiple subscribers” for OFDM communications. EX1003, ¶¶70-77; EX1023, ¶¶49-50. One example allocation would be to use blocks of time-frequency resource units as depicted below. EX1023, FIG. 1, ¶¶49- 50.

FIG.1



EX1023, FIG. 1.

These time-frequency resource units have also been referred to as “allocation units” in the art. EX1003, ¶73; EX1024, ¶¶38, 46-47, 49. It was well-known in the art to use such allocation units to define an “allocation region” using a “total number of [] allocation units” as well as an “index value” identifying the starting allocation unit as seen in the figure below. EX1024, ¶¶53, 66, 70.

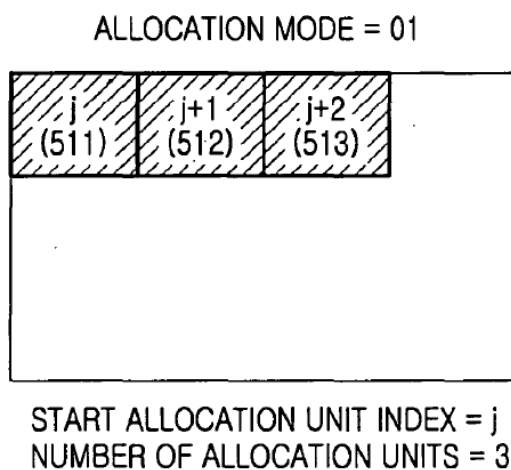
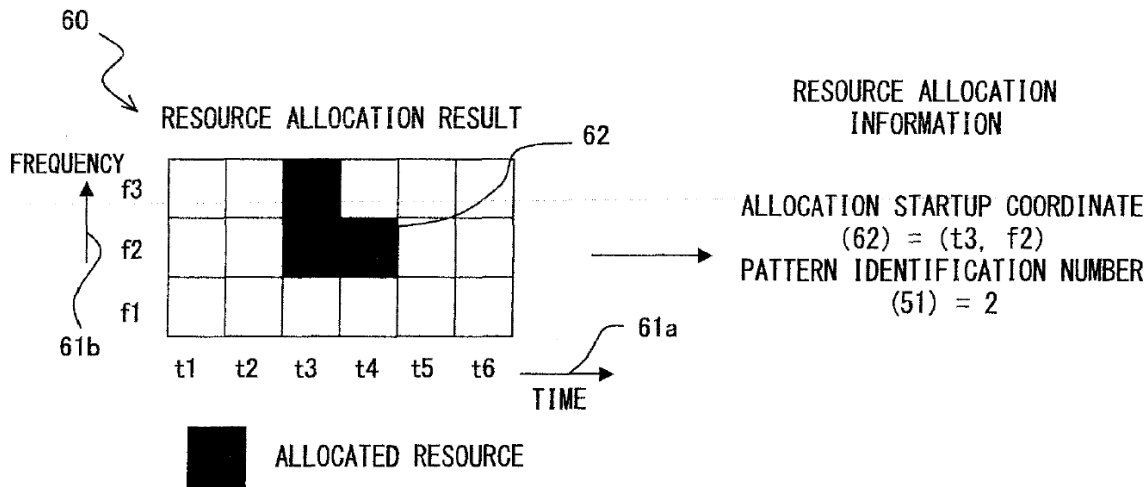


FIG.5B

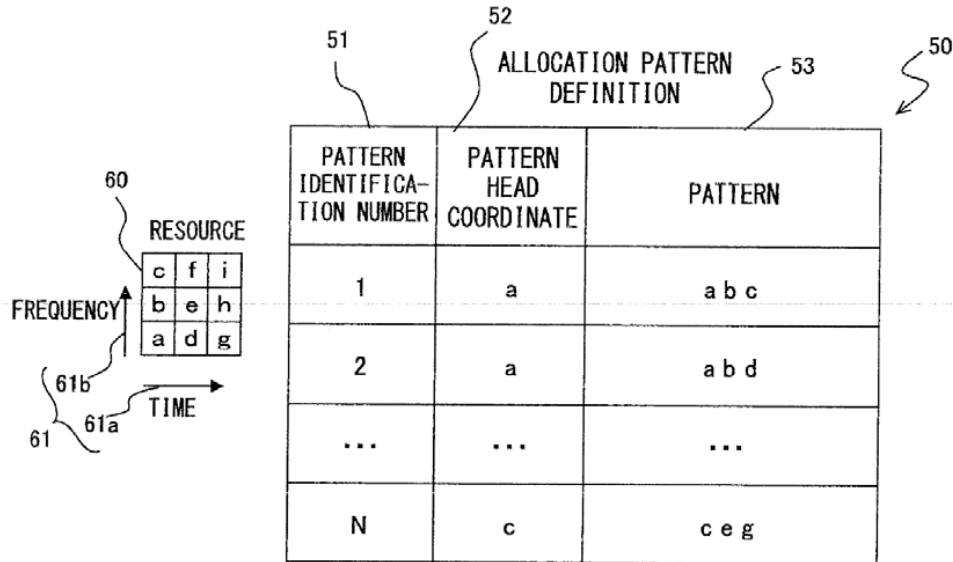
EX1024, FIG. 5B.

Similarly, the goal of minimizing the amount of bits needed to identify allocated time-frequency units was also well-known. EX1003, ¶74; EX1025, ¶¶15, 32, 34, 143. For example, it was well-known to use a resource allocation starting coordinate as well as a “pattern identification number” to specify a segment of time-frequency resource units as seen below. EX1025, ¶¶72-74.



EX1025, FIG. 6.

A pattern identification number specifies a pattern of allocated time- frequency units as indicated in the table below. *Id.*, ¶¶69-74. In the table, the pattern identification number “2” indicates the time-frequency resource units corresponding to the “a,” “b,” and “d” slots, which reflects the pattern of allocated resources (black squares) in the figure above. *Id.*; EX1003, ¶75.



EX1025, FIG. 5.

Mobile devices would store such a table in memory. EX1025, ¶¶76-79. Using this table, mobile devices receiving a “startup coordinate” and pattern identification number would discern an allocated time-frequency segment. *Id.* Thus, base stations informed mobile devices of allocated time-frequency units using fewer overhead bits. *Id.*, ¶¶15, 32, 34, 143; EX1003, ¶76.

C. Assigning an Identifier to a Mobile Device Was Well-Known

As discussed below, both Laroia and Wu disclose a base station assigning an identifier to a wireless device. *See* Sections VIII.A, VIII.B.2, IX.A, IX.B.2. Indeed, as explained by Dr. Wilson, this concept was commonly applied to OFDM systems. EX1003, ¶¶78-80.

For example, it was well-known in the art for base stations to assign wireless

terminal identifiers when “making segment assignments.” *Id.*; EX1026, ¶¶43, 55, 67. Such identifiers were ubiquitous in wireless communication networks such as those “operating under the CDMA2000 family of standards, GSM networks, AMPS/TDMA networks, Wideband CDMA (or WCDMA) networks, IEEE802.xx networks, and GSM-1x networks.” EX1027, ¶¶3, 8. Example identifiers included an “Electronic Serial Number (ESN), a User Identity Module (UIM) ID, a Subscriber Identity Module (SIM) ID, or a Mobile Equipment Identifier (MEID).” *Id.*; *see also* EX1028, Abstract, 2:61-3:16 (describing a “Temporary Mobile Station Identification (TMSI) number” assigned by a base station).

The ’450 patent describes a “basic connection identification (BCID),” but this too was well-known in the art. EX1001, 8:37-42, 9:4-29; EX1029, ¶¶3, 11-13; EX1030, ¶¶12-13, 53; EX1003, ¶80. For example, the IEEE 802.16e standard used BCIDs to identify subscriber terminals serviced by a base station well before the ’450 patent. EX1029, ¶¶2-5, 44. It was well-known in the art to use a BCID to identify messages intended for a particular mobile device: “the terminal determines whether or not its own BCID has been included in [a] message received from the BS. If so, the corresponding terminal wakes up from the sleep mode and then is switched to the active mode.” *Id.*, ¶¶9-11. Otherwise, the mobile device remains in a sleep mode to reduce power consumption. *Id.*; EX1030, Abstract, ¶¶1-8. Thus, a base station assigning an identifier to a mobile device was well-known. EX1003, ¶¶78-80.

VI. THE '450 PATENT

A. Overview

Like the prior art, the '450 patent describes allocating time-frequency “zones” for OFDM communications. EX1001, Abstract. To define a zone or segment, the '450 patent uses a starting time-frequency coordinate and an “N”- value indicating the number of time-frequency units for the segment. *Id.*, 6:22-29 (“*using a one-dimensional offset with respect to the origin of the zone* rather than the two-dimensional” mapping) (emphasis added). Using these parameters allegedly reduces the number of bits needed to map a data stream to a time- frequency segment. *Id.*, 5:54-57. Both this technique and goal, however, were well- known in the art prior to the '450 patent. EX1003, ¶¶70-77.

Figure 3 depicts the basic structure for dividing a communication frame into a time and frequency domain. EX1001, 4:16-26. Figure 3 also depicts “basic resource units” having a time and frequency dimension. *Id.*, 6:49-51, 7:7-30; EX1003, ¶¶30-41.

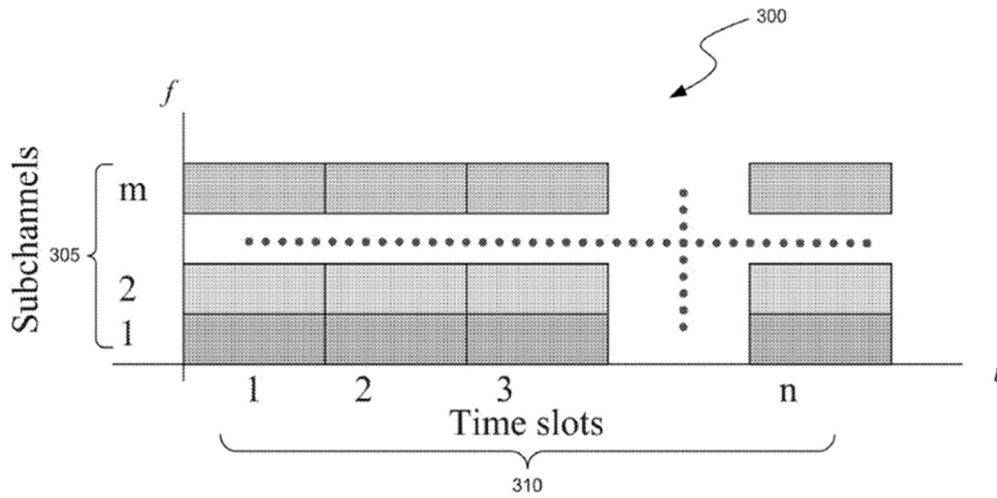


FIG. 3

EX1001, FIG. 3.

Figure 6 depicts grouping time-frequency resource units into zones and providing a time-frequency unit identification. EX1001, 2:32–33, 5:32–34.

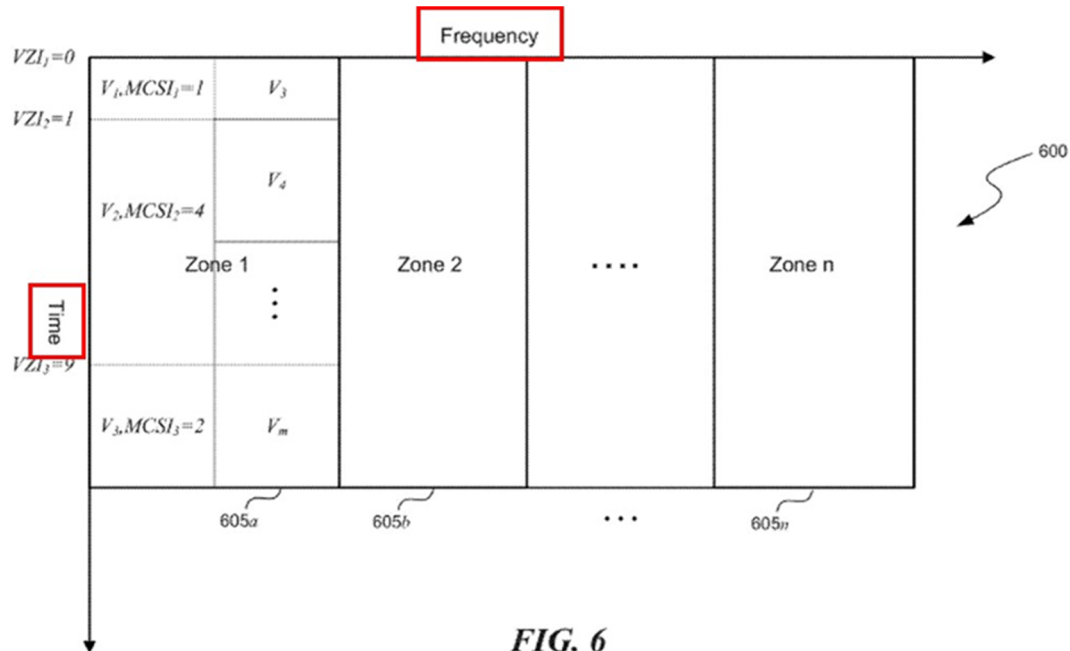


FIG. 6

EX1001, FIG. 6.

The zones in Figure 6 allegedly overcome the inefficiencies of the IEEE 802.16

standard by reducing the amount of control overhead. *Id.*, 5:34–57. To further reduce overhead, the '450 patent describes using a one-dimensional offset with respect to the origin of the zone rather than starting and ending time- frequency coordinates. *Id.*, 6:22–29.

To perform the mapping for a particular zone or segment, the '450 patent uses a “basic resource unit.” *Id.*, 6:45-52, 7:7-27. The '450 patent identifies the number of units for a segment using a modulation coding scheme (“MCS”) designation as seen in Table 1. *Id.*, 6:22-44, 7:7-39.

TABLE 1

MCSI	Modulation	Coding rate	Information bits	Raw symbols	Units
1	16QAM	$\frac{1}{2}$	160	80	1
2	QPSK	$\frac{1}{2}$	160	160	2
3	QPSK	$\frac{1}{4}$	160	320	4
4	QPSK	$\frac{1}{8}$	160	640	8

EX1001, 6:36-44 (Table 1).

As seen here, an MCSI of 1 indicates that one basic resource is used while an MCSI of 4 indicates that eight are used. *Id.*, 7:20-24; EX1003, ¶41. With this information, the '450 maps a segment using a starting point or coordinate and a number of basic time-frequency resource units. EX1001, 7:7-24.

As discussed below, however, at least Vijayan089 and Vijayan475 disclose this same technique and provide the same benefits touted in the '450 patent. *See* Sections

VIII.B.3, IX.B.3.

B. Prosecution Summary

The Examiner for the '450 patent did not analyze Vijayan089, Vijayan475, Laroia, Wu, or Choi in any rejection. In fact, no references are cited on the face of the '450 patent. EX1001. During prosecution, the Examiner issued one non-final office action rejecting the claims based on statutory double patenting in view of U.S. Patent No. 9,042,337. EX1002, 81-89. In response, the applicant canceled the original claims and submitted the claims that ultimately issued in the '450 patent. EX1002, 95-99. The Examiner did not provide any explanation as to why the '450 patent's claims were allowable. EX1002, 109-110, 114-115; EX1003, ¶¶42-46.

C. IPR2021-01486

On September 16, 2021, Dell Inc. filed a petition (IPR2021-01486) challenging all claims of the '450 patent (claims 1-18). EX1010, 1. The Petition included a single obviousness ground based on the combination of U.S. Patent Pub. No. 2005/0157803 to Kim *et al.* (EX1015) and IEEE Std 802.16, 2004 Edition (Oct. 1, 2004) (EX1016). EX1010, 1-2. Neo Wireless submitted a Preliminary Response supported by its own expert declaration. *See* EX1012, EX1013. The Board subsequently issued a decision denying institution. *See* EX1014.

In determining that the combination did not suggest a “time-frequency coordinate” or a “time-frequency resource unit,” the Board cited Neo Wireless's

argument that the “‘time-frequency’ resource unit [] transforms the time and frequency units into one combined dimension.” EX1014, 25-27 (citing EX1012, 10). The Board also referenced Neo Wireless’s argument that the ’450 patent uses “*two parameters to map a packet stream: the starting time-frequency coordinate and N, the number of time-frequency resource units.*” EX1014, 25-26 (citing EX1012, 10) (emphasis added). The Board indicated that the proposed combination did not teach these features and that Dell conflated “separate frequency subchannels and time slots as the recited singular ‘time-frequency resource’ and separate starting time and frequency coordinates as the recited singular ‘starting time-frequency coordinate.’” EX1014, 27.

D. Level of Ordinary Skill in the Art

A person of ordinary skill in the art (“POSITA”) 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. EX1003, ¶¶52-53.

E. Claim Construction

In *inter partes* review proceedings, a claim of a patent is construed using the same standard used in federal district court. *See* 37 C.F.R. § 42.100(b) (2018). Under that standard, claim terms are construed in accordance with their ordinary and customary meaning, as understood by one of ordinary skill in the art, and in view of

the patent specification and the relevant prosecution history. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-1313 (Fed. Cir. 2005) (*en banc*).

The '450 patent does not explicitly define any claim terms, and the claim terms recited in the challenged claims are sufficiently clear on their face. Thus, none of these terms require explicit constructions.

In a previous litigation, Neo Wireless argued that the term “configured to” should be construed as: “An apparatus/element is ‘configured to’ perform a function if it includes hardware and/or software enabling the apparatus/element to perform the function.” EX1020, 4. A POSITA would have understood this term to have its plain and ordinary meaning, but to the extent that this construction is adopted, the grounds of unpatentability presented below still render this claim element obvious. EX1003, ¶¶54-57.

VII. OVERVIEW OF THE APPLIED REFERENCES

A. Vijayan089

Similar to the '450 patent, Vijayan089 discloses an OFDM communication system with base stations and wireless devices as shown in Figure 1. EX1005, ¶¶36-37, 46-47, 107-11; EX1003, ¶¶81-89.

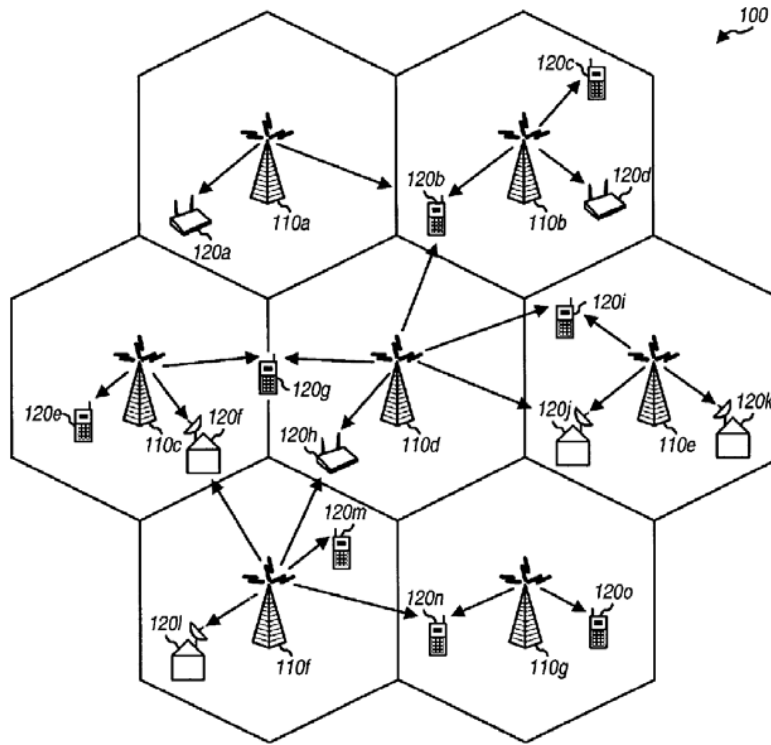


FIG. 1

EX1005, FIG. 1.

Vijayan089 also describes a frame structure for transmitting data from a base station to a wireless device. EX1005, ¶¶38-45, 48-49. Figure 2 depicts a “super-frame” that is composed of multiple “frames.” *Id.*, ¶¶38, 44-45.

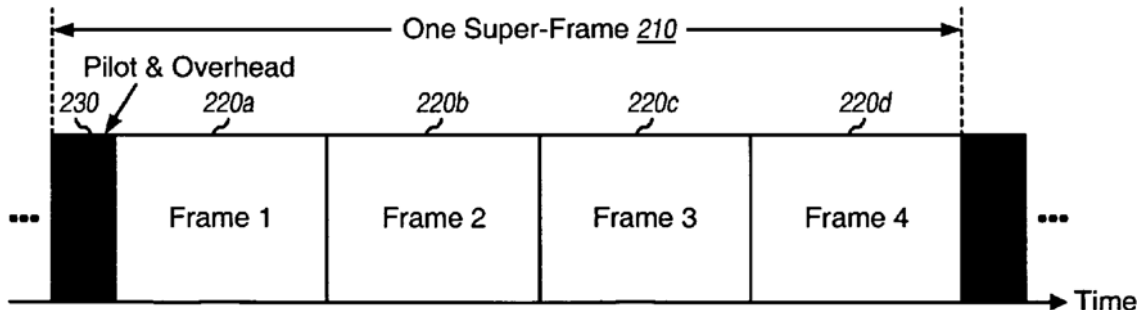


FIG. 2

EX1005, FIG. 2.

A frame is composed of “transmission units” that are defined as portions of a time and frequency plane. EX1005, FIG. 4, ¶¶46-47, 59-67. As seen in Figure 4, one transmission unit may correspond to a particular OFDM symbol period (time parameter) as well as a particular subband (frequency parameter). *Id.*, FIG. 4, FIG. 7A, FIG. 7B, ¶¶9, 11, 59, 68-76. Vijayan089’s “subbands” correspond to “subcarriers” that carry OFDM data. *Id.*, ¶5.

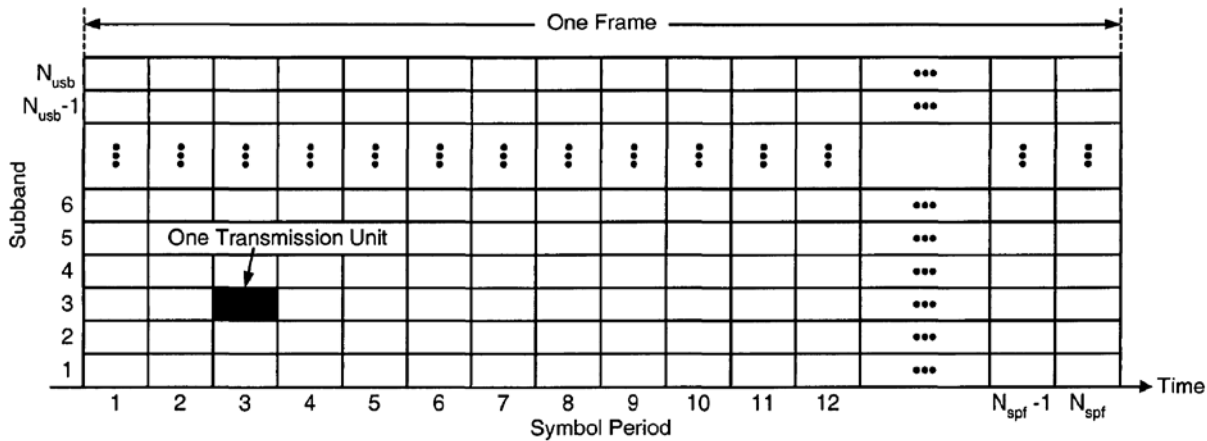


FIG. 4

EX1005, FIG. 4.

Vijayan089 also organizes transmission units into “transmission slots” in the “time-frequency plane,” where each transmission slot includes a group of subbands/subcarriers. EX1005, ¶59; *see also Id.*, ¶56. Vijayan089 groups these transmission slots into time-frequency segments corresponding to different communication channels, such as a “physical layer channel (PLC).” *Id.*, ¶¶37, 47. Figures 7A and 7B depict example PLC segments. *Id.*, ¶¶68-76.

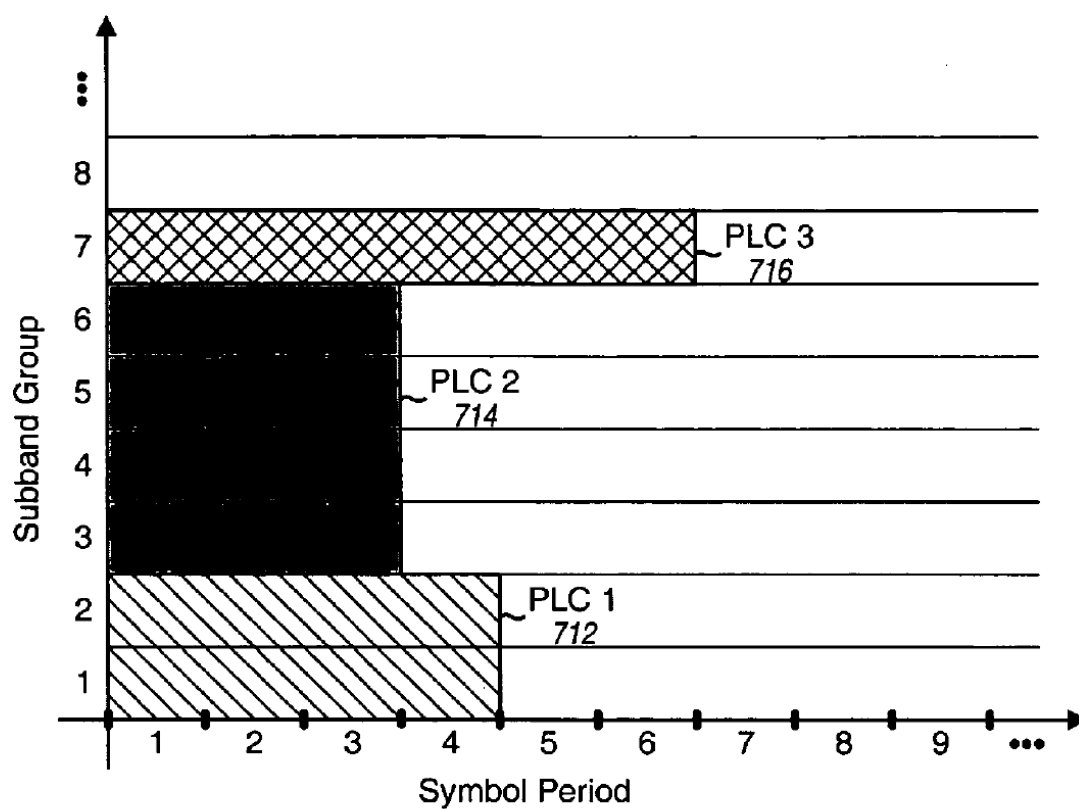


FIG. 7A

EX1005, FIG. 7A.

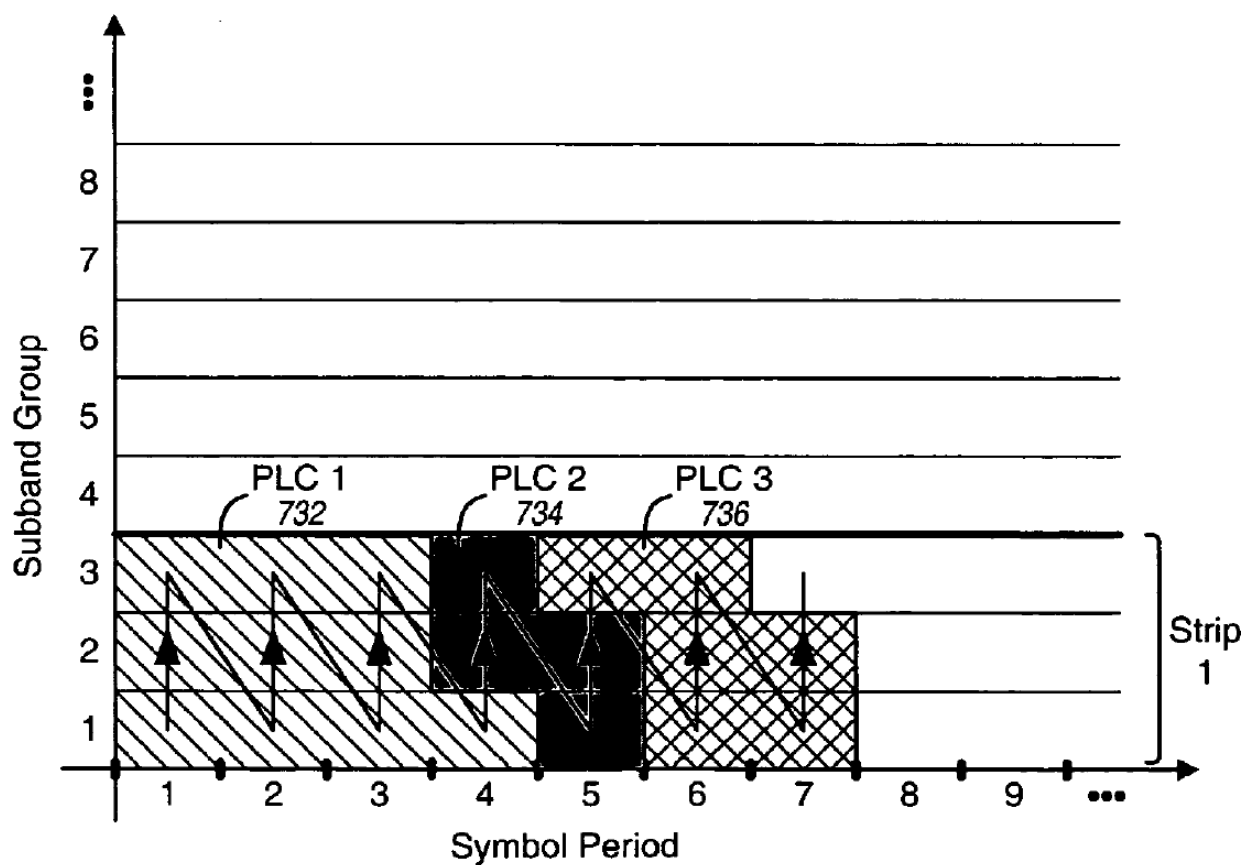


FIG. 7B

EX1005, FIG. 7B.

While “the segment assigned to each active PLC may include any number of slots,” the discussion below focuses on segment 734 corresponding to PLC 2.

EX1005, ¶74.

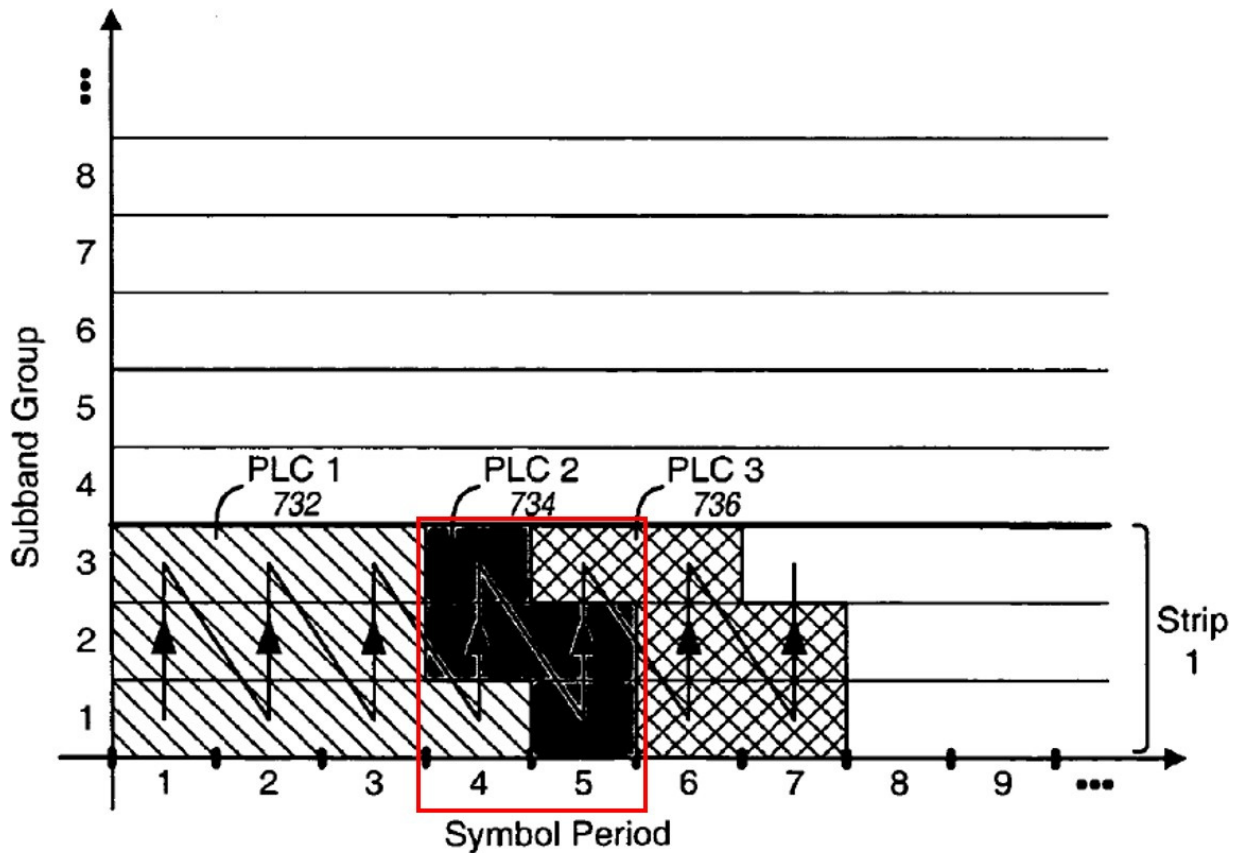


FIG. 7B

EX1005, FIG. 7B (annotated).

Segment 734 includes four transmission slots within a time interval corresponding to symbol periods four and five and has a starting coordinate of (symbol period = 4, subband group = 2). EX1005, ¶¶72-76; EX1003, ¶87. Like the '450 patent, Vijayan089 explicitly defines a segment of time-frequency resource using a starting coordinate and a number of transmission slots: an “assigned segment may 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.*” EX1005, ¶74 (emphasis

added).

Vijayan089 also explains that using two parameters “*reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC.*” *Id.*, ¶76 (emphasis added). Like the ’450 patent, Vijayan089 “effectively maps all of the slots in a two-dimensional (2-D) strip onto a one-dimensional (1-D) strip and then *performs 2-D slot assignment using one dimension.*” *Id.*, ¶74 (emphasis added).

Vijayan089 therefore discloses the same usage of time-frequency units and a starting time-frequency coordinate and N-value to inform a mobile device of an allocated time-frequency segment. *See* Section VIII.B.3; EX1003, ¶¶82-89.

B. Vijayan475

Vijayan475 includes different inventors from Vijayan089 and discloses a different process for conveying an allocated time-frequency resource segment. EX1003, ¶¶90-96.

Vijayan475 allocates a segment using a starting time-frequency coordinate and N-value, but Vijayan475 applies its process to a “multiplexed logical channel (MLC)” rather than the “physical layer channel (PLC)” described in Vijayan089. EX1006, ¶¶9, 36-42; EX1003, ¶90. As a result, Vijayan475 allocates time-frequency resource segments differently from Vijayan089. *See* Sections VIII.B.3, IX.B.3; EX1003, ¶90. Specifically, Vijayan475 uses “Start Offset,” “Slot Info,” and “Stream Lengths” parameters to define a starting time-frequency coordinate and N-value. *See* Section

IX.B.3; EX1006, ¶¶40, 42, 45-47, 56.

With that said, Vijayan475 is generally directed to OFDM communications and uses a frame structure for communications. EX1006, FIG.1, ¶¶26-27, 67-75.

Vijayan475 discloses a “super-frame” composed of multiple “frames” as depicted in Figure 2. *Id.*, FIG. 2, Abstract, ¶¶10, 12, 29-32, 37-42, 45, 56-59.

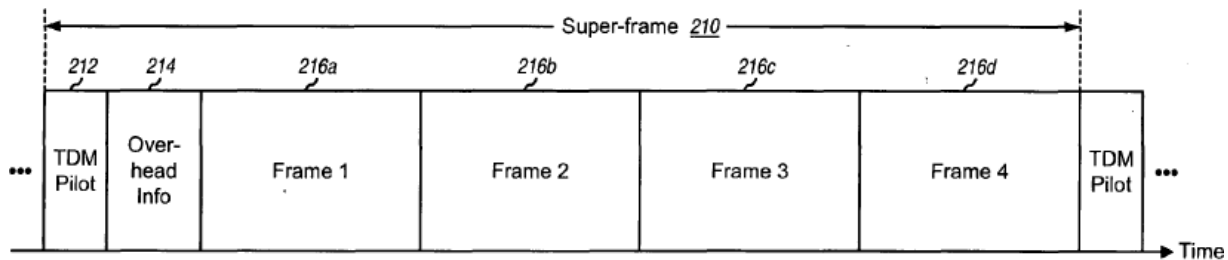


FIG. 2

EX1006, FIG. 2.

Each frame includes “slots” defined on a time-frequency plane. EX1006, FIG. 4, ¶¶36-42, 45-49, 56-57. Figure 4 depicts an example frame that carries an assigned “MLC x” segment for communications. *Id.*, ¶¶40, 42, 45-49, 56. “MLC x is assigned 16 slots.” *Id.*, ¶40.

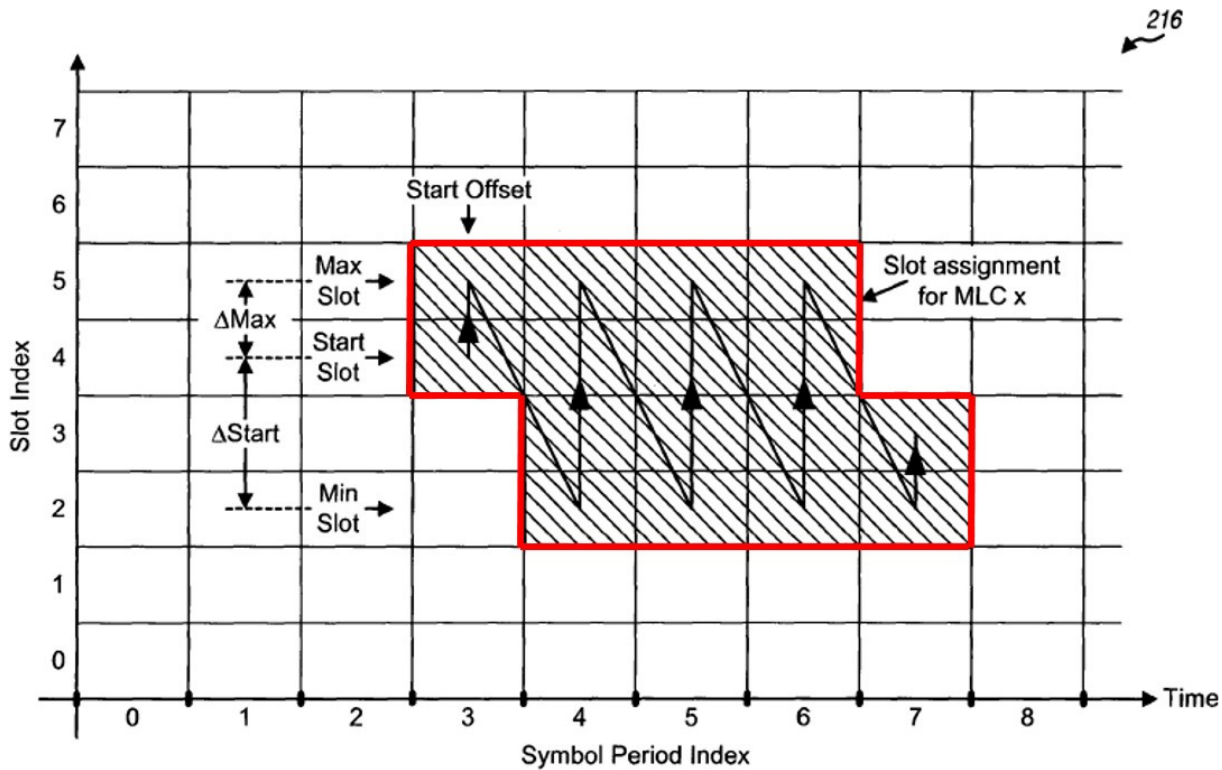


FIG. 4

EX1006, FIG. 4 (annotated).

“Each MLC may be ‘allocated’ a fixed or variable number of slots in each super-frame.” EX1006, ¶38. Figure 4 depicts a time value (Symbol Period Index) in the horizontal axis and a frequency value (Slot Index value identifying groups of subbands/subcarriers) in the vertical axis. *Id.*, FIG. 4, ¶¶25, 36, 40, 46.

To define a segment, Vijayan475 uses “Start Offset” and “Slot Info” parameters to identify a starting time-frequency coordinate corresponding to a “Start Slot.” *Id.*, ¶¶40, 42, 45-47, 56. Vijayan475 also uses a “Stream Lengths” parameter to determine the “number of slots allocated to the MLC.” *Id.*, ¶¶40, 45, 51-52, 54-55. Vijayan475

summarizes these parameters in Table 1:

TABLE 1		
<u>MLC Present = '1' (active MLC)</u>		
Starting Time-Frequency Coordinate Parameters	Start Offset	Indicate the starting symbol period index for the slots assigned to the MLC.
	Slot Info	Contain parameters describing the slots assigned to the MLC.
	Stream Lengths	Contain the length of each stream layer packet carried by the MLC in the current super-frame.
<u>MLC Present = '0' (inactive MLC)</u>		
	Next Super-frame Offset	Indicate the next super-frame in which the MLC may be sent.
	Reserved	Padding to make the location record a fixed size.

EX1006, ¶45 (Table 1, annotated).

Like the '450 patent, Vijayan⁴⁷⁵ also endeavors to reduce the amount of overhead signaling needed to convey a resource allocation to a wireless device via the use of an encoding scheme. EX1006, ¶¶38, 40, 42, 46-49, 55; EX1003, ¶¶90- 96.

C. Laroia

Laroia describes an OFDM base station assigning wireless terminal identifications to wireless terminals to route transmitted messages. EX1007, ¶¶38, 40, 53, 65, 109-11. Laroia describes “terminal identification (ID) information” which “may be a base station assigned ID for [Wireless Terminal] WT 1.” *Id.*, ¶38. The “WT identification information” allows a wireless terminal to identify that it “is the specific

intended recipient” for a particular message. *Id.*, ¶¶40, 53; *see also Id.*, FIG. 2, FIG. 3, ¶¶38-39, 49, 58; EX1003, ¶¶97-99.

D. Wu

Wu also describes an OFDM system where base stations communicate messages to wireless devices (“user equipment” or “UE”). EX1008, Abstract, ¶¶33-34, 87, 94, 98; EX1003, ¶¶100-102. Wu describes a base station assigning a “*sixteen bit UE identifier 165*” to each UE to route messages. EX1008, ¶¶94, 98. The UE identifier “*identifies which receiver is to receive* the current [downlink] content.” *Id.* (emphasis added); *see also Id.*, ¶¶4, 87, 134. This UE identifier identifies the “OFDM slots ... for a given receiver.” *Id.*, ¶¶20-21, 94, 128. Wu’s base station provides the UE identifier via a control channel that includes “identifiers for each receiver scheduled during the slot and an indication of which sub-carriers are for which receiver.” *Id.*, ¶¶33-34. The UE receiver then demodulates the “OFDM slot only if scheduled during the slot.” *Id.*, ¶¶25, 50.

E. Choi

Choi describes enhancing wirelessly communicated data using “*repetition encoding*.” EX1009, Abstract (emphasis added); EX1003, ¶¶103-105. This repetition coding may improve “error correction” and provide a “more robust data transmission scheme at reduced data rates.” EX1009, ¶2. Choi’s repetition coding can be applied to OFDM symbols in the time domain and/or frequency domain. *Id.*, ¶¶13, 16-18. This

simply involves repeating the OFDM symbols “a desired number of times.” *Id.* Choi also discloses repeating encoded data in both the time and/or frequency domains. *Id.*, ¶¶13, 51.

VIII. GROUND 1: CLAIMS 1-5, 7-11, AND 13-17 ARE OBVIOUS OVER VIJAYAN089 AND LAROIA

Vijayan089 and Laroia disclose each and every limitation of claims 1-5, 7- 11, and 13-17. EX1003, ¶¶106-189. Vijayan089 expressly discloses using time- frequency “transmission units” or “transmission slots” to allocate resources and using a starting time-frequency coordinate and an N-value of transmission slots. *See* Section VIII.B.3.

Laroia expressly assigns an identifier to a wireless terminal so that it can discern its own messages intended for reception. EX1003, ¶¶107-116, 134-137. A POSITA would have found it obvious and would have been motivated to combine Vijayan089 and Laroia to also provide this capability in Vijayan089’s system. *Id.*

A. A POSITA Would Have Been Motivated to Combine Vijayan089 and Laroia

A POSITA would have been motivated to implement Laroia’s assignment of a wireless device identifier with Vijayan089’s OFDM communication system. EX1003, ¶¶108-116. Vijayan089 discloses “unicast communications,” which already suggests the use of an identifier to differentiate between multiple wireless devices. EX1005, ¶¶6-7, 35. To implement unicast transmissions or to communicate data to a specific wireless device, a POSITA would have used an identifier to specifically identify that

wireless device. EX1003, ¶¶108-110. Despite this understanding, Vijayan089 does not explicitly discuss types of identifiers or how to implement such identifiers. *Id.* A POSITA would have therefore sought references that taught techniques for implementing wireless device identifiers. *Id.* Laroia is such a reference. *Id.*; EX1007, ¶¶40, 53, 63; Section VIII.B.2.

Laroia explains that using wireless terminal identifiers beneficially allows wireless devices to differentiate and identify their own respective messages for reception. EX1005, ¶¶6-7, 35; EX1007, ¶¶38, 40, 53, 63. Indeed, using such an identifier was already well-known in the art. EX1003, ¶¶78-80; Section V.C. Implementing a wireless device identifier within Vijayan089's system would also further Vijayan089's goal of "minimiz[ing] power consumption" and having a wireless device that powers on "only when the desired data stream is transmitted." EX1005, ¶¶7-9, 11, 44, 61. In fact, both references describe this same goal. *See* EX1007, Abstract, ¶¶3, 6, 63-64; EX1003, ¶¶110-112. Thus, a POSITA would have been motivated to combine Laroia and Vijayan089 to provide these benefits. EX1003, ¶¶110-112.

Combining Vijayan089 and Laroia would have amounted to combining well-known prior art elements to yield predictable results. *Id.*, ¶¶113-114. Assigning a wireless device identifier was a well-known technique in the prior art used to allow a mobile device to discern its own intended messages. *Id.*; Section V.C. In view of this

ubiquitous usage, a POSITA would have had a reasonable expectation of success in combining Vijayan089 and Laroia to facilitate wireless transmissions—especially in view of both references describing conventional OFDM base stations and wireless devices. *See* EX1005, FIG. 1, FIG. 11, FIG. 12, ¶¶5, 36-37, 107-11; EX1007, FIG. 1, FIG. 2, FIG. 3, ¶¶32-35, 38-42; EX1003, ¶¶113-114.

This combination would have been predictable and would have operated to perform its intended purposes in view of their common OFDM configuration. EX1003, ¶¶113-116. In the combined system, the base station would have used the identifier to specify the resource allocation parameters for a particular wireless device. EX1005, ¶¶11, 44, 74, 76, 106, 110. The wireless device would have then used the identifier to discern its assigned transmission slots—defined via a starting time-frequency coordinate and N-value—and recover its respective data. *See* Section VIII.B.5; EX1003, ¶¶113-116. Thus, implementing a wireless device identifier in Vijayan089’s system would have merely amounted to using a known technique to improve similar devices in the same way. EX1003, ¶¶113-116.

B. Claim 1

1. [1-pre]

Vijayan089 describes the same operating method and wireless network recited in claim 1. EX1003, ¶¶117-129.

a. Vijayan089 discloses “a wireless network comprising at least a base station and a mobile station”

As seen from Figure 1, Vijayan089 discloses a “wireless multi-carrier broadcast system 100” that includes “base stations 110” and “wireless devices 120.” EX1005, ¶¶36-37; EX1003, ¶118.

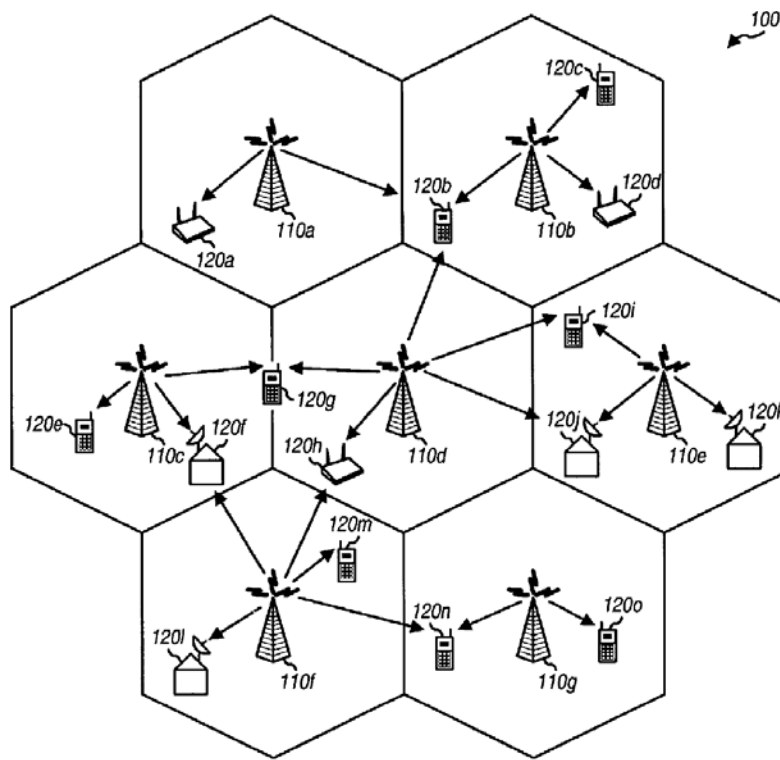


FIG. 1

EX1005, FIG. 1.

Figures 11 and 12 depict a base station and wireless device respectively. EX1005, ¶¶107-111; EX1003, ¶¶119. Vijayana089 also states that the “wireless device” may refer to a “mobile station.” EX1005, ¶36.

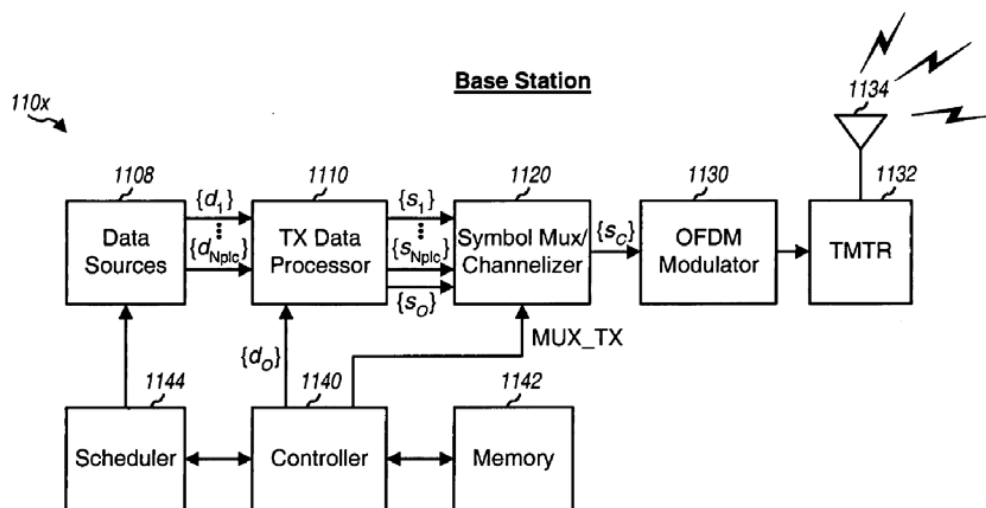


FIG. 11

EX1005, FIG. 11.

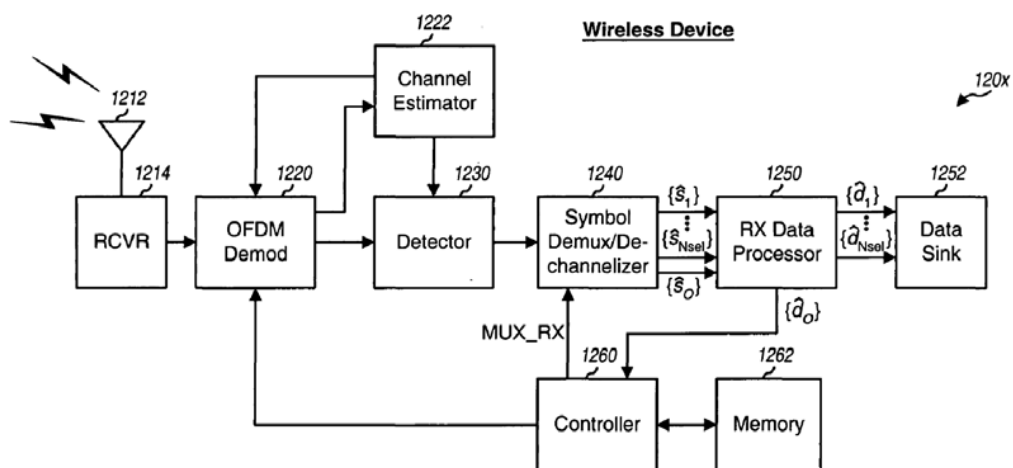


FIG. 12

EX1005, FIG. 12.

Vijayan089's base stations and mobile stations communicate wirelessly to disclose the claimed "wireless network" as depicted in Figure 1. EX1003, ¶120.

b. Vijayan089 discloses "employing a frame structure of multiple frames for transmission"

As depicted in Figure 2, Vijayan089 utilizes a "Super-Frame 210" that includes multiple frames for transmission of OFDM signals. EX1005, ¶¶38-45, 48- 49, 58-59; EX1003, ¶¶121-122. A super-frame can be "divided into multiple (e.g., two, four, or some other number of) frames." EX1005, ¶¶10, 38.

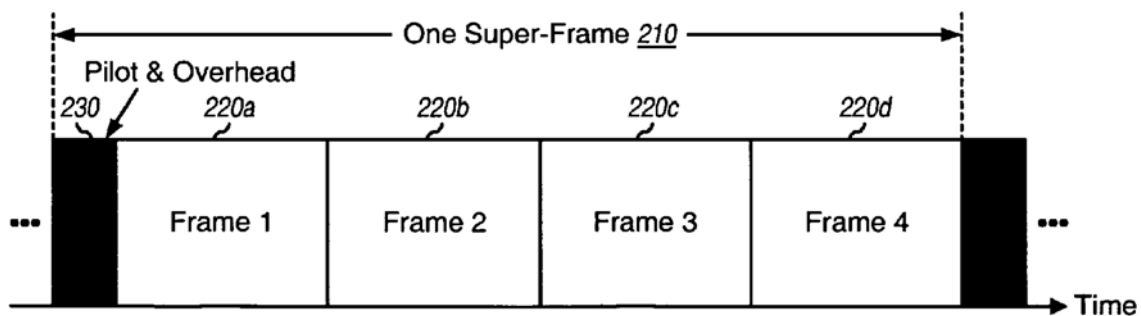


FIG. 2

EX1005, FIG. 2.

Figure 4 depicts a specific frame with time and frequency ("subband") components. EX1005, ¶¶46-47.

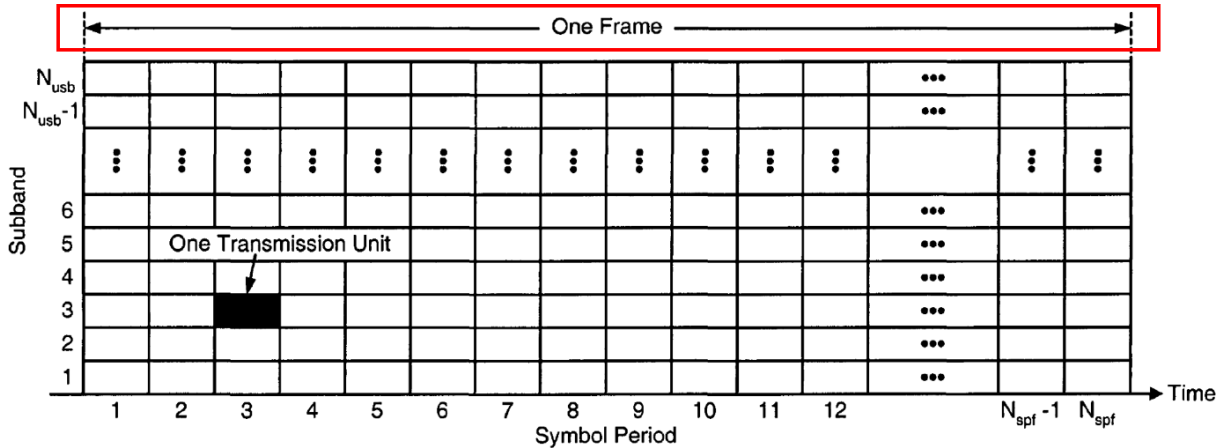


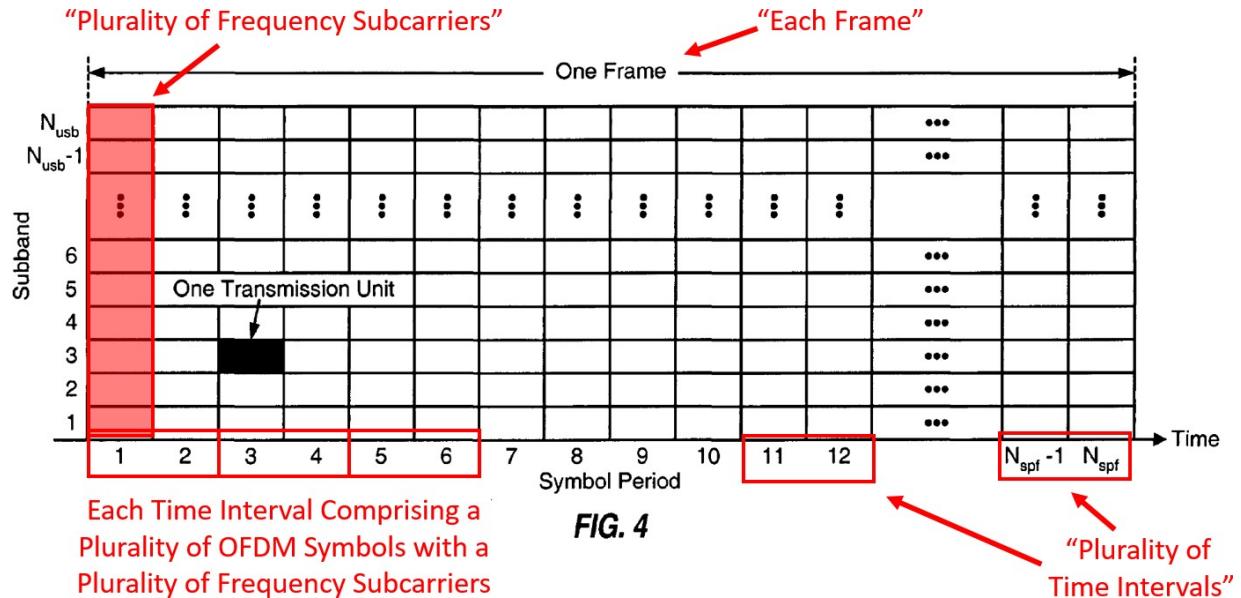
FIG. 4

EX1005, FIG. 4 (annotated).

Vijayan089 also describes using time-frequency “transmission units” within the super-frame structure to transmit data as well. *See* Section VIII.B.3; EX1003, ¶¶122-124. “Each data stream may be ‘allocated’ a variable number of transmission units in each super-frame.” EX1005, ¶11. These transmission units are located within each super-frame and carry transmitted data. *Id.*; *see also Id.*, ¶¶59-67; EX1003, ¶¶122-124.

- c. **Vijayan089 discloses “each frame comprising a plurality of time intervals, each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and each OFDM symbol containing a plurality of frequency subcarriers”**

Vijayan089’s frame discloses each of the frame elements recited in the preamble. As annotated below, Figure 4 demonstrates how Vijayan089’s frame discloses these elements. EX1005, FIG. 4, ¶¶46-47, 59-67; EX1003, ¶125.



EX1005, FIG. 4 (annotated).

“FIG. 4 shows the structure of one frame on a time-frequency plane. The horizontal axis represents time, and the vertical axis represents frequency.” EX1005, ¶46. Any grouping of symbol periods in Figure 4 discloses a “time interval” as recited in the claim. *Id.*, ¶¶59, 70-77 (describing “contiguous symbol periods”); EX1003, ¶126. Vijayan089’s time intervals are measured “in units of OFDM symbol periods... Each OFDM symbol period is the time duration to transmit one OFDM symbol.” EX1005, ¶46. A time interval would have encompassed any number of OFDM symbol periods as described in Vijayan089. EX1003, ¶¶126-127; EX1005, FIG. 4, ¶¶59, 70-77. For example, a length of time encompassing two symbol periods (i.e., a time interval as depicted in Figure 4) would encompass two OFDM symbols. EX1003, ¶¶126-127; *see also* Section VIII.B.3.b. Vijayan089 therefore discloses time intervals

that encompass a plurality of OFDM symbols. EX1003, ¶¶126-127. Additionally, as annotated in Figure 4, Vijayan089 discloses a plurality of time intervals.

Within each time interval, there are a plurality of OFDM symbols with each OFDM symbol containing a plurality of frequency subcarriers: within “each OFDM symbol period, N_{dsb} data symbols may be sent on the N_{dsb} data subbands.” EX1005, ¶47. This discloses a plurality of subbands or frequency subcarriers. *Id.*, ¶¶5, 37, 46-47, 59; EX1003, ¶¶128-129.

2. [1A]

Vijayan089 allocates transmission units via a “unicast transmission [that] is sent to a specific wireless device.” EX1005, ¶¶6-7, 35. A base station informs the particular wireless device of the allocation using “overhead signaling” that identifies the “time-frequency location of each desired data stream.” *Id.*, ¶11; *see also Id.*, ¶44. Vijayan089 also allows a wireless device “to recover each data stream independently, without having to process the other data streams being transmitted simultaneously.” *Id.*, ¶¶9, 106. To provide unicast transmissions and independent data stream recovery, a POSITA would have found it obvious for Vijayan089 to have assigned an identifier to each wireless device. *Id.*, ¶¶6-7, 9, 11, 35; EX1003, ¶¶130-133. Otherwise, it would be more difficult for each wireless device to discern its own respective data stream for recovery. EX1003, ¶¶130-133.

To the extent that it is argued that Vijayan089 does not render [1A] obvious,

Laroia explicitly discloses this feature. Laroia assigns an identifier to a wireless terminal (WT) in an OFDM system. EX1007, ¶¶38, 40. Specifically, Laroia describes “terminal identification (ID) information” which “may be a *base station assigned ID* for WT 1.” *Id.*, ¶38 (emphasis added). The “WT identification information” allows a wireless terminal to identify that it “is the specific intended recipient” for a particular message. *Id.*, ¶¶40, 53; *see also Id.*, FIG. 2, FIG. 3, ¶¶38- 39, 49, 58; EX1003, ¶¶134-137.

With respect to Figure 5, Laroia described a WT using the WT identifier to identify a corresponding message. EX1007, ¶¶63-65.

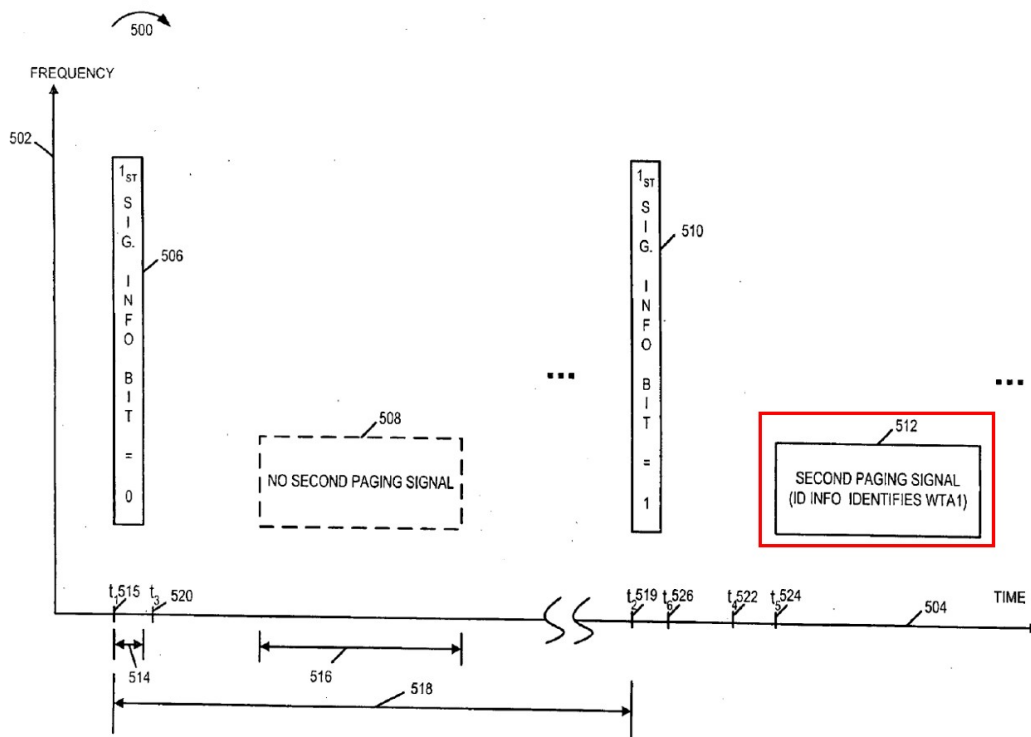


FIGURE 5

EX1007, FIG. 5 (annotated).

Here, there are “two users, WTA1 and WTA2, which both monitor the downlink channel” for paging signals. EX1007, ¶63. The base station, however, may only have a message for WTA1. *Id.* To indicate the desired WT for reception, the “***paging signal 512 includes the paging identifier of user WTA1.***” *Id.* (emphasis added). WTA1 processes the message while WTA2 returns to a sleep state because its own identifier does not match. *Id.* Thus, Laroia assigns an identifier to identify a particular wireless terminal. EX1003, ¶¶134-136.

A POSITA would have been motivated to combine Vijayan089 and Laroia for the reasons previously explained. *See* Section VIII.A; EX1003, ¶137.

3. [1B]

Vijayan089 discloses transmitting a signal “from the base station to the mobile station over a segment of time-frequency resource” as claimed. *See* EX1005, FIG. 4, ¶¶11, 59, 72-76; EX1003, ¶¶138-154. Specifically, Vijayan089 discloses that an “assigned segment may 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.***” EX1005, ¶74 (emphasis added).

Vijayan089 also provides the same overhead reduction benefits described in the ’450 patent by “reduc[ing] the amount of overhead signaling needed to indicate the specific slots assigned to each active [communication channel].” *Id.*, ¶¶74, 76. Thus, Vijayan089 discloses both [1B] and the same alleged benefits. EX1003, ¶138.

a. Vijayan089 discloses “transmitting a signal containing information from the base station to the mobile station over a segment of time-frequency resource”

Vijayan089 describes the same base station and mobile station configuration described in claim 1. *See* Section VIII.B.1; EX1003, ¶139. Using “transmitter unit 1132,” Vijayan089’s base station transmits OFDM “data streams to be individually recovered” by a wireless device. EX1005, ¶¶9, 108. The wireless device then “receives the modulated signal” and identifies the transmitted OFDM symbols. *Id.*, ¶¶109-110.

Vijayan089’s base station also transmits the OFDM symbol information “over a segment of time-frequency resource” as claimed. *See Id.*, FIG. 4, ¶¶9, 11, 59, 72-76. Vijayan089 describes transmitting data over “transmission units” or “transmission slots,” which disclose the claimed “time-frequency resource.” *Id.* “[E]ach transmission unit corresponds to one subband in one symbol period and may be used to transmit one data symbol.” *Id.*, ¶9. Therefore, each transmission unit is a resource having a time component (symbol period) and frequency component (subband). EX1003, ¶140. Figure 4 depicts a transmission unit. EX1005, ¶¶46, 59-60, 67.

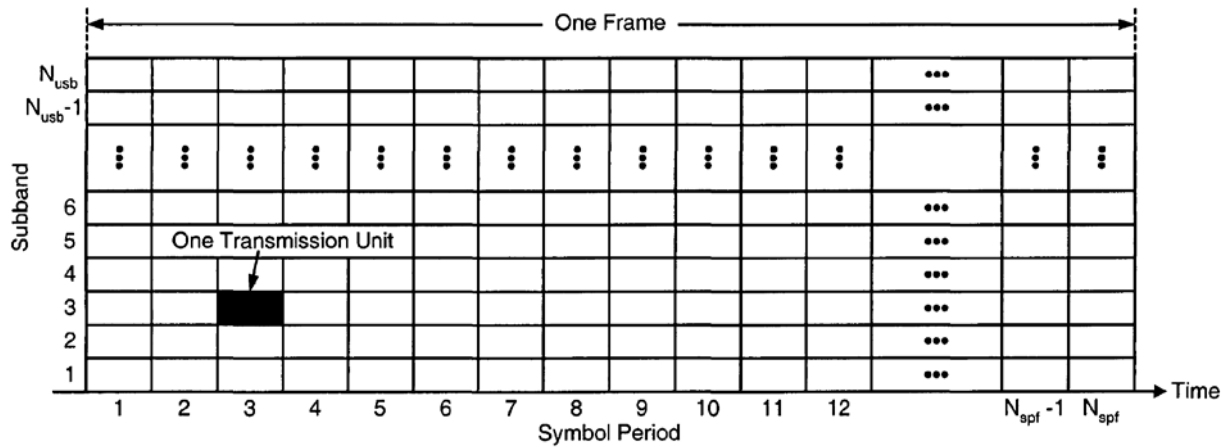


FIG. 4

EX1005, FIG. 4.

Vijayan089 also groups “transmission units” or “transmission slots” into a “physical layer channel (PLC).” EX1005, ¶37. “[E]ach active PLC may be given in units of ‘transmission slots’ (or simply, ‘slots’). A slot corresponds to one group of (e.g., 500) data subbands or, equivalently, one group of modulation symbols in one symbol period.” *Id.*, ¶59. Figures 7A and 7B depict examples of transmission slots grouped into PLC segments. *Id.*, ¶¶68-76; EX1003, ¶141.

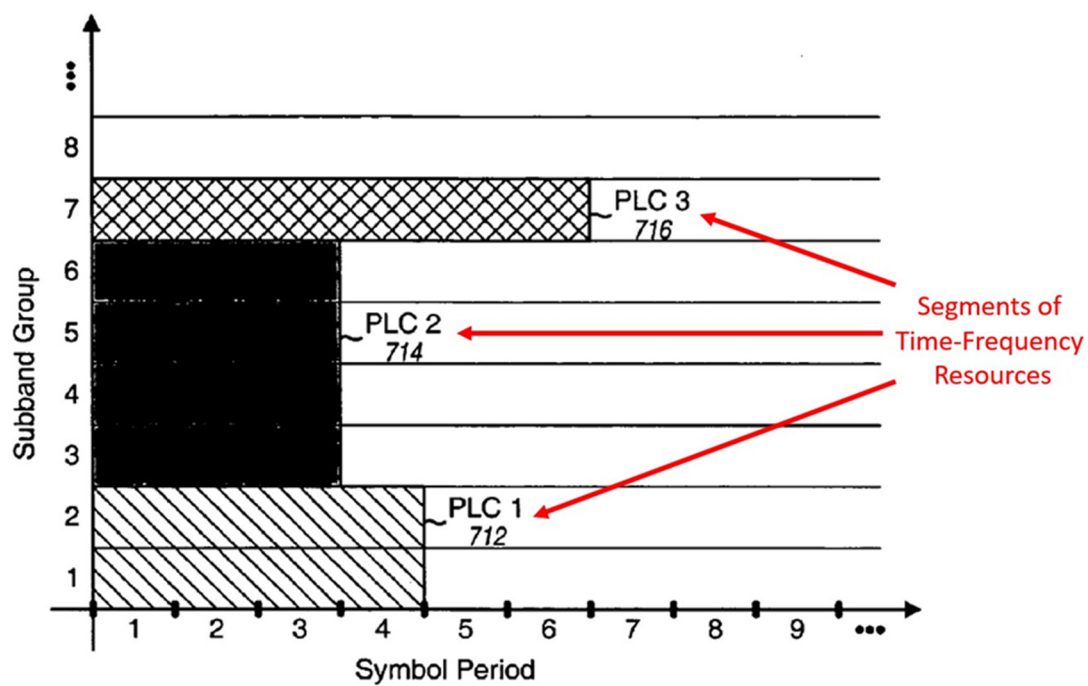


FIG. 7A

EX1005, FIG. 7A (annotated).

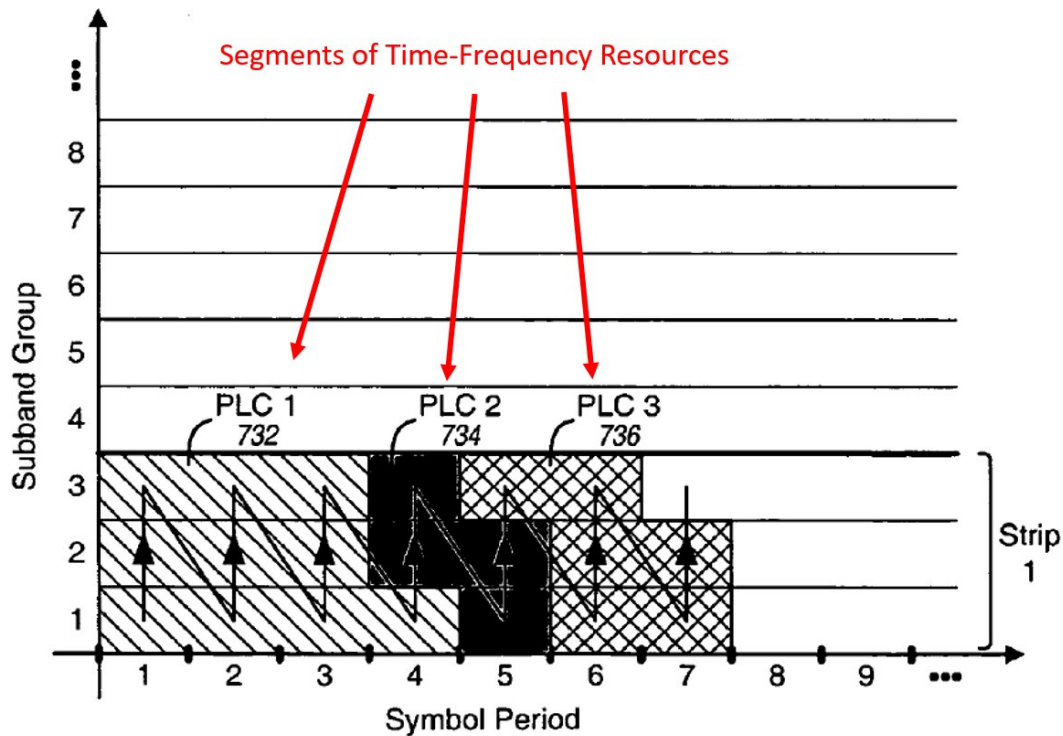


FIG. 7B

EX1005, FIG. 7B (annotated).

Vijayan089's PLC segment therefore discloses the claimed "segment of time-frequency resource." *See, e.g., id.*, ¶¶73; EX1003, ¶¶142-143.

Each PLC segment also has a "one-to-one relationship" with a corresponding data stream. EX1005, ¶37; EX1003, ¶¶142-143. Thus, the PLC segments are composed of transmission units or transmission slots, which are defined in a "time-frequency plane" and therefore disclose the claimed "time-frequency resource." EX1005, FIG. 4, FIG. 7A, FIG. 7B, ¶¶9, 11, 46, 59, 68-76; EX1003, ¶¶139-143.

- b. Vijayan089 discloses “the segment having a starting time-frequency coordinate and the segment comprising N time-frequency resource units within a time interval ... where N=2, 4, or 8”**

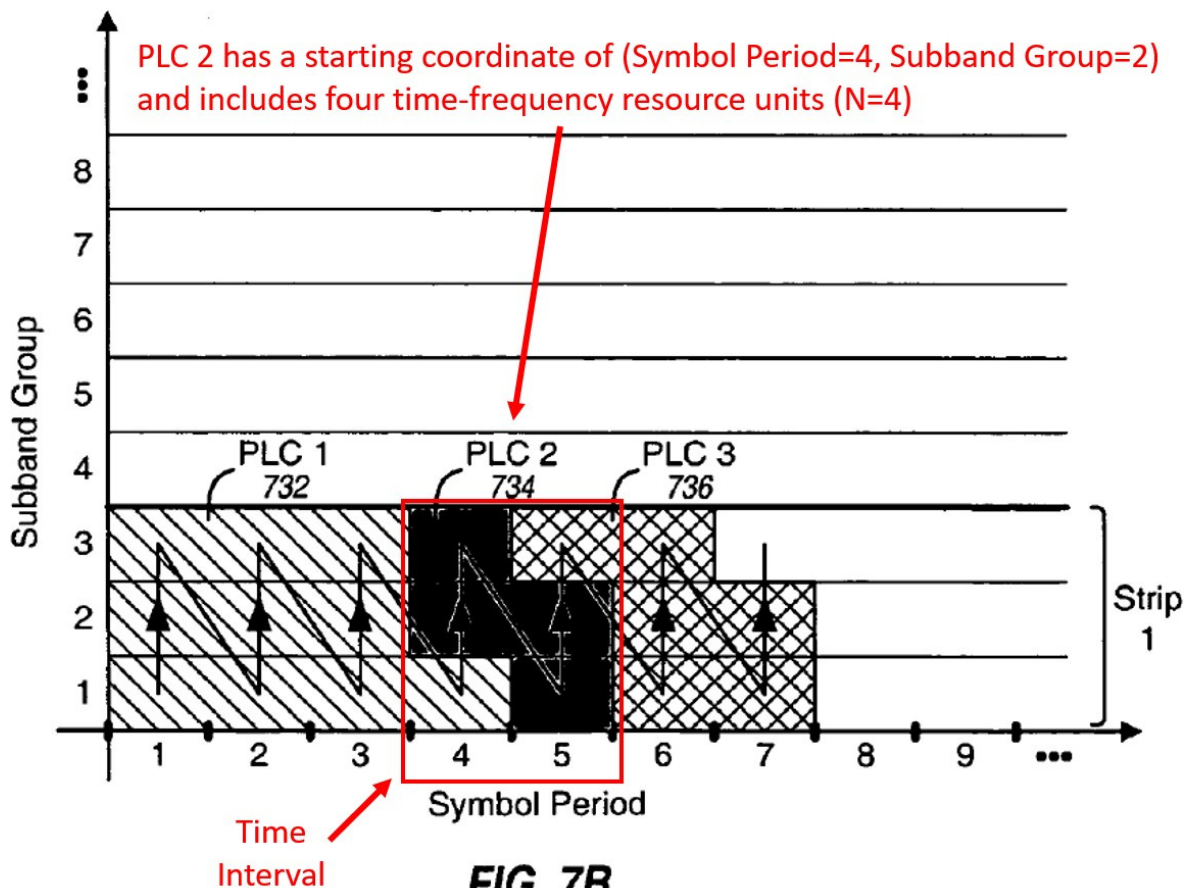
Vijayan089 explicitly states that an “assigned segment may be *specified by two parameters: the start of the segment* (which may be given by *the starting subband and symbol period*) and the *length of the segment*.” EX1005, ¶74 (emphasis added). The “start of the segment” parameter (e.g., the starting subband and symbol period) discloses the claimed “starting time-frequency coordinate.” EX1003, ¶¶144-145.

Additionally, Vijayan089 explains that a PLC segment “may include any number of slots,” such as the 2, 4, or 8 specified in the claim. EX1005, ¶74; EX1003, ¶¶144-145. “However, less overhead signaling is required to identify the assigned segments if the segment sizes are constrained to be in multiple (e.g., 2 or 4) slots.” EX1005, ¶74. As such, Vijayan089 discloses that the “length of the segment” being 2, 4, or 8 slots. *Id.*; EX1003, ¶¶144-145.

Vijayan089 further discloses that its slot assignment scheme “*reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC*.” EX1005, ¶76 (emphasis added). Vijayan089 “maps *all of the slots in a ... 2-D slot assignment using one dimension*”—i.e., the “length of the segment.” EX1005, ¶74 (emphasis added); EX1003, ¶¶146-148. This single dimension of a number of slots discloses the claimed number of “time-frequency resource units.”

EX1003, ¶¶146-148. Therefore, Vijayan089’s “length of the segment”—having 2, 4, or 8 slots—discloses the claimed “N time-frequency resource units within a time interval ... where N=2, 4, or 8.” *Id.*; EX1005, ¶74. Vijayan089 therefore discloses the same technique recited in [1B] and the same benefit disclosed the ’450 patent. *See* EX1001, Abstract, 2:45-57, 5:24-31; EX1003, ¶¶146-148.

As an example, Vijayan089 discloses “segment 734” corresponding to “PLC 2” in Figure 7B, which discloses the claimed “segment of time-frequency resource.” EX1005, ¶¶67, 72-76; *see also Id.*, ¶¶9, 11, 59, 68-71; EX1003, ¶¶149-151.



EX1005, FIG. 7B (annotated).

Segment 734 includes a starting time-frequency coordinate of: Symbol Period = 4, Subband Group = 2. EX1005, FIG. 7B, ¶73. Segment 734 also has four (i.e., N = 4) time-frequency resource units depicted as four transmission slots (colored in black). *Id.* (“PLC 2 is assigned a segment 734 containing **4 slots**.”). These four transmission slots are located within the time interval defined by symbol periods 4 and 5. *Id.*; EX1003, ¶¶149-151.

c. Vijayan089 discloses “each unit containing a set of frequency subcarriers in a group of OFDM symbols”

Vijayan089’s “transmission slot” discloses the claimed “unit.” EX1003, ¶152; Section VIII.B.3.b. A particular transmission slot or subband group includes “**one group of (e.g., 500) data subbands**.” EX1005, ¶59; *see also Id.*, ¶¶56, 87. As seen in Figure 7B, each transmission slot has a corresponding “subband group,” which discloses a “set of frequency subcarriers.” *Id.*, ¶¶56, 59, 87; EX1003, ¶¶152- 154.

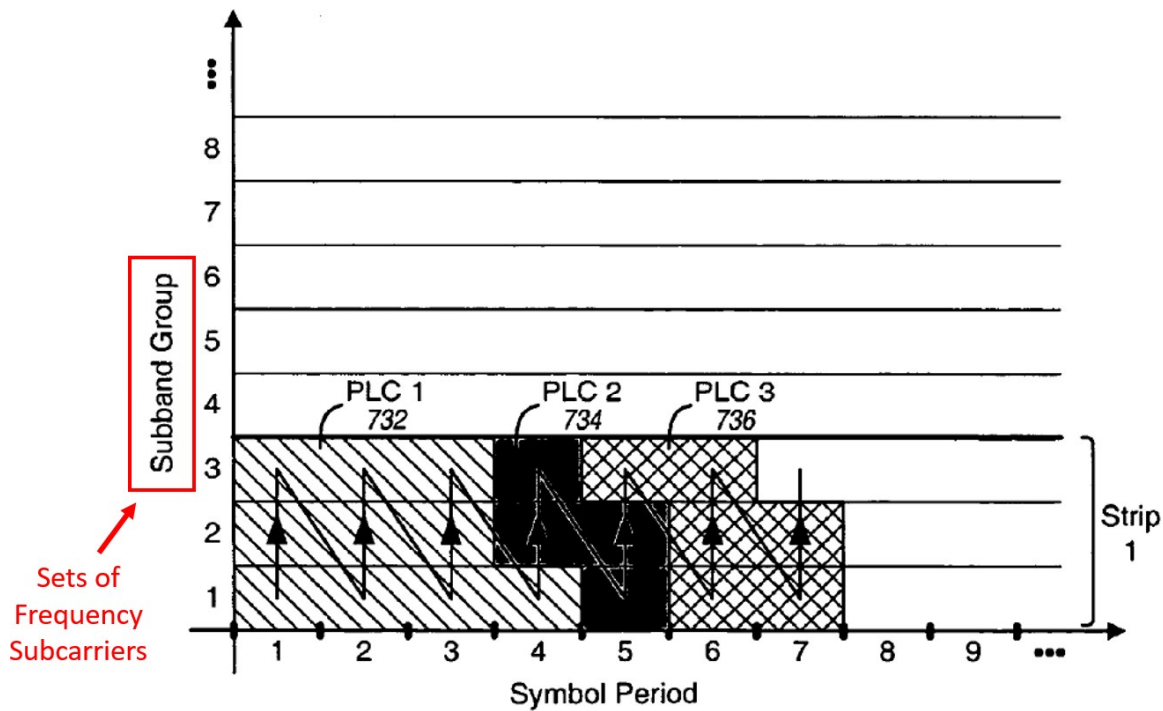


FIG. 7B

EX1005, FIG. 7B (annotated).

Each group of subbands transmits OFDM symbols. EX1005, ¶¶5, 59; *see also* Section VIII.B.1.c; EX1003, ¶¶152-154. “With OFDM, one modulation symbol may be sent on each subband in each symbol period.” EX1005, ¶47. Each slot may then transmit a “*group of modulation symbols* in one symbol period.” *Id.*, ¶59.

4. [1C]

Vijayan089 discloses a wireless device (*i.e.*, the claimed “mobile station”) receiving transmitted information signals from a base station. EX1005, FIG. 12, ¶¶109-111; *see also* Section VIII.B.1.a. Figure 12 depicts wireless device 120x including an antenna 1212 and receiver unit 1214. EX1005, ¶109.

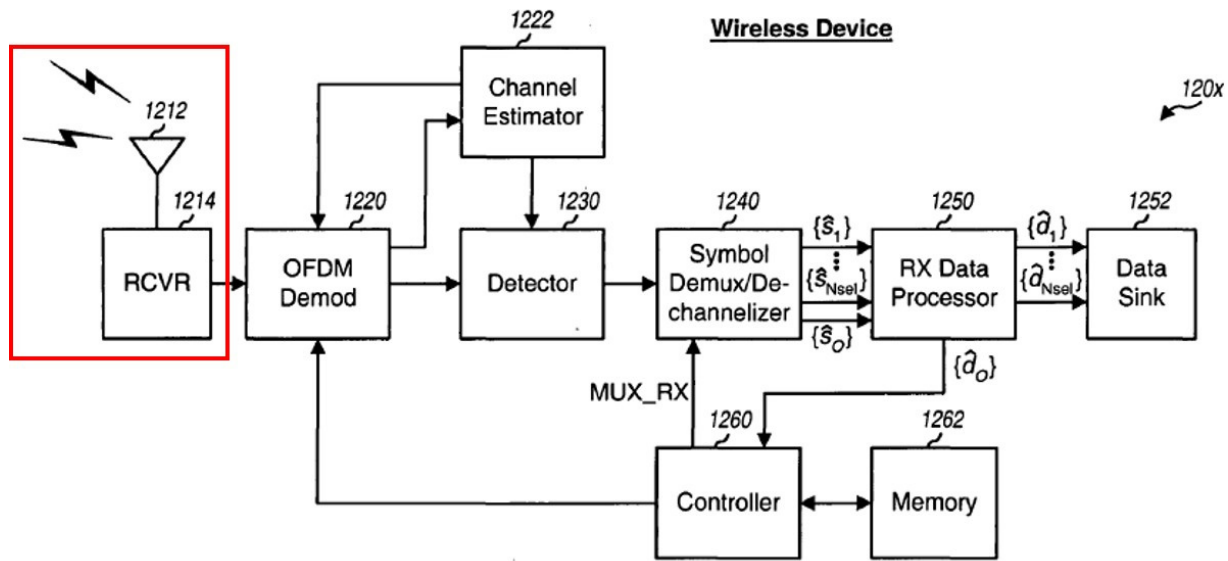


FIG. 12

EX1005, FIG. 12 (annotated).

“[A]ntenna 1212 receives the modulated signal transmitted by base station 110x and provides a received signal to a receiver unit (RCVR) 1214. Receiver unit 1214 conditions, digitizes, and processes the received signal.” EX1005, ¶109. OFDM demodulator 1220 further identifies the “received data symbols and received overhead symbols.” *Id.*

Thus, these components receive the signal transmitted from the base station corresponding to the PLC segments with corresponding slot assignments. *Id.*, ¶¶9, 11, 59, 67, 72-76, 108-10; *see* Section VIII.B.3; EX1003, ¶¶155-157.

5. [1D]

Using receiver unit 1214 and OFDM demodulator 1220, Vijayan089’s wireless device recovers data from the received OFDM signal based on the starting time-

frequency coordinate and N time-frequency resource units. EX1005, FIG. 12, ¶¶65, 109-11; Section VIII.B.4; EX1003, ¶¶158-161. Controller 1260 also uses “overhead signaling” identifying the “resource allocation and assignment for each selected PLC” to recover the OFDM data in “*one or more specific data streams/PLCs.*” EX1005, ¶110 (emphasis added).

The overhead signaling includes “*two parameters*: the start of the segment ... and the length of the segment.” See Section VIII.B.3; EX1005, ¶¶9, 11, 44, 59, 72-74 (emphasis added). With these parameters, the wireless device can “*determine the time-frequency location of each desired data stream.*” EX1005, ¶¶11, 44 (emphasis added). The wireless device therefore recovers a “given data stream of interest” using a starting time-frequency coordinate (the “start of the segment” parameter) and N time-frequency resource units (the “length of the segment”—including 2 or 4 transmission slots). *Id.*, ¶106; EX1003, ¶¶158-161.

Vijayan089 suggests using an identifier corresponding to the wireless device when recovering the data during unicast transmissions. EX1005, ¶¶6-7, 35; Section VIII.B.2; EX1003, ¶162. Laroia confirms this understanding and explicitly uses identifiers to differentiate between multiple wireless terminals. Section VIII.B.2; EX1007, ¶¶38, 40, 53, 63-68; EX1003, ¶¶162-163.

A POSITA would have found it obvious and would have been motivated to implement the identifier described in Laroia with Vijayan089’s system. Section

VIII.A; EX1003, ¶¶164-165. This identifier would allow a wireless device to differentiate its own allocation parameters from others. EX1007, ¶¶40, 53, 63. The identifier would be transmitted with Vijayan089's overhead signaling, which includes the starting time-frequency coordinate and number of slots. *Id.*; EX1005, ¶¶11, 44, 74, 76; EX1003, ¶¶164-165. Using the identifier and allocation parameters, Vijayan089's wireless device would recover signals from the slots corresponding to a PLC segment. EX1005, FIG. 12, ¶¶109-111; EX1003, ¶¶164-165.

C. Claim 7

Claim 7 is substantially similar to claim 1, but claims the functionality from the perspective of the “*mobile device*.” EX1001, 13:15-21. Vijayan089 and Laroia disclose claim 7 for at least the reasons previously presented. Section VIII.B; EX1003, ¶¶166-167.

*Petition for Inter Partes Review of
U.S. Patent No. 10,447,450*

U.S. Pat. No. 10,447,450	Obviousness - Vijayan089 and Laroia
[7-pre] A mobile device ... configured to:	<i>See</i> Claim Element [1-pre] ; Section VIII.B.1.
[7A]	<i>See</i> Claim Elements [1A] , [1C] , and [1D] ; Sections VIII.B.2, VIII.B.4, VIII.B.5.
[7B]	<i>See</i> Claim Elements [1B] and [1C] ; Sections VIII.B.3, VIII.B.4.
[7C]	<i>See</i> Claim Element [1D] ; Sections VIII.B.5.

The only differences between claim 7 and claim 1 are as follows, but Vijayan089 and Laroia still disclose every claim feature. EX1003, ¶¶168-170. First, the preamble of claim 7 recites a “wireless packet system.” Vijayan089 describes communications using “packets” as well. EX1005, Abstract, ¶¶83, 85-87, 114. For example, a “data stream for a PLC is partitioned into data packets.” *Id.*, ¶83. Vijayan089 also maps “the number of slots needed to transmit one packet” based on a particular mode or modulation scheme used for transmission. *Id.*, ¶86. Thus, Vijayan089 also describes a wireless packet system. Second, [7A] also recites the mobile device operating within a cell serviced by base station. Vijayan089 depicts base station cells in Figure 1 and a wireless device as a “cellular phone.” EX1005, ¶¶36-37.

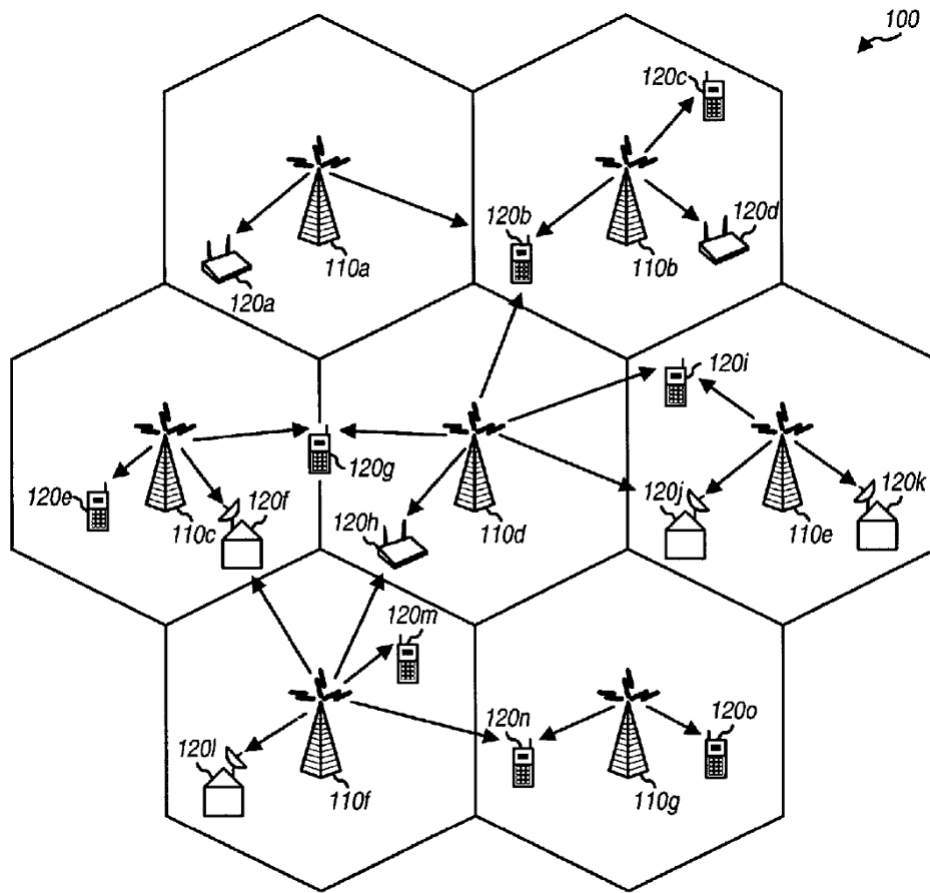


FIG. 1

EX1005, FIG. 1.

Laroia also describes this same cell-based configuration. EX1007, FIG. 1, ¶¶32-34.

D. Claim 13

Claim 13 is substantially similar to claim 1, but claims the functionality from the perspective of the “*base station*.” EX1001, 14:7-13. Vijayan089 and Laroia disclose claim 13 for at least the reasons previously presented. Section VIII.B; EX1003, ¶¶171-172.

U.S. Pat. No. 10,447,450	Obviousness - Vijayan089 and Laroia
[13-pre] A base station ... configured to:	<i>See</i> Claim Element [1-pre] ; Section VIII.B.1.
[13A]	<i>See</i> Claim Elements [1A] , [1C] , and [1D] ; Sections VIII.B.2, VIII.B.4, VIII.B.5.
[13B]	<i>See</i> Claim Element [1B] and [1C] ; Sections VIII.B.3, VIII.B.4.
[13C]	<i>See</i> Claim Elements [1B] , [1C] and [1D] ; Sections VIII.B.3, VIII.B.4, VIII.B.5.

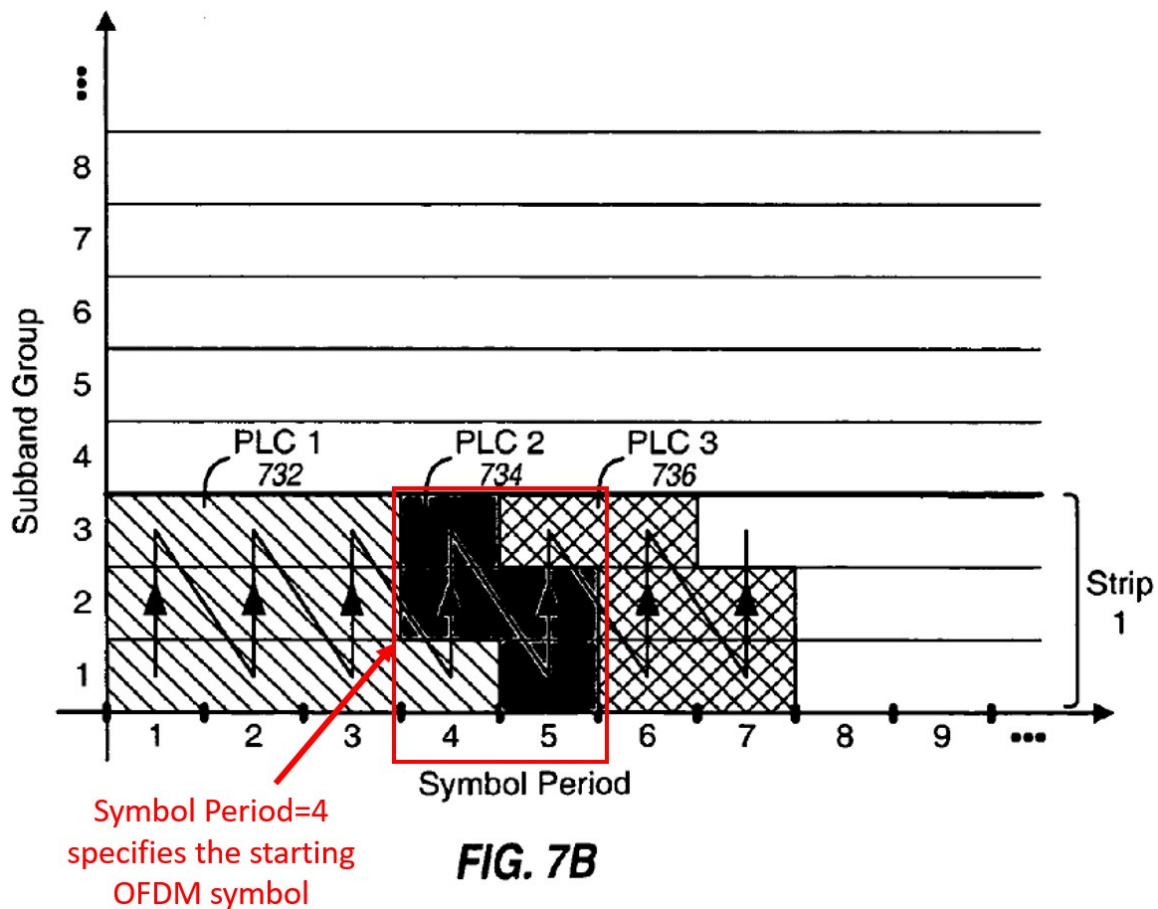
The only differences between claim 13 and claim 1 are as follows, but Vijayan089 and Laroia still disclose every claim feature. EX1003, ¶¶173-174. First, like claim 7, the preamble of claim 13 recites a “wireless packet system.” Vijayan089 discloses using “packets” as explained with reference to claim 7. EX1005, Abstract, ¶¶83, 85-87, 114; Section VIII.C. Second, [13A] also recites the mobile device operating within a base station cell. Vijayan089 also describes base station cells and corresponding wireless devices as depicted in Figure 1. EX1005, ¶¶36-37; Section VIII.C.

E. Claims 2, 8, and 14

Vijayan089 discloses the “starting time-frequency coordinate” indicating a starting OFDM symbol. Vijayan089 discloses the transmission of OFDM symbols. *See*

Section VIII.B.1.c; EX1005, ¶¶5, 37, 46-47, 59. The time component of Vijayan089's transmission unit or transmission slot is referred to as a "symbol period" and corresponds to a duration of "one OFDM symbol." EX1005, ¶46. Thus, when Vijayan089 specifies a starting symbol period for a segment, Vijayan089 also identifies a starting OFDM symbol. *Id.*, ¶¶46-47, 74; EX1003, ¶¶175-178.

Figures 4 and 7B depict examples of this configuration. EX1005, FIG. 4, FIG. 7B, ¶¶9, 11, 59, 72-76.



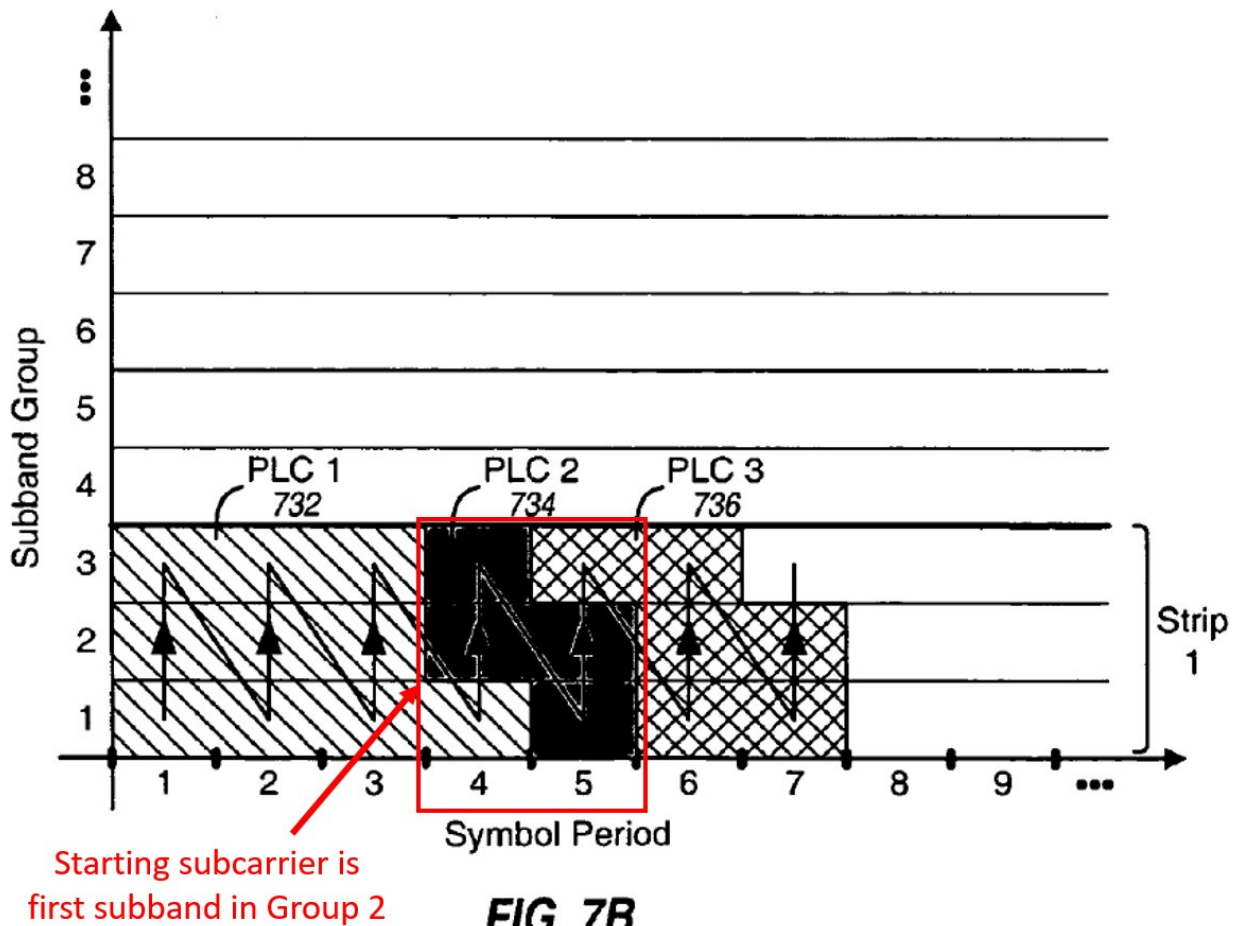
EX1005, FIG. 7B (annotated).

Vijayan089's starting time-frequency coordinate also specifies the particular starting OFDM symbol for the segment because the starting transmission slot identifies a starting group of "modulation symbols." EX1005, ¶¶59, 72-76. Thus, Vijayan089's indication of the starting symbol period of a segment identifies a starting OFDM symbol of the segment. EX1003, ¶¶175-178.

F. Claims 3, 9, and 15

Vijayan089 discloses the "starting time-frequency coordinate" indicating a starting subcarrier of the segment of time-frequency resource. EX1003, ¶¶179-182. Vijayan089 discloses a starting time-frequency coordinate which includes a "**starting subband**" or subcarrier. EX1005, ¶74 (emphasis added); *see also Id.*, ¶¶5, 59. Vijayan089's use of a starting subband to identify the start of the segment indicates a starting subcarrier for the segment. EX1003, ¶¶179-182.

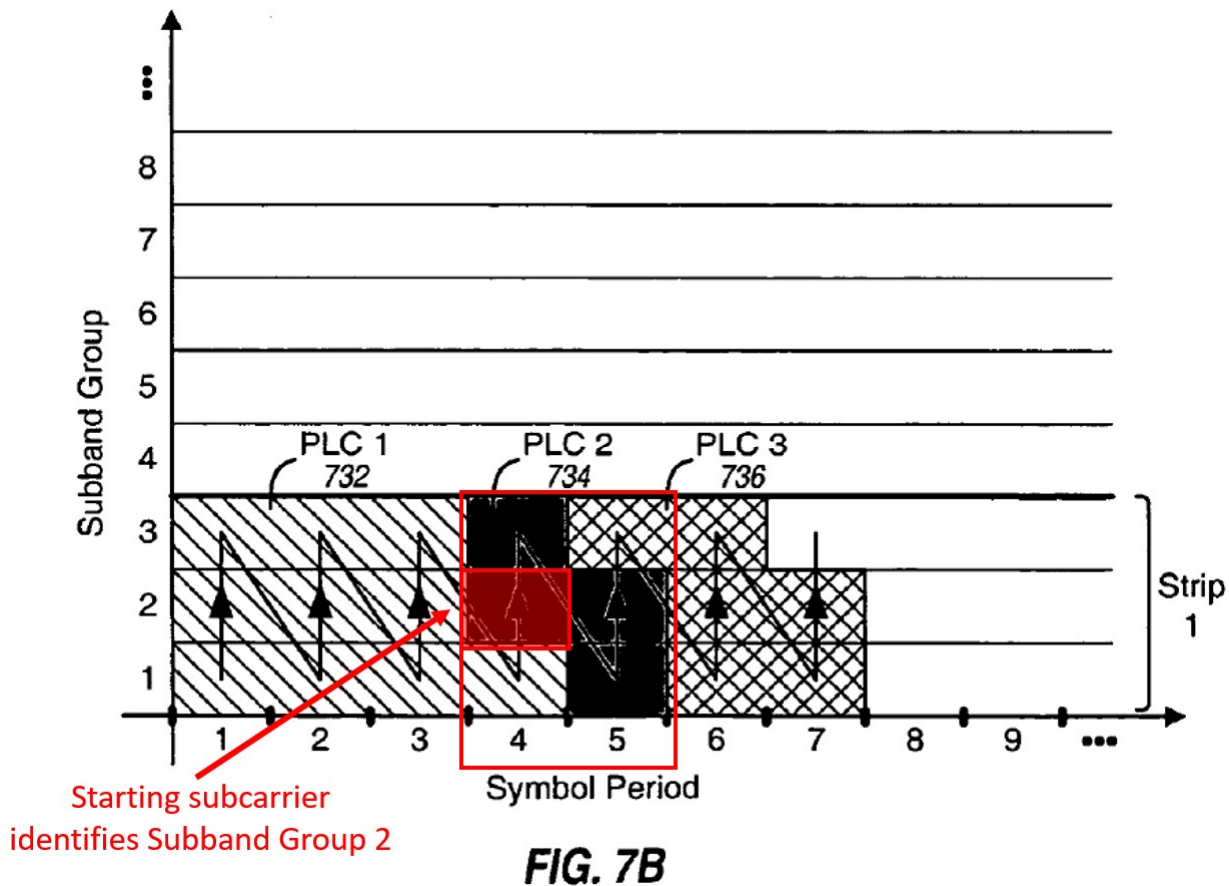
This identification also applies when the start of the segment identifies a starting transmission slot. EX1005, ¶¶59, 73-74. As seen in Figure 7B, the starting subcarrier for segment 734 is the first subband in Subband Group 2. *Id.*, ¶¶72-74; EX1003, ¶¶181-182.



EX1005, FIG. 7B (annotated).

G. Claims 4, 10, and 16

Vijayan089 discloses a “starting time-frequency coordinate” indicating a starting group of subcarriers of the segment. Vijayan089 discloses a starting time- frequency coordinate which includes a “starting subband.” EX1005, ¶¶59, 74; Section VIII.F. By virtue of being the first subband in a “subband group,” this starting subband also identifies a starting group of subcarriers. EX1003, ¶¶183-185. Figure 7B depicts an example of the starting subband identifying Subband Group 2. EX1005, ¶¶59, 72-74.



EX1005, FIG. 7B (annotated).

For example, for segment 734 corresponding to PLC 2, the starting subband parameter is the first subband in Subband Group 2 and therefore identifies Subband Group 2. *Id.*, ¶¶59, 70, 72-74. Thus, the starting time-frequency coordinate described in Vijayan089 also indicates a starting group of subcarriers for a segment. *Id.*

H. Claims 5, 11, and 17

The '450 patent uses the term “modular coding” or “modular coding schemes” to refer to well-known digital modulation techniques used in the art. EX1001, 6:22-62;

see also *Id.*, 7:7-54; EX1003, ¶¶186-189. The '450 patent provides Table 1, which “sets forth representative modulation and forward-error correction (FEC) coding schemes (MCS).” EX1001, 6:22-62.

TABLE 1

MCSI	Modulation	Coding rate	Information bits	Raw symbols	Units
1	16QAM	$\frac{1}{2}$	160	80	1
2	QPSK	$\frac{1}{2}$	160	160	2
3	QPSK	$\frac{1}{4}$	160	320	4
4	QPSK	$\frac{1}{8}$	160	640	8

EX1001, 6:35-44 (Table 1, annotated).

Vijayan089 discloses these same modulation schemes and applying “modular coding” to the time-frequency resource units of a segment. EX1005, ¶¶69, 84-88; EX1003, ¶¶186-189. Specifically, Vijayan089 explains that the “data stream for each PLC is *encoded and modulated based on a coding and modulation scheme selected for that PLC.*” EX1005, ¶39 (emphasis added). Similar to the “MCSI” value identified in the '450 patent, Vijayan089 uses a “mode” value to specify a modulation scheme applied to a PLC segment. *Id.*, ¶¶84- 88; EX1001, 6:22-62, 7:7-54. Table 1 from Vijayan089 depicts the available modulation coding schemes which are the same as those described in the '450 patent. EX1005, ¶¶84-88; EX1003, ¶¶188-189.

TABLE 1

Mode m	Modulation Scheme	Inner Code Rate R_{in} (m)	Number Slots/ Packet N_{spp} (m)	Number Slots/ Subblock N_{sps} (m)
1	QPSK	1/3	3	12
2	QPSK	1/2	2	8
3	16-QAM	1/3	1.5	6
4	16-QAM	1/2	1	4
5	16-QAM	2/3	0.75	3
6	QPSK/QPSK	1/3	3	12
7	QPSK/QPSK	1/2	2	8
8	QPSK/QPSK	2/3	1.5	6

EX1005, ¶85 (Table 1, annotated).

Vijayan089 therefore discloses applying a selected modulation scheme to the time-frequency slots of a PLC segment. EX1005, FIG. 10, ¶¶85-86, 89, 102-08; EX1003, ¶¶186-189.

IX. GROUND 2: CLAIMS 1-5, 7-11, AND 13-17 ARE OBVIOUS OVER VIJAYAN475 AND WU

Vijayan475 and Wu disclose each and every limitation of claims 1-5, 7-11, and 13-17. EX1003, ¶¶190-274. Vijayan475 expressly discloses using time-frequency “slots” to allocate resources as well as using a starting time-frequency coordinate and “number of slots allocated” to inform a wireless device of an allocation. EX1006, ¶¶36-42.

Wu discloses a user equipment (UE) identifier to specifically designate a wireless device to receive allocated transmissions. EX1008, ¶¶33-34, 92, 94, 98.

EX1003, ¶¶190-191. A POSITA would have found it obvious and would have been motivated to combine Vijayan475 and Wu to also provide this capability.

EX1003, ¶¶192-199.

Moreover, Vijayan475 is similar to Vijayan089 because it assigns a segment of a time-frequency resource using a starting time-frequency coordinate and N-value. Vijayan475, however, defines a segment differently. *See* Sections VIII.B.3, Vijayan475 uses “Start Offset,” “Slot Info,” and “Stream Lengths” parameters to define a starting time-frequency coordinate and N-value. *See* Section IX.B.3; EX1006, ¶¶40, 42, 45-47, 56. Further, Vijayan475 applies its allocation to a “multiplexed logical channel (MLC)” rather than “physical layer channel (PLC).” EX1006, ¶¶9, 36-42. Therefore, Vijayan475 operates in a way that is not cumulative with Vijayan089. EX1003, ¶¶90, 191.

A. A POSITA Would Have Been Motivated to Combine Vijayan475 and Wu

A POSITA would have been motivated to implement Wu’s assignment of a UE identifier with Vijayan475’s OFDM communication system. EX1003, ¶¶192-199. Vijayan475 discloses “unicast communications,” which already suggests the use of an identifier to differentiate between multiple wireless devices. EX1006, ¶¶5, 25-26. To implement unicast transmissions or to communicate data to a specific wireless device, a POSITA would have used an identifier to specifically identify that

wireless device. EX1003, ¶¶192-199. Despite this understanding, Vijayan⁴⁷⁵ does not explicitly discuss types of identifiers or how to implement such identifiers. *Id.* A POSITA would have therefore sought references that taught techniques for implementing wireless device identifiers. *Id.* Wu is such a reference. *Id.*; EX1008, ¶¶33-34; *see also Id.*, ¶¶32, 87, 92, 94, 98; Section IX.B.2.

Wu describes a “**sixteen bit UE identifier**” that “**identifies which receiver is to receive**” data. EX1008, ¶98 (emphasis added); *see also Id.*, ¶¶32-34, 92, 94. Wu’s base station provides the UE identifier when identifying the “OFDM slots ... for a given receiver.” *Id.*, ¶¶20-21, 94. A POSITA would have been motivated to combine this UE identifier with Vijayan⁴⁷⁵ to allow its wireless devices to differentiate and identify its own slot allocation and respective messages for reception. EX1006, ¶¶5, 25-26, 44; EX1008, ¶¶33-34, 87, 92, 94, 98. Thus, combining Wu with Vijayan⁴⁷⁵ would have improved the functionality of Vijayan⁴⁷⁵’s wireless devices by providing a simple process for discerning resource allocation slots. EX1003, ¶¶194-195.

Combining Vijayan⁴⁷⁵ and Wu would have amounted to combining well-known prior art elements to yield predictable results. *Id.*, ¶¶196-199. Assigning a wireless device identifier was a well-known technique in the prior art used to allow a mobile device to discern its own intended resource allocation. *Id.*, ¶¶78-80, 193; Section V.C. In view of this ubiquitous usage, a POSITA would have had a reasonable expectation of success in combining Vijayan⁴⁷⁵ and Wu to facilitate

wireless transmissions—especially in view of both references describing conventional OFDM base stations and wireless devices and allocating time-frequency slots for communications. *See* EX1006, FIG. 1, FIG. 8, FIG. 9, ¶¶25-27, 36, 39-42, 67-75; EX1008, FIG. 6, ¶¶101, 134, 137; EX1003, ¶¶196-199.

This combination would have been predictable and would have operated to perform its intended purposes in view of their common OFDM configuration and assignment of OFDM slots. EX1003, ¶¶196-199. The combined system would have used the UE identifier to specify the resource allocation parameters (e.g., Vijayan475's slot allocation parameters and/or stream lengths) for a particular wireless device. *See* Section IX.B.5; EX1006, ¶¶42, 45-55. Using these parameters, Vijayan475's wireless device would identify its assigned transmission slots to receive and recover the corresponding data. EX1006, ¶¶9-12, 38, 43-44, 55, 62, 64; EX1003, ¶¶195-199. Thus, implementing Wu's UE identifier with Vijayan475 would have merely amounted to using a known technique to improve similar devices in the same way. EX1003, ¶¶194-199.

B. Claim 1

1. [1-pre]

Vijayan475 describes the same operating method and wireless network recited in claim 1. EX1003, ¶¶200-214.

a. Vijayan475 discloses “a wireless network comprising at least a base station and a mobile station”

As seen from Figure 1, Vijayan475 discloses a “wireless multi-carrier broadcast system 100” that includes “base stations 110” and “wireless devices 120.” EX1006, ¶¶26-27; EX1003, ¶¶201-203.

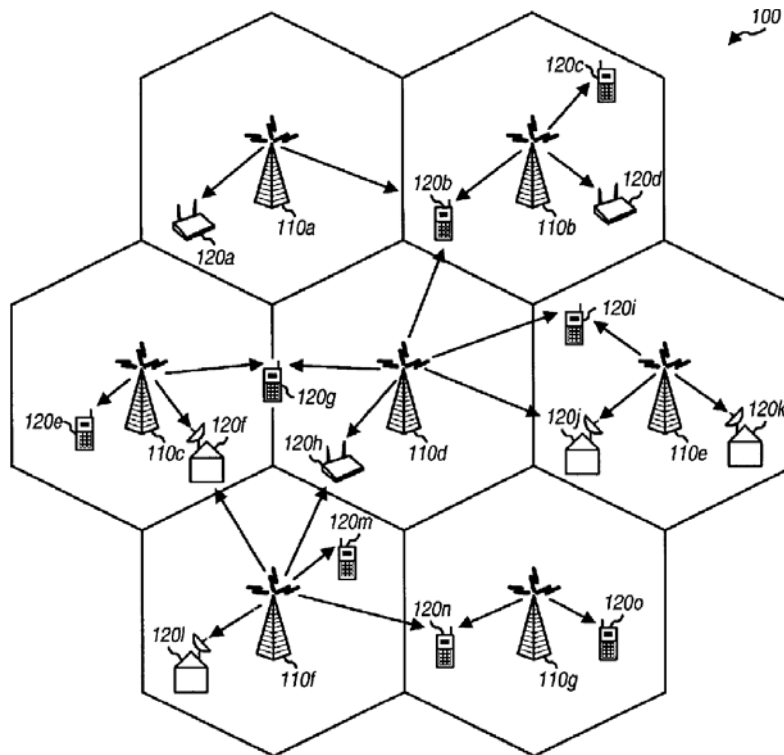


FIG. 1

EX1006, FIG. 1.

Figures 8 and 9 depict a base station and wireless device respectively. EX1006, ¶¶67-75. Vijayan475 also states that the “wireless device” may refer to a “mobile station.” *Id.*, ¶26.

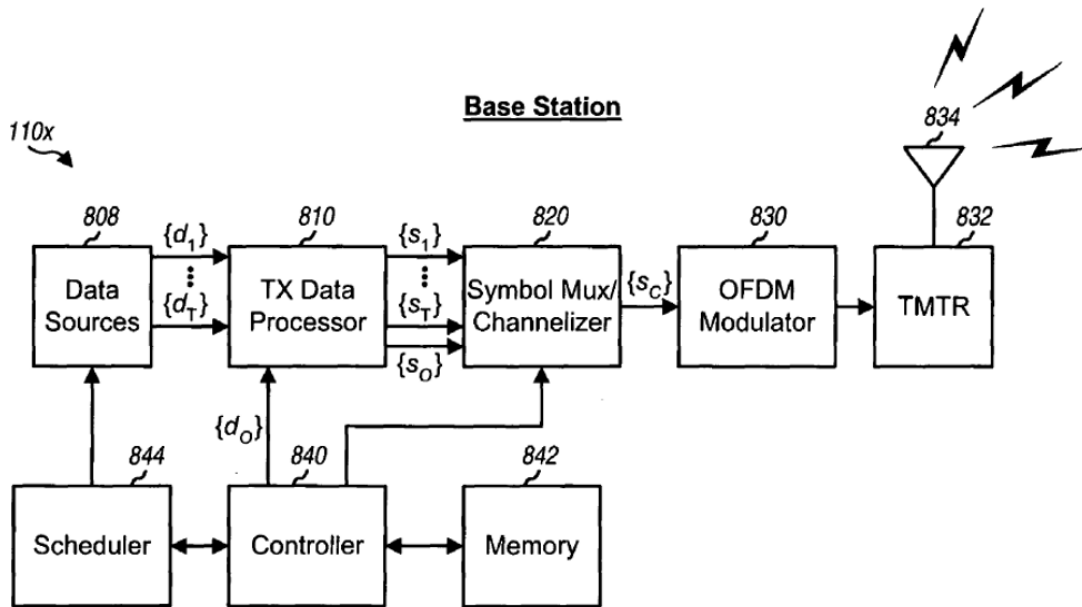


FIG. 8

EX1006, FIG. 8.

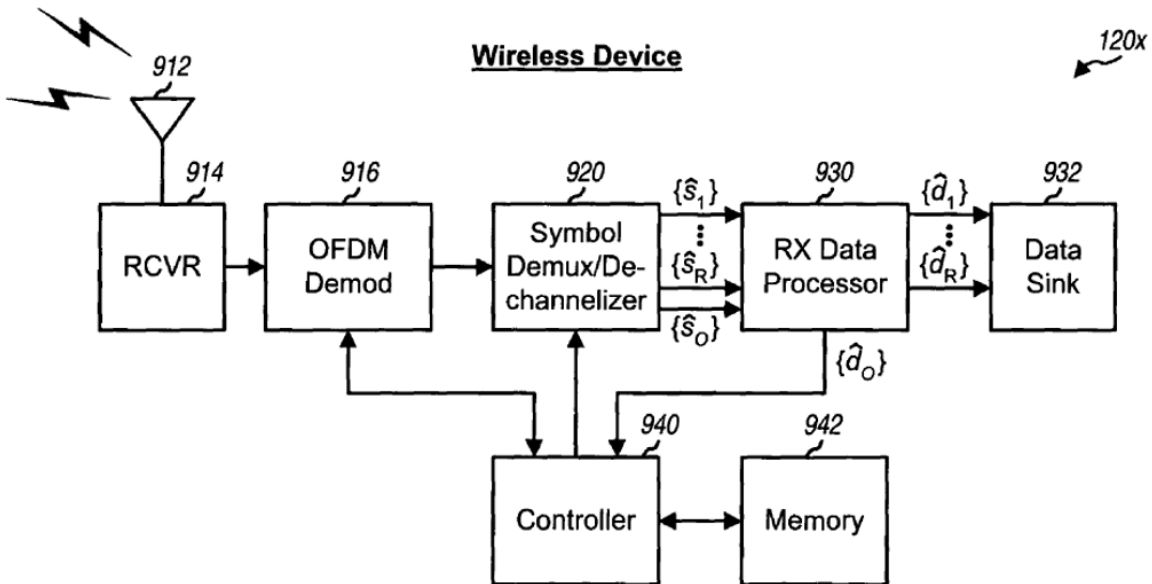


FIG. 9

EX1006, FIG. 9.

Vijayan475's base stations and mobile stations communicate wirelessly to disclose the claimed "wireless network" as depicted in Figure 1. EX1003, ¶¶201-203.

b. Vijayan475 discloses "employing a frame structure of multiple frames for transmission"

As depicted in Figure 2, Vijayan475 utilizes a "Super-Frame 210" that includes multiple frames for transmission of OFDM signals. *See* EX1006, Abstract, ¶¶10, 12, 29-32, 37-42, 45, 56-59. The super-frame may include "any number of frames." *Id.*, ¶¶29-31; EX1003, ¶¶204-206.

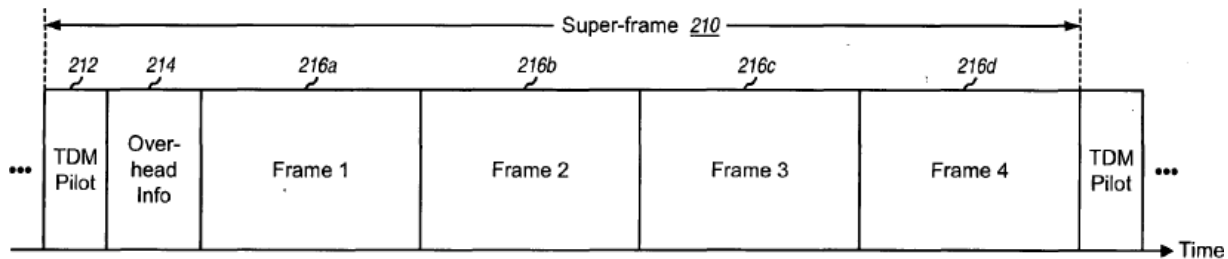


FIG. 2

EX1006, FIG. 2.

Figure 4 depicts an example frame that carries an assigned segment for communications: "FIG. 4 also shows the assignment of slots to a given MLC x for one frame 216." EX1006, ¶¶39-40, 57; EX1003, ¶¶207-208.

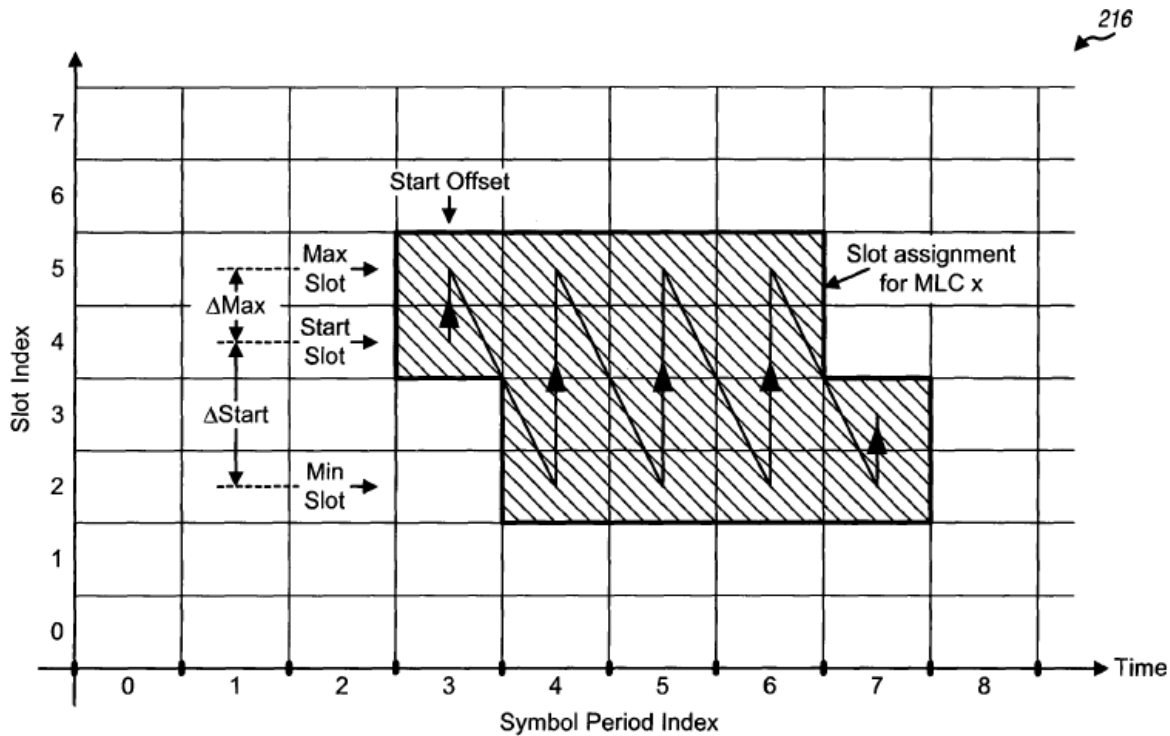


FIG. 4

EX1006, FIG. 4.

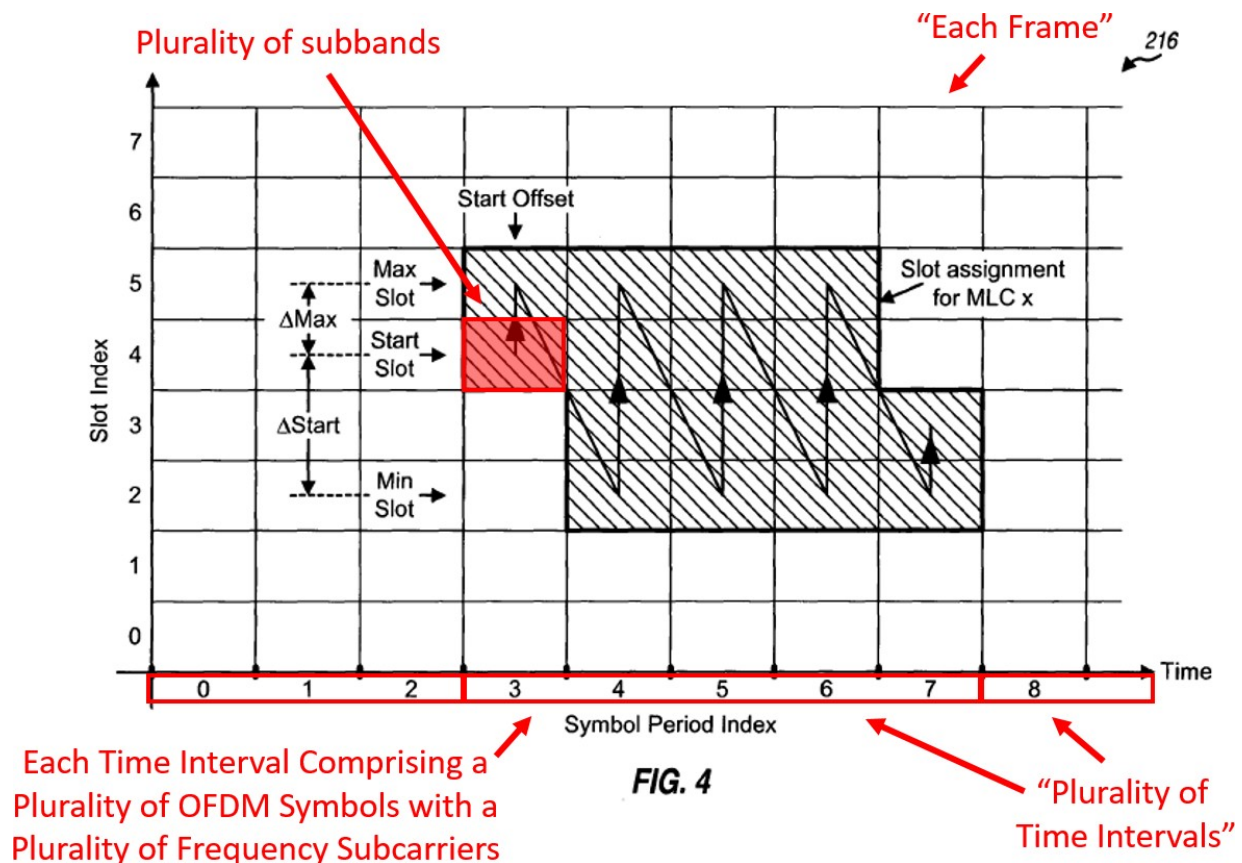
Vijayan475 also describes using time-frequency “slots” within the super-frame structure to transmit data. EX1006, ¶¶36-41, 45-49, 57. Vijayan475 describes allocating a “fixed or variable number of slots in each super-frame” for a multiplexed logical channel (MLC) segment. *Id.*, ¶38. Vijayan475 provides overhead information to the wireless device to indicate “the time-frequency location where the MLC will be transmitted in the super-frame.” *Id.*, Abstract, ¶¶9- 10, 62; EX1003, ¶¶207-208.

c. Vijayan475 discloses “each frame comprising a plurality of time intervals, each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and each OFDM symbol containing a plurality of frequency subcarriers”

Vijayan475's frame discloses each of the elements recited in the preamble.

EX1006, FIG. 4, ¶¶39-42. As annotated below, Figure 4 demonstrates how

Vijayan475's frame discloses these elements. EX1003, ¶¶209-214.



EX1006, FIG. 4 (annotated).

Figure 4 depicts “the assignment of slots to a given MLC x for one frame 216.” EX1006, FIG. 4, ¶40. Frame 216 has a time value in the horizontal axis

(Symbol Period Index values). *Id.* Regardless of size, multiple groupings of these symbol periods disclose the claimed “plurality of time intervals” as annotated above. *Id.* The analysis below focuses on a time interval spanning Symbol Period Indices 3 through 7. *Id.*; EX1003, ¶210.

Vijayan475 discloses each time interval comprising a plurality of OFDM symbols. EX1003, ¶¶211-213. Vijayan475 describes OFDM communications provided on the subbands within each slot. EX1006, ¶¶25, 69-71. Each slot within the time interval has a duration of one OFDM “symbol period” as seen in Figure 4. *Id.*, FIG. 4, ¶¶36, 39-42; EX1003, ¶¶211-213. Therefore, the time interval spanning Symbol Period Indices 3-7 includes five OFDM symbols. EX1003, ¶¶211-213. Thus, each time interval comprises a plurality of OFDM symbols. *Id.*

Vijayan475 also discloses “each OFDM symbol containing a plurality of frequency subcarriers” as claimed. EX1006, ¶¶25, 36. “**Multiple carriers** may be provided by orthogonal frequency division multiplexing (OFDM).” *Id.*, ¶25 (emphasis added). “OFDM effectively partitions the overall system bandwidth into **multiple (N) orthogonal subbands**” or “subcarriers.” *Id.* (emphasis added). Thus, within each OFDM symbol, Vijayan475 discloses a plurality of subcarriers. *Id.*, ¶¶25, 36.

2. [1A]

Vijayan475 allocates transmission units or “slots” for a “unicast transmission [that] is sent to a specific wireless device.” EX1006, ¶¶5, 25. A POSITA would have found it obvious for Vijayan475’s wireless device to be assigned an identifier to discern its own intended data streams for recovery. *Id.*, ¶¶5, 25-26; EX1003, ¶¶215-218. This includes discerning allocated slots corresponding to a “multiplexed logical channel (MLC)” and allowing the wireless device to “**determine the time-frequency location of each MLC of interest.**” EX1006, ¶¶9-10, 36-42, 60 (emphasis added).

A POSITA would have found it obvious to assign an identifier to the specific wireless device especially to provide unicast transmissions. *Id.*, ¶¶5-8, 25- 26, 37-42, 62. This would allow the wireless device to discern its own intended data streams and “quickly find and extract” or recover “individual data streams of interest.” *Id.*, ¶¶5, 8-9, 25-26, 44; EX1003, ¶¶215-218. Otherwise, it would be more difficult for each wireless device to discern its own respective data stream for recovery. EX1003, ¶¶215-218.

To the extent that it is argued that Vijayan475 does not render [1A] obvious, Wu explicitly discloses this feature. EX1003, ¶¶219-222. Wu discloses a base station assigning a UE identifier to a wireless device in an OFDM system. EX1008, Abstract, ¶¶33-34, 87, 94, 98. Specifically, Wu describes a “**sixteen bit UE identifier**” that “**identifies which receiver is to receive** the current HSDPA content.”

Id., ¶¶98 (emphasis added); *see also Id.*, ¶¶32-34, 92, 94. “HSDPA” refers to “high speed data packet access” and corresponds to data transmitted in the downlink direction from a base station to a mobile device as depicted in Figure 2. *Id.*, ¶¶4, 87, 134.

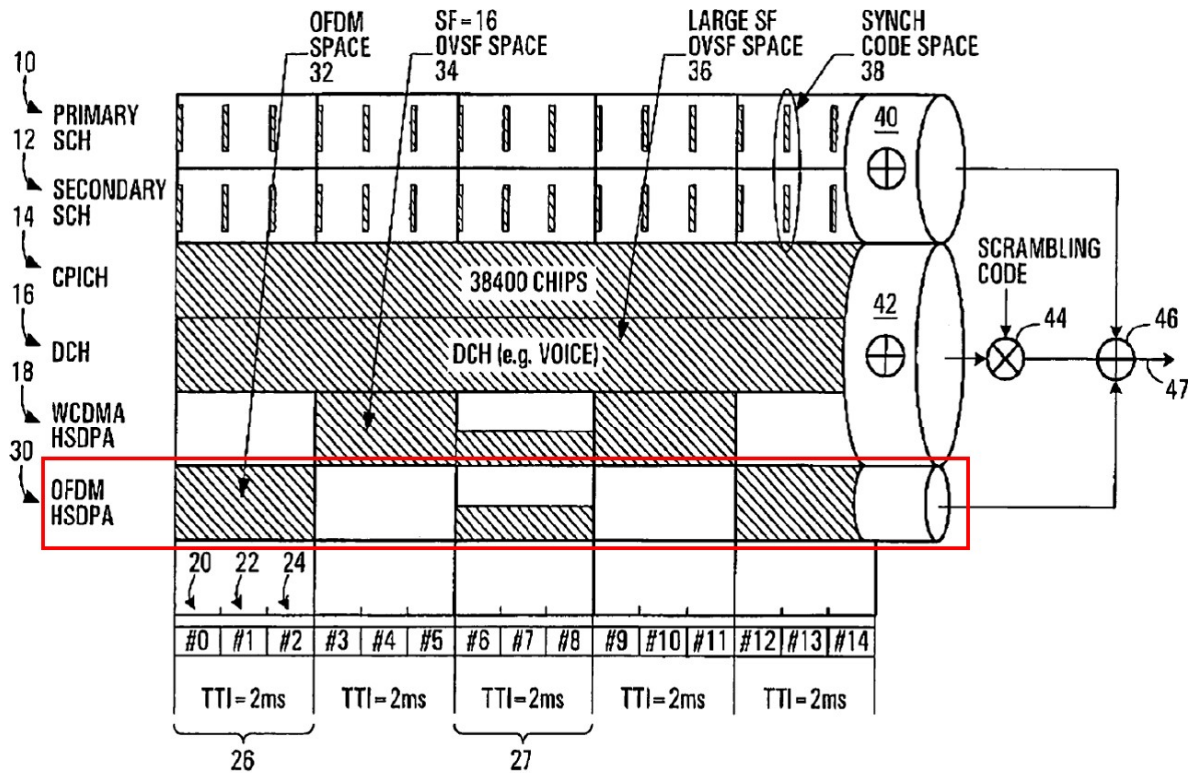


FIG. 2

EX1008, FIG. 2 (annotated).

Wu’s base station assigns and uses the UE identifier when identifying the “OFDM slots ... for a given receiver.” EX1008, ¶¶20-21, 94. Wu’s base station provides the UE identifier via a control channel that includes “identifiers for each receiver scheduled during the slot and an indication of which sub-carriers are for

which receiver.” *Id.*, ¶¶33-34. The receiver then demodulates the “OFDM slot only if scheduled during the slot.” *Id.*, ¶¶25, 50; EX1003, ¶¶219-222. An example UE identifier may be a “MAC-ID” that can identify “particular users for which capacity is [] allocated.” EX1008, ¶128; *see also Id.*, ¶¶129-133.

Thus, Wu describes a base station assigning an identifier to identify a particular wireless terminal to receive data transmitted. EX1003, ¶¶219-222. Wu’s mobile device uses this identifier to recover content from specified slots in an “OFDM time-frequency plane.” EX1008, ¶128.

A POSITA would have been motivated to combine Vijayan⁴⁷⁵ and Wu for the reasons previously explained. *See* Section IX.A; EX1003, ¶¶192-199, 222.

3. [1B]

Vijayan⁴⁷⁵ discloses transmitting a signal “from the base station to the mobile station over a segment of time-frequency resource” as claimed. *See* EX1006, FIG. 4, ¶¶38-42, 45-55; EX1003, ¶¶223-241. Specifically, Vijayan⁴⁷⁵ defines a “segment” using a “starting time-frequency coordinate” and N time- frequency resource units in the form of encoded starting “slot information” and “stream length” parameters. EX1006, FIG. 4, ¶¶38-42, 45-55. Vijayan⁴⁷⁵’s encoded parameters provide the same overhead reduction benefits described in the ’450 patent. *Id.*, ¶¶38, 55; EX1003, ¶¶223-241. Thus, Vijayan⁴⁷⁵ discloses [1B] and the same alleged benefits described

by the '450 patent. EX1003, ¶¶223-241.

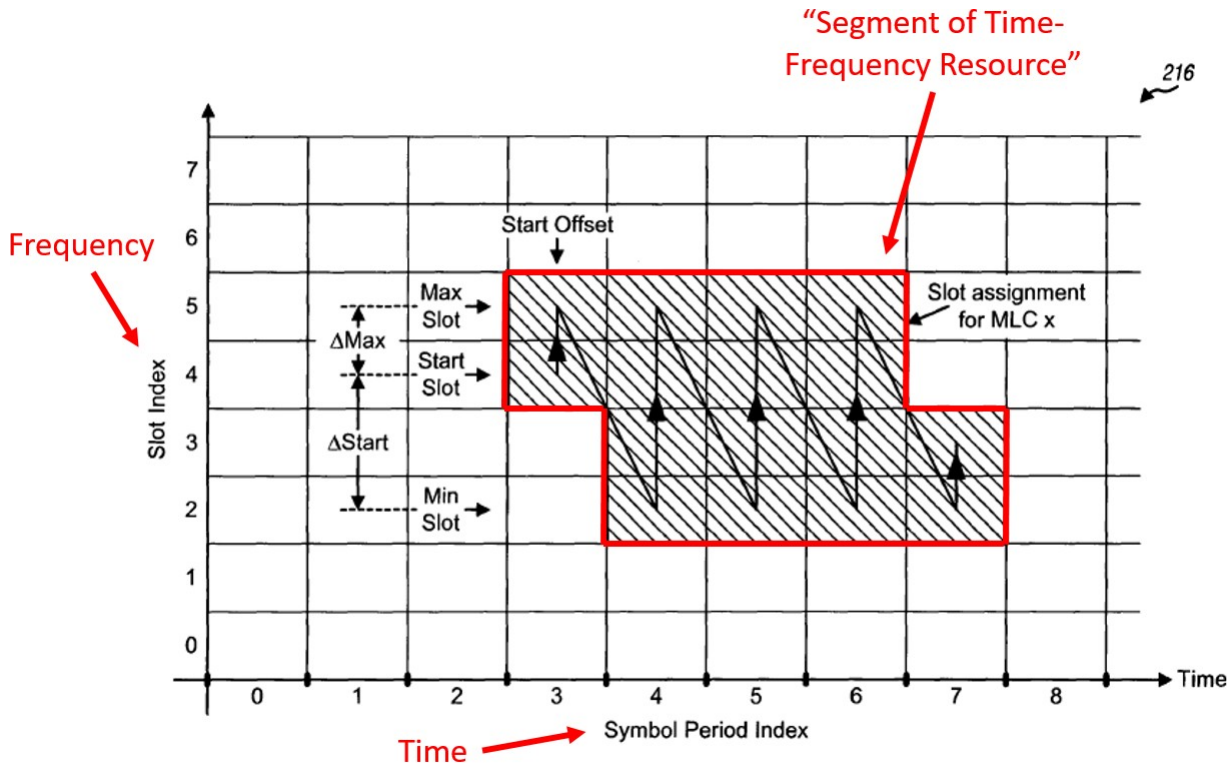
a. Vijayan475 discloses “transmitting a signal containing information from the base station to the mobile station over a segment of time-frequency resource”

Vijayan475 describes the same base station and mobile station configuration described in claim 1. *See* Section IX.B.1. Using “transmitter unit 832,” Vijayan475’s base station transmits “multiple [OFDM] data streams on multiple data channels” which may be recovered by wireless devices. EX1006, Abstract, ¶¶9, 60, 69; EX1003, ¶¶224-227. The wireless device then “receives the modulated signal” and identifies the transmitted OFDM symbols. EX1006, ¶¶71-73.

Vijayan475’s base station also transmits the OFDM symbol information “over a segment of time-frequency resources” as claimed. *Id.*, FIG. 4, ¶¶36-42. Vijayan475 describes transmitting data over “slots,” which disclose the claimed “time-frequency resource.” *Id.* “M slots are formed in each symbol period and are mapped to M disjoint or non-overlapping sets of subbands, where $M \geq 1$.” *Id.*, ¶36. Therefore, each slot is a resource having a time component (symbol period) and frequency component (subband). EX1003, ¶225.

“Each MLC may be ‘allocated’ a fixed or variable number of slots.” EX1006, ¶38. The term “MLC” to refer to a “multiplexed logical channel” segment that is assigned one or more slots to carry “one or more data streams.” *Id.*, ¶9. Figure 4 depicts an MLC x (i.e., segment of time-frequency resources) that is “assigned 16

slots.” *Id.*, ¶40; EX1003, ¶225.



EX1006, FIG. 4 (annotated).

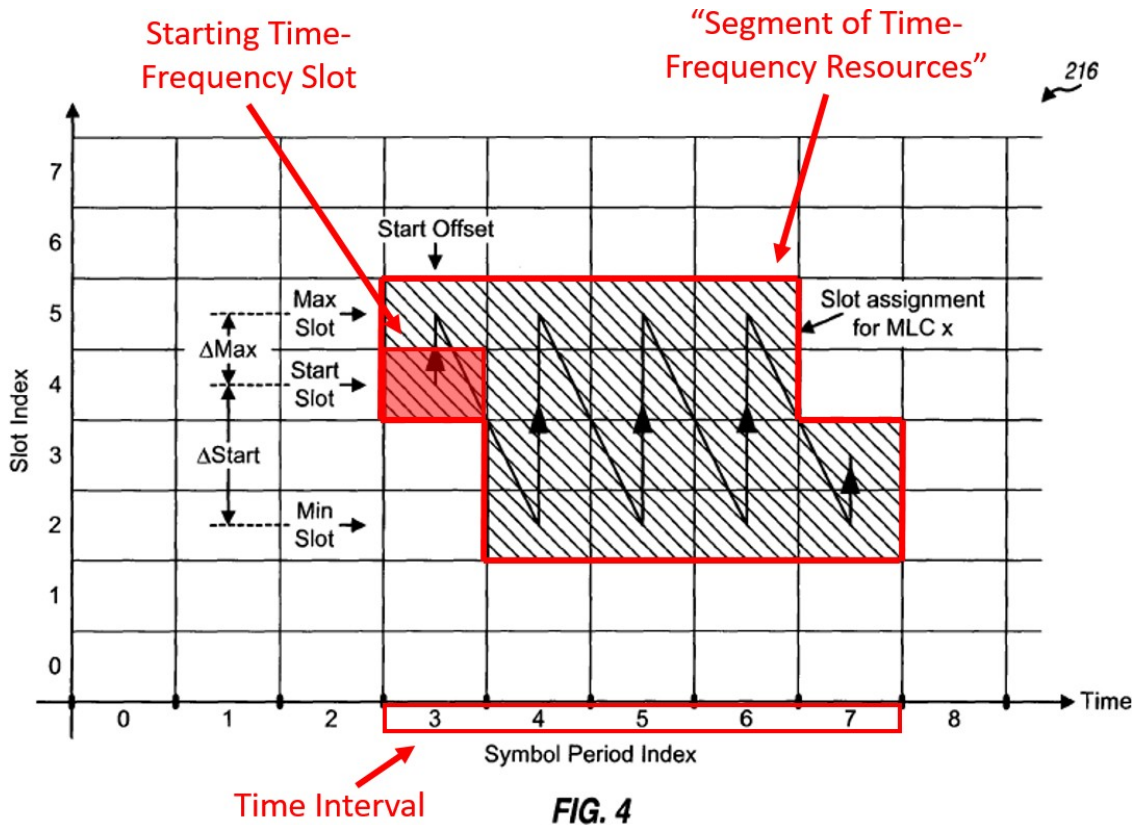
Each MLC may carry a data stream to a wireless device. EX1006, ¶¶9, 27- 28, 51-52. “These data streams may carry multimedia content ... [and] are sent on data channels or MLCs.” *Id.*, ¶¶27-28. Vijayan475 therefore transmits a signal via an MLC corresponding to a group of slots. *Id.*, ¶¶36-42. This assignment of “slots” in the time-frequency plane discloses the claimed “segment of time-frequency resources.” *Id.*, ¶¶27-28, 36-42, 45; EX1003, ¶¶226-227.

b. Vijayan475 discloses “the segment having a starting time-frequency coordinate and the segment comprising N time-frequency resource units within a time interval ... where N=2, 4, or 8”

Vijayan475’s MLC segment discloses the claimed “segment.” *See* Section IX.B.3.a. MLC segments are composed of “slots” defined in a time-frequency plane as seen in Figure 4. EX1006, ¶¶36-42, 45-49, 57. These “slots” disclose the claimed “time-frequency resource units.” EX1003, ¶228. To define a segment, Vijayan475 uses:

- (1) a starting time-frequency coordinate—defined using “Start Offset” and “Slot Info” parameters corresponding to the “Start Slot”; and
- (2) N time-frequency resource units—“*the number of slots allocated to the MLC*, as shown in FIG. 4.”

EX1006, ¶¶40, 42, 45-47, 56 (emphasis added); EX1003, ¶¶228-238.



EX1006, FIG. 4 (annotated).

Vijayan475's "Start Offset" and "Slot Info" parameters collectively identify a starting time-frequency coordinate. EX1006, ¶¶40, 42, 45-49, 56. Vijayan475 defines these parameters in Table 1. *Id.*, ¶45.

TABLE 1

MLC Present = '1' (active MLC)		
Starting Time-Frequency Coordinate Parameters	Start Offset	Indicate the starting symbol period index for the slots assigned to the MLC.
	Slot Info	Contain parameters describing the slots assigned to the MLC.
	Stream Lengths	Contain the length of each stream layer packet carried by the MLC in the current super-frame.
MLC Present = '0' (inactive MLC)		
	Next Super-frame Offset	Indicate the next super-frame in which the MLC may be sent.
	Reserved	Padding to make the location record a fixed size.

EX1006, ¶45 (Table 1, annotated).

The “Start Offset” indicates the “starting symbol period index for the slots assigned to the MLC.” EX1006, ¶45. The “Slot Info” parameter includes “Min Slot, **Start Slot**, and Max Slot” parameters as seen in Figure 4. *Id.*, ¶¶40, 42, 46-49. Together, these parameters discloses a starting time-frequency coordinate. EX1003, ¶¶228-230.

Vijayan475 also discloses a second way to convey this information to reduce overhead signaling. EX1006, ¶¶40, 42, 46-49. The “slot information may be encoded to reduce the number of bits needed to convey this information.” *Id.*, ¶46. This encoding uses “ΔStart” and “ΔMax” parameters along with the Min Slot parameter as seen in Figure 4 to convey the starting time-frequency coordinate. *Id.*, FIG. 4,

¶¶46-49; EX1003, ¶¶231-234.

Vijayan475 encodes these parameters as shown in Table 2. EX1006, ¶48.

The simple “Slot Info Code” transmitted by a base station conveys the Min Slot, Δ Start, and Δ Max parameters to a wireless device. *Id.*, FIG. 4, ¶¶46-49; EX1003, ¶¶232-234. The wireless device then derives the starting time-frequency coordinate using the Slot Info Code and the Start Offset value. EX1006, ¶¶45, 48-49.

TABLE 2

Min Slot	Δ Start	Δ Max	Slot Info Code
1	0	0	0
1	0	1	1
1	0	2	2
1	0	3	3
1	0	4	4
1	0	5	5
1	0	6	6
1	1	0	7
1	1	1	8
1	1	2	9
1	1	3	10
1	1	4	11
1	1	5	12
1	2	0	13
1	2	1	14
1	2	2	15
1	2	3	16
1	2	4	17
1	3	0	18
1	3	1	19
1	3	2	20
1	3	3	21
1	4	0	22
1	4	1	23

EX1006, ¶48 (Table 2, annotated excerpt).

Using this encoded Slot Info Code “*reduces the number of bits needed to convey the slot information for each MLC.*” EX1006, ¶49 (emphasis added). For example, the slot information can be conveyed using 7 bits rather than 9 bits. *Id.* Vijayan475 therefore discloses conveying a starting time-frequency coordinate with or without encoding. *Id.*, ¶¶40, 42, 45-49, 56; EX1003, ¶¶232-234.

Vijayan475 also conveys a number of slots corresponding to a segment. EX1006, ¶¶40, 45, 51-52, 54-55. Vijayan475’s “Stream Lengths” parameter conveys the “*number of slots allocated to the MLC.*” *Id.*, ¶45; EX1003, ¶¶235-237. Vijayan475’s Stream Lengths parameter identifying the number of slots in the segment therefore discloses the claimed N time-frequency resource units. EX1003, ¶¶235-237.

Vijayan475 also discloses or otherwise renders obvious a segment having N time-frequency resources units within a time interval where N=2, 4, or 8. *Id.*, ¶¶237-238. For example, Vijayan475 discloses that each MLC may be assigned “*M slots ... where $M \geq 1$.*” EX1006, ¶¶36, 38 (emphasis added). A POSITA would have therefore understood that M could equal 2, 4, or 8 slots. EX1003, ¶¶237-238. In fact, a POSITA would have understood that using 2, 4, or 8 slots for a segment would beneficially utilize less overhead signaling. *Id.* Moreover, MLC x shown in Figure 4 is “assigned 16 slots.” EX1006, FIG. 4, ¶40. As such, it would have been a simple

design choice for a POSITA to use any number of slots between one and sixteen (including 2, 4, or 8) to convey an MLC segment. *Id.*, FIG. 4, ¶¶36, 38, 40; EX1003, ¶¶237-238.

c. Vijayan475 discloses “each unit containing a set of frequency subcarriers in a group of OFDM symbols”

Vijayan475’s “slot” discloses the claimed “unit.” *See* Section IX.B.3.b; EX1003, ¶¶239-241. The MLC segments and their corresponding slots convey OFDM symbols. *See* Section IX.B.3.b. Each slot includes a set of frequency subcarriers: “M slots are formed in each symbol period and are mapped to *M disjoint or non-overlapping sets of subbands*, where $M \geq 1$.” EX1006, ¶36 (emphasis added). These “subbands” are “subcarriers.” *Id.*, ¶25. Therefore, each slot contains a set of frequency subcarriers. *Id.*, FIG. 4, ¶¶25, 36; EX1003, ¶¶239- 241.

Vijayan475 conveys data using OFDM symbols, which also use sets of subcarriers. EX1006, FIG. 4, ¶¶25, 36, 69-71. When transmitting OFDM symbols, multiple carriers or “multiple [] orthogonal subbands” are used. *Id.*, ¶25. Thus, Vijayan475 discloses each slot including a set of frequency subcarriers in a group of OFDM symbols. *Id.*, FIG. 4, ¶¶25, 36, 69-71; EX1003, ¶¶239-241.

4. [1C]

Vijayan475 discloses a wireless device (*i.e.*, the claimed “mobile station”) receiving transmitted information signals from a base station. EX1006, FIG. 9, ¶¶71-

73; see also Section IX.B.1.a. Figure 9 depicts wireless device 120x including an antenna 912 and receiver unit 914. EX1006, FIG. 9, ¶71.

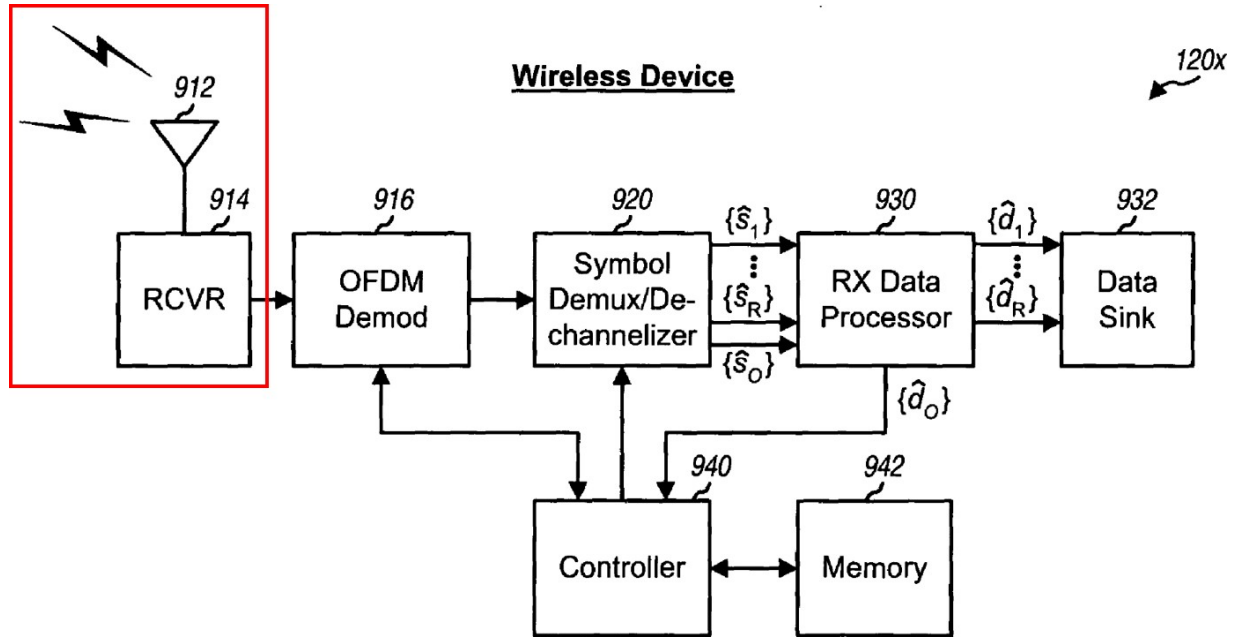


FIG. 9

EX1006, FIG. 9 (annotated).

“[A]ntenna 912 receives the modulated signal transmitted by base station 110x and provides a received signal to a receiver unit (RCVR) 914. Receiver unit 914 conditions, digitizes, and processes the received signal” and then provides the stream to OFDM demodulator 916 to extract the data and overhead symbols. EX1006, ¶71.

Thus, these components receive the signal transmitted from the base station corresponding to the MLC segments with corresponding slot assignments. *See Id.*, FIG. 4, ¶¶36, 38-55; Section IX.B.3; EX1003, ¶¶242-244.

5. [1D]

Using receiver unit 914 and OFDM demodulator 916, Vijayan475's wireless device recovers data from the received OFDM signal based on the starting time-frequency coordinate and N time-frequency resource units. EX1006, FIG. 9, ¶¶71- 73; Section IX.B.4; EX1003, ¶¶245-247. Controller 940 and RX Data Processor 930 also recover the relevant information by identifying "one or more MLCs" and the corresponding "slot assignment for each selected MLC." EX1006, ¶72. RX data processor 930 then "processes each detected data symbol stream for each MLC of interest." *Id.*

Vijayan475 recovers MLC segments using overhead signaling information. *Id.*; EX1003, ¶¶245-247. This overhead signaling information conveys a starting time-frequency coordinate and a number of slots ("N-value") using Start Offset, Slot Info, and Stream Length parameters. EX1006, ¶¶40, 42, 44-47, 56. With these parameters, the wireless device determines the "time-frequency location of each MLC" and recovers the corresponding information. *Id.*, Abstract, ¶¶9-10, 40, 42, 44-55, 60; Section IX.B.4; EX1003, ¶¶245-248.

A POSITA would have also found it obvious and would have been motivated to implement the identifier described in Wu with Vijayan475's system. Section IX.A; EX1003, ¶¶248-251. This identifier would have been provided to the particular wireless device to allow recovery of the MLC segment and therefore would have

also corresponded to the wireless device's Start Offset, Slot Info, and Stream Length parameters. EX1006, ¶¶5, 25-26, 42, 45-55; EX1008, ¶¶33-34, 87, 92, 94, 98; EX1003, ¶¶248-251. Using the identifier and these parameters, the receiver would determine whether to recover data from a transmitted OFDM signal based on "whether or not the receiver is scheduled during the slot." EX1008, ¶¶25, 50, 100; Section IX.A; EX1003, ¶251. In view of Vijayan⁴⁷⁵'s "unicast transmissions," a POSITA would have implemented Wu's UE identifier to allow a wireless device to identify its own allocation parameters from those intended for other wireless devices. EX1006, ¶¶5, 25-26; EX1008, Abstract, ¶¶32-34, 87, 94, 98. The wireless device would then recover the information corresponding to its allocated transmission slots or MLC segment in the manner described above. Section IX.B.3; EX1003, ¶251.

C. Claim 7

Claim 7 is substantially similar to claim 1, but claims the functionality from the perspective of the "*mobile device*." EX1001, 13:15-21. Vijayan⁴⁷⁵ and Wu disclose Claim 7 for at least the reasons previously presented. Section IX.B; EX1003, ¶¶252-253.

U.S. Pat. No. 10,447,450	Obviousness - Vijayan475 and Wu
[7-pre] A mobile device ... configured to:	See Claim Element [1-pre] ; Section IX.B.1.
[7A]	See Claim Elements [1A] , [1C] , and [1D] ; Sections IX.B.2, IX.B.4, IX.B.5.
[7B]	See Claim Elements [1B] and [1C] ; Sections IX.B.3, IX.B.4.
[7C]	See Claim Element [1D] ; Sections IX.B.5.

The only differences between claim 7 and claim 1 are as follows, but Vijayan475 and Wu still disclose every claim feature. EX1003, ¶¶254-256. First, the preamble of claim 7 recites a “wireless packet system.” Vijayan475 describes communications using “packets” as well. EX1006, ¶¶28, 32-35, 45, 50-54. For example, a “each MLC may carry up to three data streams, e.g., one data stream for signaling and up to two data streams for *packet/traffic data*.” *Id.*, ¶28 (emphasis added). Vijayan475 also discloses the use of MAC packets to transmit data as well as defining a Stream Length based on the length of a “stream layer packet.” *Id.*, ¶¶28, 32-35, 45, 50-54. Thus, Vijayan475 also describes a wireless packet system. Second, [7A] also recites the mobile device operating within a cell serviced by base station. Vijayan475 depicts base station cells in Figure 1 and a wireless device a “cellular phone.” EX1006, ¶¶26-28.

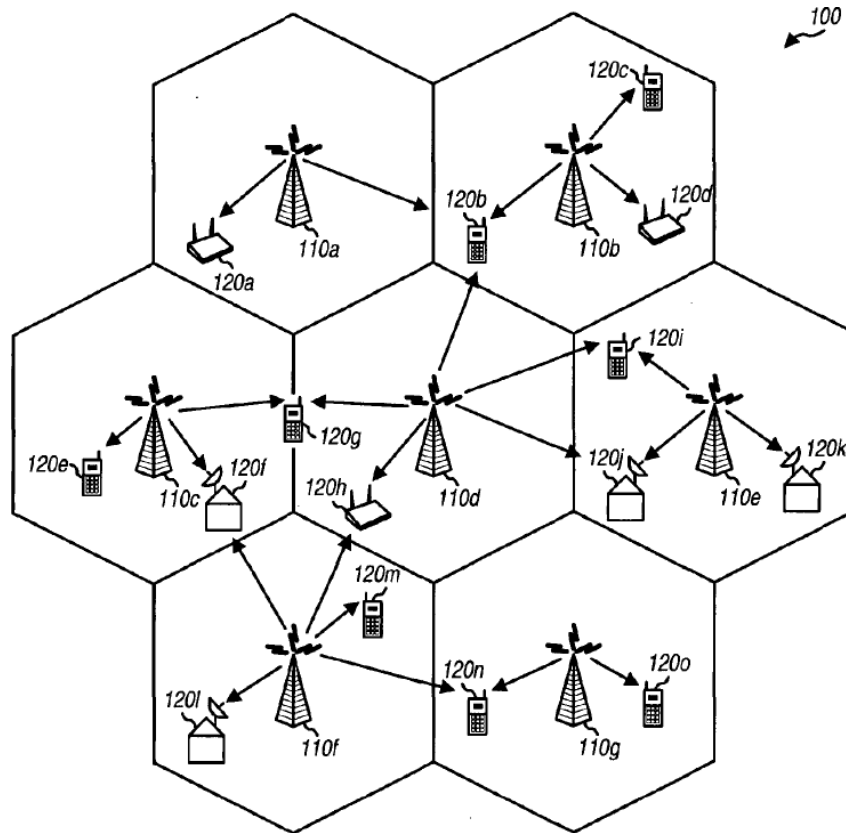


FIG. 1

EX1006, FIG. 1.

D. Claim 13

Claim 13 is substantially similar to claim 1, but claims the functionality from the perspective of the “*base station*.” EX1001, 14:7-13. Vijayan475 and Wu disclose Claim 13 for at least the reasons previously presented. Section IX.B; EX1003, ¶¶257-258.

U.S. Pat. No. 10,447,450	Obviousness - Vijayan475 and Wu
[13-pre] A base station ... configured to:	<i>See</i> Claim Element [1-pre] ; Section IX.B.1.
[13A]	<i>See</i> Claim Elements [1A] , [1C] , and [1D] ; Sections IX.A.2, IX.A.4, IX.A.5.
[13B]	<i>See</i> Claim Element [1B] and [1C] ; Sections IX.A.3, IX.A.4.
[13C]	<i>See</i> Claim Elements [1B] , [1C] and [1D] ; Sections IX.A.3, IX.A.4, IX.A.5.

The only differences between claim 13 and claim 1 are as follows, but Vijayan475 and Wu still disclose every claim feature. EX1003, ¶¶259-260. First, like claim 7, the preamble of claim 13 recites a “wireless packet system.” Vijayan475 discloses using “packets” as explained with reference to claim 7. EX1006, ¶¶28, 32-35, 45, 50-54; Section IX.C. Second, [13A] also recites the mobile device operating within a base station cell. Vijayan475 also describes base station cells and corresponding wireless devices as depicted in Figure 1. EX1006, FIG. 1, ¶¶26-28; Section IX.C.

E. Claims 2, 8, and 14

Vijayan475 discloses the “starting time-frequency coordinate” indicating a starting OFDM symbol. Vijayan475 discloses the transmission of OFDM symbols. *See* Section IX.B.1.c; EX1006, FIG. 4, ¶¶25, 36, 39-42, 69-71. The time component of

Vijayan475's transmission slot is referred to as "symbol period" and is identified using a "symbol period index." EX1006, FIG. 4, ¶¶39-40. Vijayan475 identifies a "Start Slot" with a "Start Offset" at a particular symbol period. *Id.* And as discussed above, Vijayan475's starting time-frequency coordinate is derived using the "Start Offset" and "Start Slot" parameters. *Id.*, ¶¶40, 42, 45-49, 56. Therefore, Vijayan475's starting time-frequency coordinate specifies a starting OFDM symbol for a time-frequency resource segment. *Id.*; EX1003, ¶¶261-264.

Figure 4 depicts an example configuration. EX1006, ¶¶36, 39-40, 45-49.

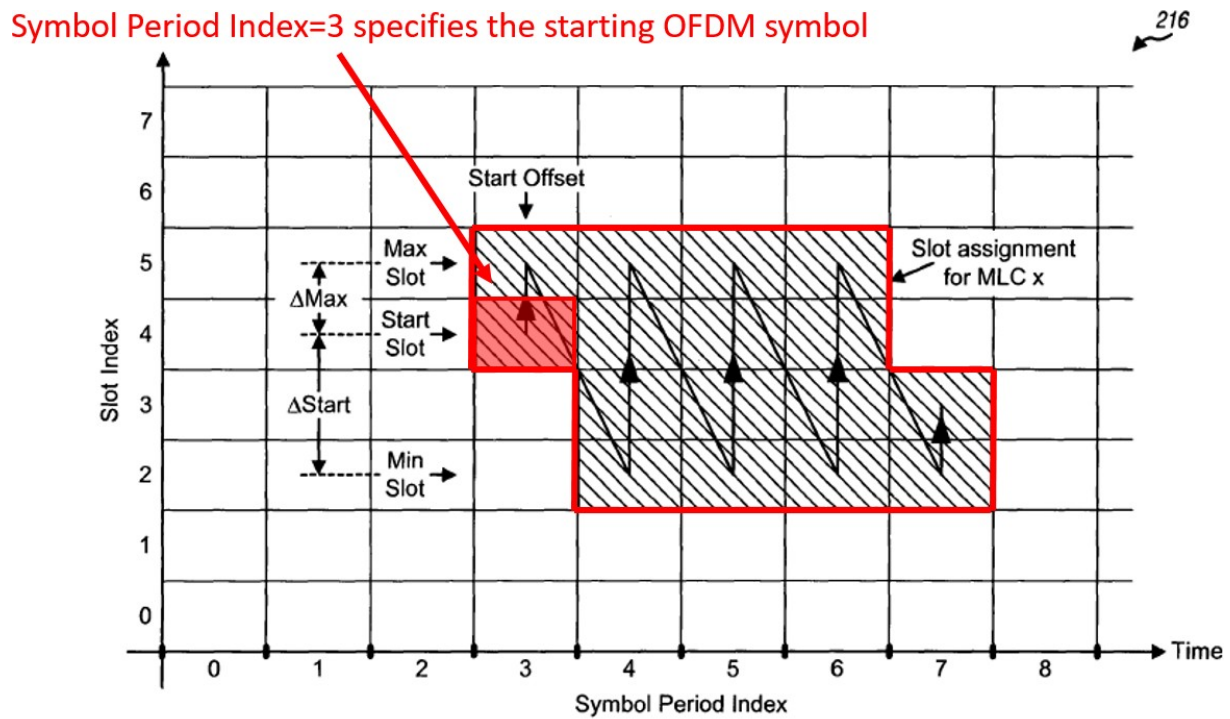


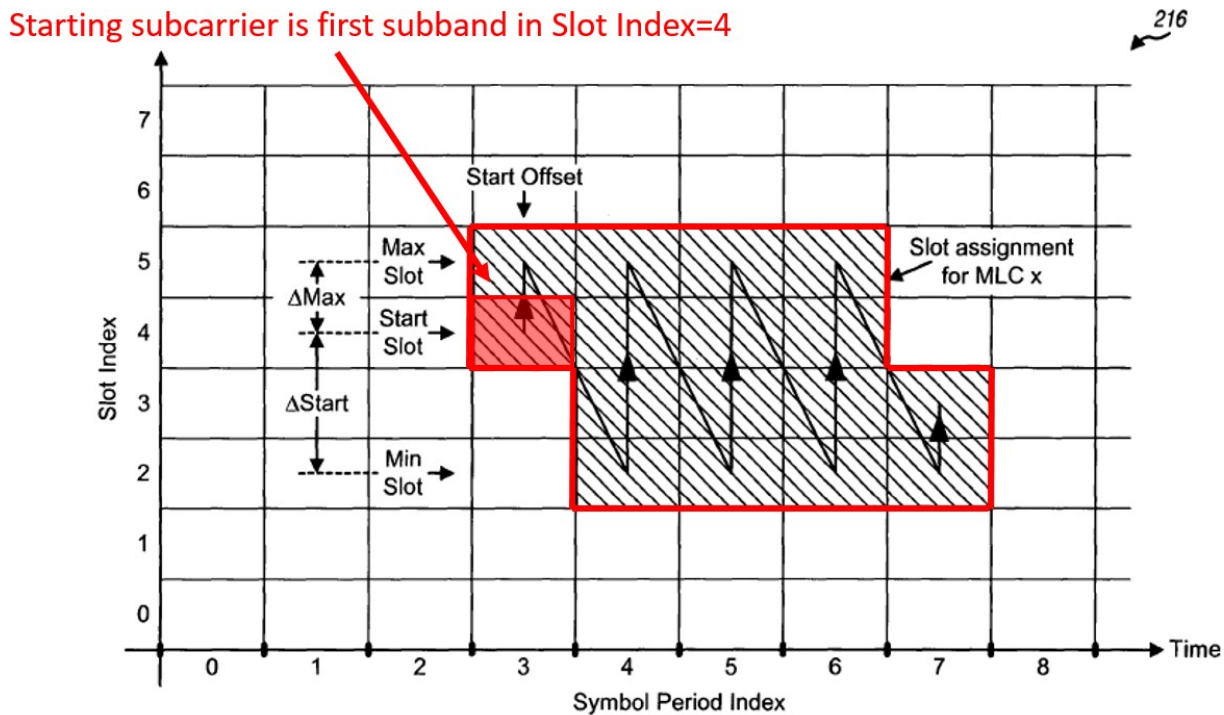
FIG. 4

EX1006, FIG. 4 (annotated).

F. Claims 3, 9, and 15

Vijayan475 discloses the “starting time-frequency coordinate” indicating a starting subcarrier of the segment of time-frequency resource. EX1003, ¶¶265-268. Vijayan475 discloses a starting time-frequency coordinate corresponding to a Start Slot. EX1006, ¶¶40, 42, 46-49; Section IX.B.3. The Start Slot’s “slot index” identifies a starting set of “subbands” for a segment of time-frequency slots. EX1006, ¶36 (“M slots ... are mapped to *M disjoint or non-overlapping sets of subbands.*”) (emphasis added); *see also Id.*, ¶25. Thus, when Vijayan475 specifies a “Start Slot,” Vijayan475 identifies a starting subcarrier for a time-frequency resource segment (i.e., the first subcarrier in the Start Slot). *Id.*, ¶25; EX1003, ¶266.

Figure 4 illustrates this teaching where the MLC x segment has a starting Slot Index of 4. EX1006, FIG. 4, ¶40. The starting subband or subcarrier for the MLC x segment would be the first subband in the set of subbands corresponding to Slot Index 4. *Id.*, FIG. 4, ¶¶25, 36, 40, 42, 46-49; EX1003, ¶267.



EX1006, FIG. 4 (annotated).

G. Claims 4, 10, and 16

Vijayan475 discloses the “starting time-frequency coordinate” indicating a starting group of subcarriers of the segment of time-frequency resource.

Vijayan475 discloses a starting time-frequency coordinate corresponding to a Start Slot for a segment. EX1006, ¶¶40, 42, 46-49; Section IX.B.3; EX1003, ¶¶269-271.

In the Start Slot, Vijayan475 discloses the use of a group of subcarriers (i.e., “*M disjoint or non-overlapping sets of subbands*”). EX1006, ¶36 (emphasis added).

The Start Slot identified by the starting time-frequency coordinate therefore identifies a starting group of subcarriers. *Id.*, FIG. 4, ¶¶25, 36, 40, 42, 46-49.

Figure 4 depicts an example of the Start Slot identifying a particular group or set of subbands corresponding to Slot Index 4. *Id.*; EX1003, ¶¶269-271.

Slot Index=4 identifies a group of subbands

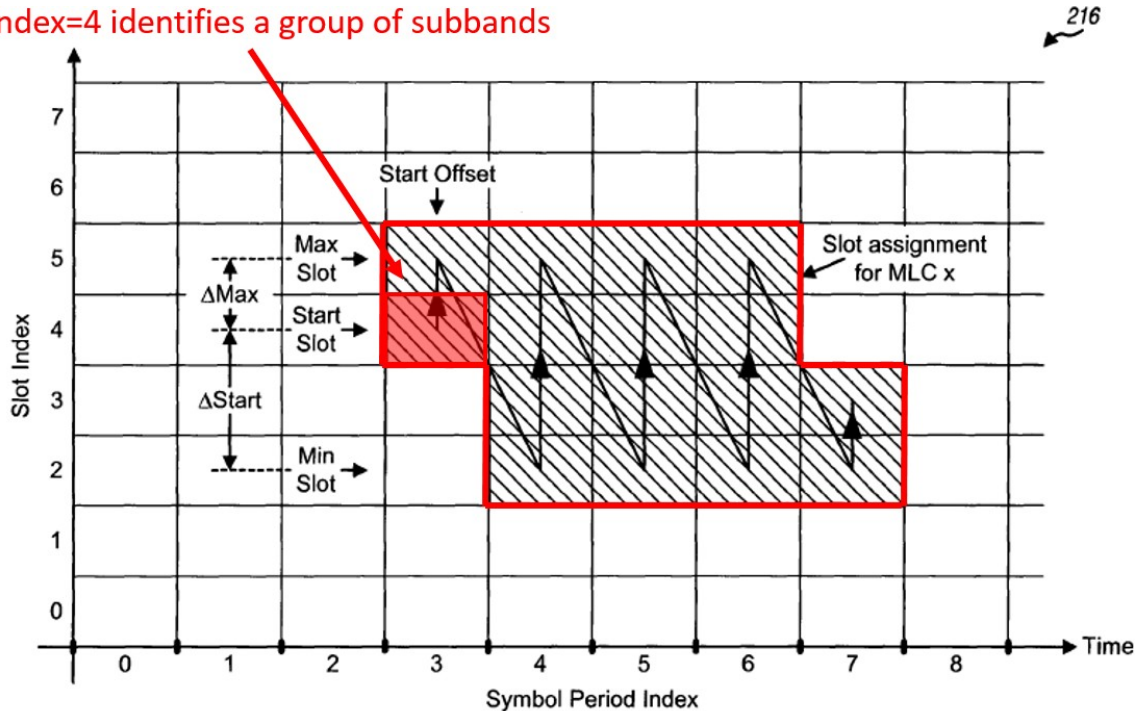


FIG. 4

EX1006, FIG. 4 (annotated).

H. Claims 5, 11, and 17

As previously explained in Section VIII.H, the '450 patent uses the term “modular coding” or “modular coding schemes” to refer to well-known digital modulation techniques used in the art. EX1001, 6:22-62, 7:7-54. Vijayan475 also discloses applying “modular coding” to the time-frequency resource units of a segment. EX1006, ¶¶35, 45, 66; EX1003, ¶¶272-274.

Vijayan475 explicitly applies a “code rate and *modulation scheme*” to slots

of an MLC. EX1006, ¶45 (emphasis added). Vijayan⁴⁷⁵ explains that “different coding and modulation schemes” may be used to improve the reception of data bits. *Id.*, ¶63. The base station informs the wireless device of the particular “modulation scheme used for the MLC.” *Id.*, ¶¶66-68. Example modulation schemes include “M-PSK” and “M-QAM.” *Id.*, ¶67. Vijayan⁴⁷⁵ explains that any of these modulation schemes may be applied by the base station to the time- frequency slots of a MLC segment. *Id.*, ¶¶35, 45, 66-70. Thus, Vijayan⁴⁷⁵ discloses the claimed application of “modular coding” to the segment of time- frequency resource units. EX1003, ¶¶272-274.

X. GROUND 3: CLAIMS 6, 12, AND 18 ARE OBVIOUS OVER VIJAYAN⁰⁸⁹, LAROIA, AND CHOI.

Claims 6, 12, and 18 refer to applying “repetition coding” to the time-frequency resource units.² The ’450 patent does not provide any special definition for “repetition coding,” but states that “[t]hose skilled in the art will appreciate that coding and *signal repetition* can be combined to provide lower coding rates.” EX1001, 6:58-62 (emphasis added); EX1003, ¶¶275-279. A POSITA would have therefore recognized “repetition coding” as referring to a simple and well-known

² The claims include a typographical error: “time-frequence [*sic*] resource units.”

EX1003, ¶276.

technique where information bits are repeated. *Id.* (citing EX1021, ¶4; EX1022, ¶¶86, 88; EX1016, 500-502). Choi confirms that it would have been obvious to apply repetition coding to time-frequency resource units. *Id.*, ¶¶280-281.

Choi describes “enhancing the transmission of the data by further **repetition encoding** the data” to improve “error correction” and provide a “more robust data transmission scheme at reduced data rates.” EX1009, Abstract, ¶2 (emphasis added). Choi applies this repetition coding to OFDM symbols. *Id.*, ¶¶16-18; EX1003, ¶¶280-281. Choi applies repetition coding in both the time and/or frequency domains. EX1009, ¶¶13, 16, 51; EX1003, ¶¶280-281.

A POSITA would have been motivated to combine Choi with Vijayan089 and Laroia to provide “error correction” and “more robust data transmission[s].” EX1009, ¶2; EX1003, ¶¶282-284. Vijayan089 acknowledges that repeating portions of signals was a well-known technique and also explicitly uses redundancy checks to provide “forward error correction coding.” EX1005, ¶39; *see also Id.*, ¶¶83, 101, 114, 118. Choi’s repetition coding would have furthered this goal and would have alleviated errors in OFDM systems. EX1009, ¶¶16-18, 22-24, 45. As Choi explains, repetition coding would be applied in the time domain, the frequency domain, or both. *Id.*, ¶¶13, 16, 18, 51. A POSITA would have therefore applied Choi’s repetition coding to Vijayan089’s time-frequency units. EX1005, ¶39; *see also Id.*, ¶¶83, 101, 114, 118; EX1003, ¶¶282-284.

A POSITA would have also had a reasonable expectation of success in combining Choi with Vijayan089 and Laroia in view of their common OFDM usage. EX1009, ¶¶16-18, 22-24, 45; Sections VIII.A, VIII.B.1.c; EX1003, ¶¶282-284.

XI. GROUND 4: CLAIMS 6, 12, AND 18 ARE OBVIOUS OVER VIJAYAN475, WU, AND CHOI.

Choi discloses the “repetition coding” recited in claims 6, 12, and 18 for the reasons presented in Ground 3. *See* Section X; EX1009, ¶¶13, 16-18, 51; EX1003, ¶¶285-287. When combined with Vijayan475 and Wu, the combination renders claim 6, 12, and 18 obvious. EX1009, ¶¶2, 39, 83, 101, 114, 118.

Similar to Ground 3, a POSITA would have been motivated to combine Choi with Vijayan475 and Wu to provide “error correction” and “more robust data transmission[s].” EX1003, ¶¶288-289; EX1009, ¶¶2, 39, 83, 101, 114, 118. Vijayan475 acknowledges that repeating portions of signals is a well-known technique and also explicitly uses redundancy to improve the reception of signals. EX1006, ¶64. Choi’s repetition coding would have furthered this goal and would have alleviated errors in OFDM systems. EX1009, ¶¶16-18, 22-24, 45; EX1003, ¶¶288-289. As Choi explains, repetition coding would be applied in the time and/or frequency domain. EX1009, ¶¶13, 16, 18, 51. A POSITA would have therefore applied Choi’s repetition coding to the time-frequency slots disclosed in Vijayan475. EX1006,

¶¶36-42, 45-49, 57; EX1003, ¶¶288-289.

A POSITA would have also had a reasonable expectation of success in combining Choi with Vijayan⁴⁷⁵ and Wu in view of their common OFDM usage. EX1009, ¶¶16-18, 22-24, 45; Sections IX.A, IX.B.1.c; EX1003, ¶¶290-291.

XII. DISCRETIONARY CONSIDERATIONS UNDER SECTIONS 314(a) AND 325(d) FAVOR INSTITUTION.

This Petition includes the same prior art and invalidity grounds as IPR2022-01567 (“VW IPR”), is accompanied by a concurrently-filed Motion for Joinder, and has been timely filed under 37 C.F.R. § 42.122. Thus, it is proper under 35 U.S.C. §§ 314(a)/325(d).

A. The *Fintiv* factors favor institution.

The *Fintiv* factors favor institution. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (P.T.A.B. Mar. 20, 2020) (precedential); *see also* June 21, 2022 Memorandum: Interim Procedure for Discretionary Denials in AIA Post Grant Proceedings with Parallel District Court Litigation (“June 2022 Memo”).

On March 29, 2022, Patent Owner filed complaints alleging infringement of the ’450 patent against Petitioners. On June 14, 2022, the cases were centralized for pre-trial proceedings in multidistrict litigation (MDL) in the Eastern District of Michigan (EDMI). EX1040; EX1041. The court has not issued a scheduling order or set a trial date.

***Petition for Inter Partes Review of
U.S. Patent No. 10,447,450***

The stage and location of the parallel litigation (factors 2, 3), Petitioner's below stipulation (factor 4), and the strong merits (factor 6), demonstrate that denial under *Fintiv* is inappropriate. *See* June 2022 Memo, 3-5, 7-9.

Factor 1 is neutral or favors institution. Following institutions of IPR2022-01539 and IPR2022-01567, Petitioner, as part of a joint defense group, filed a motion to staying pending IPR of the '450 patent. *See In re Neo Wireless, LLC Patent Litig.*, 2:22-md-3034-TGB, Dkt. 145 (E.D. MI, May 17, 2023). The court has yet to rule on the motion.

Factor 2 favors institution because the litigation is in early stages, no trial date has been set, and the median time to trial for civil actions in EDMI is 46.8 months. EX1042, 40; *see* June 2022 Memo, 3. Thus, trial would likely occur (if at all) in early 2026—years after the Board's projected deadline for a final written decision here. *See Mylan Pharma. Inc. v. Bayer Pharma. Aktiengesellschaft*, IPR2022-00517, Paper 15 at 8-9 (P.T.A.B. Aug. 9, 2022).

Factor 3 favors institution because neither the parties nor the court have invested significant resources in the litigation. The court has not issued a scheduling order, or any substantive rulings. Other than claim construction briefs being exchanged and a *Markman* hearing set for June 21, 2023, no substantive progress has been made in the litigation.

Factor 4 favors institution. Petitioner stipulates that, if the Board institutes this

Petition, Petitioner will not raise at trial in the parallel litigation any invalidity challenges based on the prior art asserted here. This significantly mitigates the concerns for duplication and inconsistent conclusions embodied in factor 4.

Factor 5 is neutral or weighs against discretionary denial. Petitioner's status as joint defendants in District Court would promote judicial efficiency and integrity by potentially relieving the District Court of the need to conduct trial, and by enabling the Board to determine invalidity of claims that Patent Owner has serially asserted.

Factor 6 favors institution because the merits of the Petition are strong, as indicated by the fact that the VW IPR (IPR2022-01567), which Petitioners seek to join has already been instituted. *See also supra*; June 2022 Memo, 3-5. Other considerations favoring institution under factor 6 include: (1) the Board is best suited to address the technical issues raised here; (2) a decision on the merits at institution may aid the parties in resolving their disputes through alternative dispute resolution; and (3) a patentability ruling will benefit the public by providing a complete record and rationale absent from a black box jury verdict form, such as by deterring future litigation. Patent Owner has filed suit against nine defendants and is likely to file against others given the remaining patent term of the '450 patent and Patent Owner's allegations that the '450 patent is essential to certain telecommunication standards.

The *Fintiv* factors favor IPR.

B. *General Plastic* favors institution.

General Plastic does not apply here because Petitioner has not previously challenged this patent and Petitioner and the Volkswagen Petitioner are not similarly situated; for example, they are not accused in the litigation of infringing based on the same products as examined under Factors 1 and 3.³ *General Plastic Industrial Co., Ltd. v. Canon Kabushiki Kaisha*, IPR2016-01357, Paper 19 at 15-19 (PTAB Sept. 6, 2017). As to timing under Factors 2, 4, and 5, while Petitioner became aware of the prior art references in the Volkswagen IPR and the Dell IPR as of at least the time of their filing, Petitioner made no serial attack on the '450 patent and has filed this Petition within the one-month period under 37 C.F.R. § 42.122(b). As to Factors 6 and 7, Petitioner seek to join the Volkswagen IPR and is not raising new arguments and will participate in an inactive/understudy role so that there should be no material impact on the Board's finite resources or its ability to issue a final determination within one year. *See General Plastic* at 15-19; *Apple Inc. v. Uniloc 2017 LLC*, IPR2020-00224, Paper 10 at 4-5 (PTAB Apr. 6, 2020).

C. *Advanced Bionics* favors institution.

The two-part framework from *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH* demonstrates that denial under §325(d) is not

³ The same can be said for Dell, Inc., petitioner in the prior Dell IPR (IPR2021-01486).

appropriate. IPR2019-01469, Paper 6 at 8-9 (P.T.A.B. Feb. 13, 2020) (precedential). Under part one, the same or substantially the same art or arguments were not previously presented to the Office, ending the inquiry in favor of institution. The “new, noncumulative prior art asserted in the Petition” strongly favors IPR. *Oticon Medical AB v. Cochlear Ltd.*, IPR2019-00975, Paper 15 at 20 (P.T.A.B. Oct. 16, 2019) (§§II.B and II.C precedential). Should Patent Owner attempt to analogize any previously considered art or arguments to those presented here, Petitioner reserves the right to respond.

Petitioner notes that U.S. Patent No. 7,221,680 to Vijayan (“Vijayan680,” EX1043), which issued from Vijayan089 (EX1005), was considered in certain applications related to the ’450 patent—U.S. Patent No. 7,948,944 (EX1044) and U.S. Patent No. 9,735,944 (EX1046). However, the claims of those related applications substantially differ from those in the ’450 patent.

The Board should institute review because the merits are strong and the circumstances here trigger none of the discretionary denial policy considerations. Should Patent Owner raise any discretionary denial theory not addressed above, Petitioner reserves the right to respond before institution.

XIII. CONCLUSION

The Board should grant IPR and cancel claims 1-18.

*Petition for Inter Partes Review of
U.S. Patent No. 10,447,450*

Respectfully submitted,

Dated June 5, 2023

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***Petition for Inter Partes Review of
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CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 13,656 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated June 5, 2023

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on June 5, 2023, a complete and entire copy of this Petition for *Inter Partes* Review and all supporting exhibits were provided by Federal Express, to the Patent Owner, by serving the correspondence address of record as follows:

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