

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VOLKSWAGEN GROUP OF AMERICA, INC.,
Petitioner

v.

NEO WIRELESS LLC,
Patent Owner

Case IPR2022-01567
Patent 10,447,450

DECLARATION OF SARAH KATE WILSON, PH.D.

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Patent Trial and Appeal Board
U.S. Patent & Trademark Office
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I, Sarah Kate Wilson, declare as follows:

I. Introduction

1. I have been retained by Sterne, Kessler, Goldstein & Fox P.L.L.C. on behalf of Volkswagen Group of America (“VWGoA” and/or “Petitioner”) for the above-captioned *inter partes* review proceeding. I understand that this proceeding involves U.S. Patent No. 10,447,450 (EX1001, “the ’450 Patent”), which is entitled “Method and System for Multi-Carrier Packet Communication with Reduced Overhead,” and that the ’450 patent is currently assigned to Neo Wireless LLC (“Patent Owner”).

2. Specifically, I have been retained as a technical expert by VWGoA to study and provide my opinions on the technology claimed in, and the patentability or unpatentability of, claims 1-18 of the ’450 patent (“the Challenged Claims”). This declaration is directed to the challenged claims of the ’450 patent, and sets forth the opinions I have formed, the conclusions I have reached, and the bases for each. For purposes of this declaration, I was not asked to provide any opinions that are not expressed herein.

3. I am familiar with the technology described in the ’450 patent as of its earliest possible priority date of September 28, 2005. I have been asked to provide my technical review, analysis, insights, and opinions regarding the ’450 patent. I have used this experience and insight along with the references identified herein as

the basis for my opinions that support the grounds of unpatentability set forth in the Petition for *Inter Partes* Review of the '450 patent.

4. I have reviewed and am familiar with the specification of the '450 patent, which issued on October 15, 2019. I understand that the '450 patent has been provided as EX1001. I will cite to the specification using the following formats: EX1001, '450 patent, 1:1-10 (long form) and EX1001, 1:1-10 (short form). These example citations both point to the '450 patent specification at column 1, lines 1-10.

5. I am being compensated by VWGoA at my standard hourly rate for the time I spend in connection with this proceeding. My compensation is not dependent in any way on the substance of my opinions or in the outcome of this proceeding.

II. Grounds of Unpatentability

6. In forming my opinions about the '450 patent, I have considered the following grounds of unpatentability. Based on my review of the prior art references that form the basis of these grounds, it is my opinion that claims 1-18 of the '450 patent would have been obvious to a person of ordinary skill in the art ("POSITA") as of September 28, 2005.

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

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Ground	Basis	Claims	References
4.	§ 103	6, 12, and 18	Vijayan475 + Wu + Choi

7. I have been asked to consider how a POSITA would have understood the challenged claims in light of the disclosures of the '450 patent. I also have been asked to consider how a POSITA would have understood the prior art references Vijayan089, Vijayan475, Laroia, Wu, and Choi. Further, I have been asked to consider and provide my technical review, analysis, insights, and opinions regarding whether a POSITA would have understood that the combinations of the prior art references listed in the table above render obvious claims 1-18 of the '450 patent.

III. Qualifications

8. In formulating my opinions, I have relied upon my training, knowledge, and experience in the relevant art. I have over 32 years of experience working with wireless communication systems, and 30 years specifically working with OFDM systems. As detailed below, I have worked on many projects that are highly relevant to the subject matter of the '450 patent.

9. In particular, I have experience in the field of wireless communications through my education, my research work and my teaching. I earned a Bachelor of Arts in mathematics with honors from Bryn Mawr College in 1979. After working in industry as a programmer/analyst for the IIT Research

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Institute and SRI International, I went back to school at Stanford University and earned a Master's in Electrical Engineering. I then worked for a medical electronics company as a signal processing engineer and in 1989 returned to Stanford to pursue my Ph.D. in Electrical Engineering in wireless communications; my thesis was on Orthogonal Frequency Division Multiplexing (OFDM).

10. Since graduating from Stanford with my Ph.D., I have published over 60 journal and conference papers in digital communications, two book chapters, and edited one book on transmission techniques for wireless communications. My research has focused mainly on OFDM and has spanned the areas of cellular communications, wireless LANs, digital subscriber lines (DSL), LiFi and underwater communications. I am a joint inventor on three US Patents, one on smart antennas and two on DSL.

11. I have researched communications and taught both undergraduate and graduate courses in digital and wireless communications at universities in the United States (Stanford University, Purdue University, and Santa Clara University) and Sweden (Lulea University of Technology and the Royal Institute of Technology). I also worked in industry at Agilent Laboratories, and ArrayComm, a smart antenna company. I have also consulted for companies. While a researcher at Lulea University of Technology in the late 90's I worked with my students on OFDM; we published papers that have been heavily cited including one on

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multiple access for OFDM in cellular system. During the period of 2005-2006, I consulted for Texas Instruments on the LTE standard, working on modeling the physical layer and on handover schemes. Since 2006, I have been teaching at Santa Clara University in the Electrical and Computer Engineering Department where I am a full professor.

12. I have worked within my professional society, the IEEE Communications Society as an associate editor for top-tier journals. From 2009-2011, I was the Editor-in-Chief of IEEE Communications Letters. Then from 2012-2013, I was Director of Journals and from 2014-2015 I was the Vice-President for Publications for the IEEE Communications Society.

13. My community has acknowledged this work through awards. I became an IEEE Fellow in 2014 “for contributions to OFDM.” I also received the Joseph LoCicero Award for Exemplary Service to Publications, “For sustained and innovative contributions to Publications” in 2017 from the IEEE Communications Society. In 2018 I was awarded the IEEE Education Society Harriett B. Rigas award for “for excellence in communications engineering, education and promoting equity.”

14. A copy of my *curriculum vitae* is provided as EX1004, which contains further details on my experience, technical expertise, and other qualifications.

IV. Materials Considered

15. In formulating my opinions, I have relied upon my training, knowledge, and experience that are relevant to the '450 patent. Furthermore, I have considered specifically the following documents listed below in addition to any other documents cited in this declaration:

<i>Exhibit No.</i>	<i>Description</i>
1001	U.S. Patent No. 10,447,450 to Li <i>et al.</i> (“’450 patent”).
1002	Prosecution History of U.S. Patent No. 10,447,450 (“Prosecution History”).
1004	<i>Curriculum Vitae</i> of Dr. Sarah Kate Wilson
1005	U.S. Patent Pub. No. 2005/0058089 to Vijayan <i>et al.</i> (“Vijayan089”).
1006	U.S. Patent Pub. No. 2005/0141475 to Vijayan <i>et al.</i> (“Vijayan475”).
1007	U.S. Patent Pub. No. 2005/0277429 to Laroia <i>et al.</i> (“Laroia”).
1008	U.S. Patent Pub. No. 2005/0063345 to Wu <i>et al.</i> (“Wu”).
1009	U.S. Patent Pub. No. 2005/0243774 to Choi <i>et al.</i> (“Choi”).
1010	Petition (Paper 3), <i>Dell Inc. v. Neo Wireless LLC</i> , IPR2021-01486, filed September 16, 2021
1011	Ding Declaration (EX1003), <i>Dell Inc. v. Neo Wireless LLC</i> , IPR2021-01486, filed September 16, 2021
1012	Patent Owner’s Preliminary Response (Paper 7), <i>Dell Inc. v. Neo Wireless LLC</i> , IPR2021-01486, filed December 20, 2021

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<i>Exhibit No.</i>	<i>Description</i>
1013	Alberth Declaration (EX2001), <i>Dell Inc. v. Neo Wireless LLC</i> , IPR2021-01486, filed December 20, 2021
1014	Decision Denying Institution (Paper 10), <i>Dell Inc. v. Neo Wireless LLC</i> , IPR2021-01486, issued March 16, 2022
1015	U.S. Patent Pub. No. 2005/0157803 to Kim <i>et al.</i> (“Kim”)
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”)
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)
1021	U.S. Patent Pub. No. 2005/0073973 to Laroia <i>et al.</i> (“Laroia973”).
1022	U.S. Patent Pub. No. 2008/0192851 to Golitschek Edler Elbwart <i>et al.</i> (“Golitschek”).
1023	U.S. Patent Pub. No. 2005/0135324 to Kim <i>et al.</i> (“Kim”)
1024	U.S. Patent Pub. No. 2006/0039274 to Park <i>et al.</i> (“Park274”)
1025	U.S. Patent Pub. No. 2008/0123593 to Fujita <i>et al.</i> (“Fujita”)
1026	U.S. Patent Pub. No. 2006/0285481 to Lane <i>et al.</i> (“Lane”)
1027	U.S. Patent Pub. No. 2006/0046647 to Parikh <i>et al.</i> (“Parikh”)
1028	U.S. Patent No. 6,039,624 to Holmes (“Holmes”)
1029	U.S. Patent Pub. No. 2005/0197123 to Chang <i>et al.</i> (“Chang”)
1030	U.S. Patent Pub. No. 2005/0075148 to Park (“Park148”)

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Exhibit No.	Description
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.
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. 4, 1971, pp. 628-634.
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.
1034	J. Bingham, <i>Theory and Practice of Modem Design</i> , John Wiley and Sons, 1988.
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.
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.
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.

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<i>Exhibit No.</i>	<i>Description</i>
1038	C. Reiners and H. Rohling, “Multicarrier transmission technique in cellular mobile communications systems,” <i>Proceedings of IEEE Vehicular Technology Conference (VTC)</i> , vol.3, 1994, pp. 1645-1649.
1039	M. Wahlquist, 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.
1043	U.S. Patent No. 7,221,680 to Vijayan <i>et al.</i> (“Vijayan680”).
1044	U.S. Patent No. 7,948,944 to Li <i>et al.</i>
1045	Prosecution History for U.S. Patent Application 11/908,257 corresponding to U.S. Patent No. 7,948,944
1046	U.S. Patent No. 9,735,944 to Li <i>et al.</i>
1047	Prosecution History for U.S. Patent Application 14/720,554 corresponding to U.S. Patent No. 9,735,944

16. To the best of my knowledge, the above-mentioned documents and materials are true and accurate copies of what they purport to be. An expert in the field would reasonably rely on them to formulate opinions such as those set forth in this declaration.

17. I have also relied upon various legal principles (as explained to me by VWGoA’s counsel) in formulating my opinions. My understanding of these principles is summarized below.

V. Legal Understanding

A. My Understanding of Claim Construction

18. I understand that during an *inter partes* review proceeding, claims are to be construed in light of the specification as would be read by a person of ordinary skill in the relevant art at the time the application was filed. I understand that claim terms are given their ordinary and customary meaning as would be understood by a person of ordinary skill in the relevant art in the context of the entire disclosure. A claim term, however, will not receive its ordinary meaning if the patentee acted as his own lexicographer and clearly set forth a definition of the claim term in the specification. In this case, the claim term will receive the definition set forth in the patent.

B. My Understanding of Obviousness

19. I understand that a patent claim is invalid if the claimed invention would have been obvious to a person of ordinary skill in the art at the time the application was filed. I understand that this means that even if all of the requirements of the claim cannot be found in a single prior art reference that would anticipate the claim, the claim can still be invalid.

20. To obtain a patent, a claimed invention must have been, as of its priority date, nonobvious in view of the prior art in the field. I understand that a patent claim is obvious when the differences between the subject matter sought to

be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art.

21. I understand that to prove that prior art or a combination of prior art renders a patent obvious, it is necessary to: (1) identify the particular references that, singly or in combination, render the patent obvious; (2) specifically identify which elements of the patent claim appear in each of the asserted references; and (3) explain how the prior art references could have been combined in order to create the inventions claimed in the asserted claim.

22. I also understand that prior art references can be combined under several different circumstances. For example, it is my understanding that one such circumstance is when a proposed combination of prior art references results in a system that represents a predictable variation, which is achieved using prior art elements according to their established functions.

23. I also understand that when considering the obviousness of a patent claim, one should consider whether a teaching, suggestion, or motivation to combine the references exists so as to avoid impermissibly applying hindsight when considering the prior art. I understand this test should not be rigidly applied, but that the test can be important to avoiding such hindsight.

24. I understand that certain objective indicia can be important evidence

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as to whether a patent is obvious or nonobvious. Such indicia include:

(1) commercial success of products covered by the patent claims; (2) a long-felt need for the invention; (3) failed attempts by others to make the invention; (4) copying of the invention by others in the field; (5) unexpected results achieved by the invention as compared to the closest prior art; (6) praise of the invention by the infringer or others in the field; (7) the taking of licenses under the patent by others; (8) expressions of surprise by experts and those skilled in the art at the making of the invention; and (9) the patentee proceeded contrary to the accepted wisdom of the prior art. At this point, I am not aware of any secondary indicia of non-obviousness. But, I reserve the right to review and opine on any evidence of objective indicia of nonobvious that may be presented during this proceeding.

25. I also understand that “obviousness” is a legal conclusion based on the underlying factual issues of the scope and content of the prior art, the differences between the claimed invention and the prior art, the level of ordinary skill in the prior art, and any objective indicia of non-obviousness. For that reason, I am not rendering a legal opinion on the ultimate legal question of obviousness. Rather, my testimony addresses the underlying facts and factual analysis that would support a legal conclusion of obviousness or non-obviousness, and when I use the term obvious, I am referring to the perspective of one of ordinary skill at the time of invention.

C. My Understanding of a Person Having Ordinary Skill in the Art

26. I understand that a person of ordinary skill in the relevant art (herein “POSITA”) is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity—not an automaton.

27. I have been asked to consider the level of ordinary skill in the field that someone would have had at the time the claimed invention was made. In deciding the level of ordinary skill, I considered the following:

- the levels of education and experience of persons working in the field;
- the types of problems encountered in the field; and
- the sophistication of the technology.

28. My opinion below explains how a POSITA would have understood the technology described in the references I have identified herein around the September 28, 2005 timeframe. I have been advised that the alleged earliest possible effective filing date for some claims of the ’450 Patent is September 28, 2005.

29. Regardless if I use “I” or a “POSITA” during my technical analysis below, all of my statements and opinions are always to be understood to be based

on how a POSITA would have understood or read a document at the time of the invention.

VI. Overview of the '450 Patent

30. U.S. Patent 10,447,450 (“the ’450 patent”) is titled “Method and System for Multi-Carrier Packet Communication with Reduced Overhead.” I understand that the ’450 patent a continuation in a chain of patents that claim priority to a provisional application. EX1001, codes (60), (63). Through a series of continuations, I note that the ’450 patent claims priority to a provisional application filed on September 28, 2005. EX1001, codes (60). I have been asked to use this date to conduct my analysis of the ’450 patent and the prior art discussed below.

31. The ’450 patent describes systems and methods for allocating time-frequency “zones” for OFDM communications between base stations and mobile devices. EX1001, Abstract. The patent describes using different zones for different application types, such as voice-over-IP (VoIP). *Id.*, Abstract, 2:45-57. The ’450 patent describes grouping communications into these zones to save overhead and reduce the number of bits needed to inform a mobile device of an allocated time-frequency resource space. *Id.*, 2:45-64, 7:28-39.

32. The '450 patent states that one way to define a zone or segment is to use a starting time-frequency coordinate as well as a value indicating the number of time-frequency units for the segment:

When the zones are further subdivided into time-frequency segments in accordance with certain rules, a mapping of packet streams to segment may be achieved using ***a one-dimensional offset with respect to the origin of the zone*** rather than the two-dimensional (i.e. starting time-frequency coordinate and ending time-frequency coordinate relative to the starting point of the zone) mapping method discussed above.

EX1001, 6:22-29.

33. Based on this definition, the '450 patent alleges that there is a reduction in the number of bits needed to map a data stream to a time-frequency segment. *Id.*, 5:54-57. As I further explain below, this goal—as well as using this time-frequency organization to achieve this goal—was well-known in the art prior to the '450 patent.

34. The '450 patent acknowledges that it was well known for bandwidth efficiency to be an important factor for wireless communication systems. *Id.*, 1:33–34. The '450 patent restates this goal and aims to address different applications having different sized application payloads. *Id.*, 1:34–40. The '450 patent states that the IEEE 802.16 (“WiMAX”) standard is inefficient when accounting for

different applications because its control overhead results in low spectral efficiency. *Id.*, 1:51–2:13.

35. To allegedly improve spectral efficiency, the '450 patent describes a system and method for minimizing the control overhead in a multi-carrier wireless communication network by using a “time-frequency resource.” *Id.*, 2:13–16, 2:45–47. One or more zones in the time-frequency resource may be dedicated for particular applications, such as VoIP applications. *Id.*, 2:47–50. By grouping applications of a similar type together within a zone, the '450 patent asserts that a reduction in the number of bits necessary for mapping a packet stream to a portion of the time-frequency resource can allegedly be achieved. *Id.*, 2:50–54.

36. Figure 3 depicts the basic structure for dividing a communication frame into a time and frequency domain. EX1001, 4:16-26. The frequencies are depicted as “subchannels” within a particular time slot. *Id.* As I will further discuss below, Figure 3 also depicts “basic resource units” having a time and frequency dimension.

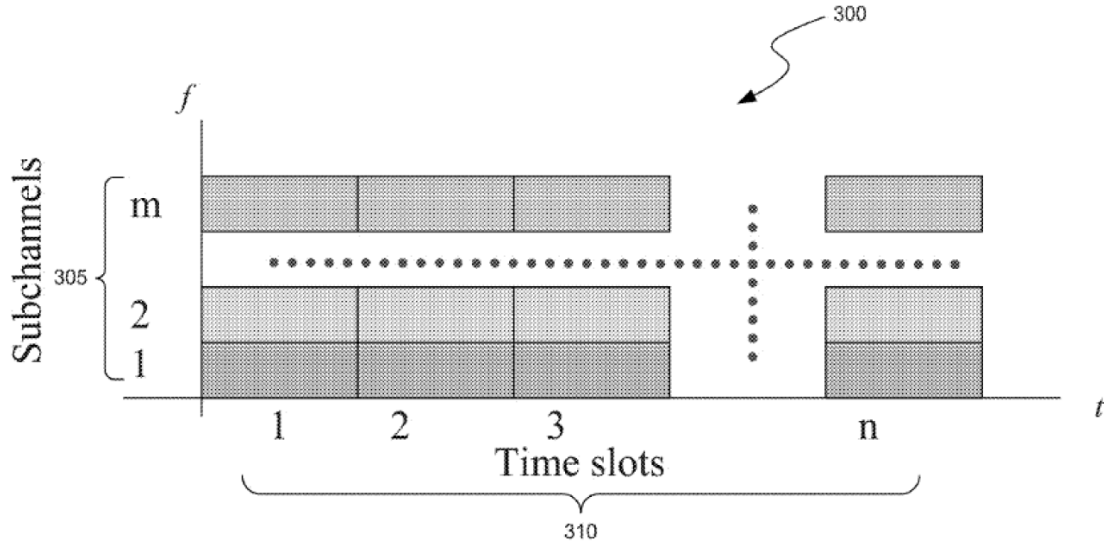


FIG. 3

EX1001, FIG. 3.

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

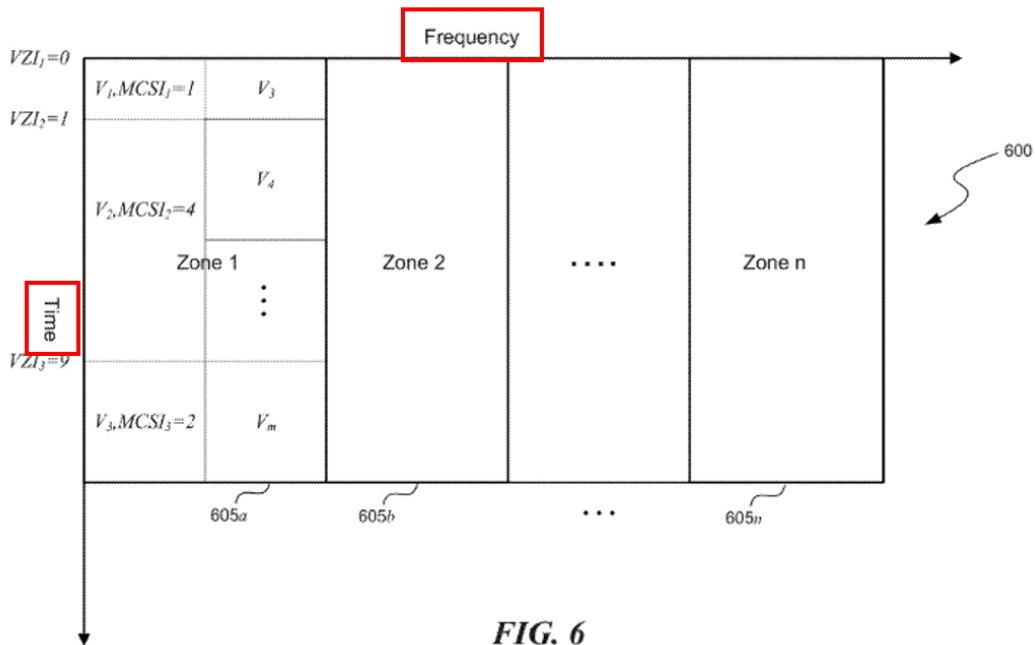


FIG. 6

EX1001, FIG. 6.

38. The '450 patent explains that Figure 6 depicts an alternative way of managing multiple packet streams to allegedly overcome the inefficiencies of the IEEE 802.16 standard. *Id.*, 5:34–43. In Figure 6, time-frequency resource 600 is divided into zones 605a, 605b, . . . 605n, each of which is associated with a particular type of application (e.g., VoIP, video applications). *Id.*, 5:43–49. By grouping like applications together, the '450 patent alleges that the amount of control overhead in MAC headers is reduced. *Id.*, 5:49–51. The '450 patent states that when applications are grouped together within a zone, a reduction in the number of bits necessary for mapping a packet stream to a time-frequency segment can be achieved. *Id.*, 5:54–57.

39. The '450 patent further explains that within each zone 605a, 605b, . . . 605n, the time-frequency resource may be further divided to accommodate multiple packet streams V1, V2, . . . Vm. EX1001, 6:3–6. Moreover, when the zones are further subdivided into time-frequency segments, a mapping of packet streams to segments may be achieved using a one-dimensional offset with respect to the origin of the zone rather than the two-dimensional (i.e., starting time-frequency coordinate and ending time-frequency coordinate relative to the starting point of the zone) mapping method discussed above. *Id.*, 6:22–29.

40. To perform the mapping for a particular zone or segment, the '450 patent describes the use of a “basic resource unit.” *Id.*, 6:45–52, 7:7–27. The '450

patent describes identifying the number of units for a segment using a modulation coding scheme (“MCS”) designation. The ’450 patent includes this 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).

41. As seen from Table 1, when a “first packet stream has an MCS of 1, [this] implies that one basic resource unit is used.” EX1001, 7:20-21. Similarly, when a “second packet stream has an MCS of 4, [this] implies that eight basic resource units are used.” *Id.*, 7:23-24. In this manner, the ’450 patent describes identifying a zone using a starting point or coordinate as well as indicating the number of basic time-frequency resource units for that zone. *Id.*, 7:7-24. The ’450 patent states that such a configuration reduces the number of bits required to represent a zone location within a time-frequency plane. *Id.*, 7:28–30. As I further discuss in the grounds below, however, this same technique was already known in the art and provided the same benefits recited in the ’450 patent. See Sections IX.B.3, X.B.3.

A. Prosecution History of the '450 Patent

42. Based on my review of the prosecution history, I note that the U.S. Patent and Trademark Office (“USPTO”) 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, 0081-0089. In response, the applicant canceled the original claims and submitted the claims that ultimately issued in the '450 patent. *Id.*, 0095-0099. The examiner subsequently issued a Notice of Allowance but did not provide any additional explanation as to why the '450 patent's claims were allowable. *Id.*, 0109-0110, 0114-0115.

43. I also reviewed the prosecution history for the other patents and applications in the chain of continuations. *See, e.g.*, EX1045, EX1047. In the Notice of Allowance for the first application in the chain of continuations (U.S. Patent No. 7,948,944 / U.S. Appl. No. 11/908,257), the examiner provided some rationale for allowing those claims, but those claims substantially differ from the claims of the '450 patent. EX1045, 0222-0228. Due to this difference of claim scope, the Examiner's rationale does not substantially influence the analysis of the '450 patent claims.

44. During examination of the '257 application, the examiner considered U.S. Pat. No. 7,221,680 (EX1043)—which is the patent corresponding to EX1005 (“Vijayan089”). EX1045, 0166-0179. To overcome the reference, the applicant

amended the claims to add several limitations not present in the '450 patent.

EX1045, 0187-0193. Specifically, the applicant amended the claims to recite:

“the zone is designated for a type of application and is capable of carrying two or more packet streams associated with the type of application, each of the two or more packet streams associated with the type of application utilizing one of a plurality of modulation and coding schemes, the plurality of modulation and coding schemes utilizing a basic time-frequency resource unit and integer multiples of the basic time-frequency resource unit; and wherein

the portion of the ~~airlink~~time-frequency resource falling outside of the zone is capable of carrying two or more packet streams not associated with the type of application;”

EX1045, 0187; EX1044, Claim 1.

45. This claim language is not present in the claims of the '450 patent, and indeed the '450 patent's claims are substantially broader. Specifically, the independent claims of the '450 patent do not refer to “zones “ that are designated for a type of application and the “zones” being capable of carrying ***two or more packet streams*** of that type. *See, e.g.*, EX1001, claim 1. The claims of the '450 patent also do not include the requirement that “each of the two or more packet streams” utilize “one of a plurality of modulation and coding schemes” where the “plurality of modulation and coding schemes utilizing a basic time-frequency

Declaration of Sarah Kate Wilson
U.S. Patent No. 10,447,450

resource unit and integer multiples of the basic time-frequency resource unit.” *Id.* The ’450 patent claims also do not refer to portions of time-frequency resources falling outside of a zone also carrying two or more packet streams. *Id.*

Similarly, I also reviewed the prosecution history for U.S. Patent No. 9,735,944 / U.S. Appl. No. 14/720,554. (EX1046, EX1047). I note that the allowed claims recite “quadrature phase-shift keying (QPSK) modulated signal from the base station over a zone of time-frequency resource that is allocated for an application type.” EX1046, Claim 1; EX1047, 0093-0100. This language is also not present in the claims of the ’450 patent. Specifically, the ’450 patent claims do not recite an “application type.”

46. In this manner, the claims at issue in the ’450 patent are significantly different and broader than those considered in the parent applications. I note that the Examiner for the ’450 patent did not analyze Vijayan089 in any rejection and that Vijayan089 is not cited on the face of the ’450 patent. EX1001. Vijayan089, however, discloses a substantial portion of the features of the claims as I further discuss below. *See* Section IX. In addition to Vijayan089, Vijayan475 also discloses these claim features and in a different way from Vijayan089. *See* Section X.

B. *Dell Inc. v. Neo Wireless LLC (IPR2021-01486)*

47. I understand that the '450 patent was also challenged at the PTAB via a previous IPR petition with a corresponding declaration. *See* EX1010, EX1011. I understand that Dell Inc. and Dell Technologies Inc. filed this petition (IPR2021-01486) on September 16, 2021 and challenged 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, IEEE Standard for Local and metropolitan area networks, Part 16: Air Interface for Fixed Broadband Wireless Access Systems (Oct. 1, 2004) (EX1016). EX1010, 1. On December 20, 2021, Neo Wireless submitted a Preliminary Response supported by its own expert declaration. *See* EX1012, EX1013. On March 16, 2022, the Board issued a decision denying institution of the IPR. *See* EX1014.

48. In denying institution, the Board focused on Neo Wireless's expert testimony describing and characterizing the '450 patent. EX1014, 2, 25-27. Specifically, the Board determined that the proposed combination of Kim and IEEE802.16-2004 did not teach or suggests a "time-frequency coordinate" or a "time-frequency resource unit." *Id.*, 26-27. The Board referenced the following argument from Neo Wireless and its expert:

Just as in the IEEE 802.16 standard expressly distinguished in the background of the patent, these two references merely

describe time units (symbols) and frequency units (subchannels) and suggest no “time-frequency” resource unit that transforms the time and frequency units into one combined dimension as disclosed and claimed by the ’450 patent.

Id., 25 (citing EX1012, 10).

49. The Board also referenced Neo Wireless additional explanation that:

[B]y transforming time and frequency to a single dimension—time-frequency—measured in time-frequency resource units, the invention can use ***two parameters to map a packet stream: the starting time-frequency coordinate and N, the number of time-frequency resource units.*** Ex. 1001[,] 6:3–21, 7:7–39. Because there is no time-frequency dimension taught in Kim or IEEE802.16-2004, the combination lacks both innovative parameters. Instead, the combination of Kim and IEEE802.16-2004 uses an independent time dimension and an independent frequency dimension and requires four parameters to map a packet stream, just like the prior art distinguished in the Background of the ’450 patent.

Id., 25-26 (citing EX1012, 10) (emphasis added).

50. In view of these arguments, the Board determined that the Petitioner’s arguments relied on a “conflation of 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.’”

Id., 27. The Board then ultimately denied institution. *Id.*, 29.

51. As I further explain below, the deficiencies identified by the Board are not present in the Grounds presented in this declaration and in the corresponding Petition. See Sections IX.B.3, X.B.3. Vijayan089 and Vijayan475 both describe time-frequency resource units and using a number of time-frequency resource units when allocating a communication segment. *Id.*

C. Level of Ordinary Skill in the Art

52. In my opinion, a person of ordinary skill in the art (“POSITA”) in the context of the ’450 patent as of September 28, 2005 (the earliest priority date of the ’450 patent), would have a B.S. degree in electrical engineering, computer engineering, or computer science, or an equivalent field, as well as at least 3-5 years of academic or industry experience in mobile wireless communications, or comparable industry experience. A greater amount of education, i.e., a doctorate in electrical engineering, computer engineering, computer science, or an equivalent field would also qualify as a POSITA for the ’450 patent in lieu of a B.S. degree. Experience could take the place of some formal training, as domain knowledge may be learned on the job. This description is approximate, and a higher level of education or skill might make up for less experience and vice versa.

53. I am well qualified to determine the level of ordinary skill in the art. I am very familiar with the technology of the '450 patent during the September 2005 timeframe. As mentioned above, by 2005, I had obtained both a Masters and a Ph.D. in Electrical Engineering from Stanford University and had acquired extensive experience relating to wireless communication systems. Specifically, by 2005 I had acquired experience in OFDM used in mobile and wireless communication systems. I thus also qualify as a POSITA for the '450 patent.

D. Claim Construction

54. I have been instructed that the challenged claims of the '450 patent are to be given their ordinary and customary meaning as understood by one of ordinary skill in the art at the time of the invention in light of the specification and the prosecution history pertaining to the patent. Based on my review of the challenged claims, it is my opinion that none of the claim terms require explicit constructions. Accordingly, all claim terms should receive their plain and ordinary meaning, in the context of the '450 patent specification, which I understand is sometimes referred to as the *Phillips* standard.

55. I understand that in a previous litigation, Neo Wireless provided certain positions regarding some of the claim terms of the '450 patent. EX1020, 0004-0005, 0010. In general, I do not dispute these positions. The grounds of

unpatentability discussed below still render the claims obvious even under the constructions provided by Neo Wireless. *Id.*

56. Regarding Claim 7, I understand that Neo Wireless argued that the preamble should be limiting and that it should receive its plain and ordinary meaning. *Id.*, 0005. I also understand that for the term “the segment having a starting time-frequency coordinate,” Neo Wireless stated that the term should receive its plain and ordinary meaning and that no construction was necessary. *Id.*, 0010. Regarding these terms, I also agree that they should receive their plain and ordinary meaning.

57. Additionally, I understand that Neo Wireless provided a construction for the term “configured to.” *Id.*, 0004. Neo Wireless proposed a construction as follows: “An apparatus/element is ‘configured to’ perform a function if it includes hardware and/or software enabling the apparatus/element to perform the function.” *Id.* I believe that the term should receive 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.

VII. Background of the Technology

58. I understand that analyzing the state of wireless or mobile communications during the years prior to the earliest possible priority date of

September 2005 can provide valuable insight into what people of ordinary skill in the art were aware of at the time, and in what direction the industry was taking.

59. Prior to the priority date of the '450 patent, all of the technology at issue in the '450 patent was broadly applied and well known by individuals working in the wireless or mobile communications industry in general. No individual elements of the '450 claims were new or novel by September 2005, and there was nothing new or novel about the way in which those elements were combined in the claims of the '450 patent.

60. Further, there were no technological barriers to combining these elements to form the claimed invention. Indeed, combining these elements would have yielded predictable results. Thus, the concepts of using time-frequency units to allocate communication resources and informing a mobile device of a starting time-frequency coordinate and a number of units for a communication segment were well known prior to September 2005. Below, I discuss this, and the other claimed technological aspects, in the prior art.

**A. Orthogonal Frequency Division Multiplexing (OFDM)
Communication Systems Were Well Known**

61. The '450 patent acknowledges that the IEEE 802.16 (WiMAX) standard was well-known and used to support wireless communications before September 2005. EX1001, 1:42-45. The WiMAX standard implements Orthogonal Frequency Division Multiplexing (OFDM), which the '450 patent adopts for its

system. *Id.*, 3:6-12. As I further explain below, OFDM systems were well-known in the art as demonstrated by Vijayan⁰⁸⁹, Vijayan⁴⁷⁵, Laroia, Wu, and Choi. EX1005, EX1006, EX1007, EX1008, EX1009. These are just a few of many prior art systems that describe the use of OFDM.

62. The '450 patent's application to OFDM is not surprising because OFDM, which allows for the transmission of multiple signals simultaneously, was first proposed in the 1960's as an analog technique, employing Frequency Division Multiple Access (FDMA). EX1031. FDMA is a way to separate signals in the radio spectrum; an example of this is commercial radio. The radio station, 91.7 FM is a frequency-modulated signal of bandwidth 200 kHz centered at 91.7 MHz. The other radio stations are separated in frequency, each one is centered at carrier frequency ideally 400 kHz away from other stations. A radio receiver uses a bandpass filter (filters out all frequencies except for the radio station of interest) to separate the desired radio station from all others.

63. In the 1970's the use of the discrete Fast Fourier Transform (FFT) for OFDM allowed the transmission of multiple subcarriers that were orthogonal. EX1032. Here, the bandwidth for the signal is divided into narrow bandwidths called subcarriers or tones; each tone sends separate information. For example, if the bandwidth of the signal is 5 MHz, one can divide the bandwidth into 100 subcarriers, each of bandwidth approximately 500 kHz. Because the signals are

separable in frequency (orthogonal) the receiver can recover the data from each subcarrier. OFDM can be thought of as a set of chords, each tone can be separated (hence orthogonal) at the receiver so the multiple messages can be recovered. The number of subcarriers or tones is related to the size of the FFT. Because FFTs depend on an algorithm based on powers of 2, the number of tones in an OFDM symbol is based on a powers of 2. Each tone carries a modulated symbol, e.g. QPSK modulation.

64. Starting in the 1980's OFDM was used in telephone modems and later digital subscriber lines (DSL). EX1034; EX1035. Also in the 1980's OFDM was proposed for use in a fast-fading wireless channel. EX1033. OFDM would provide better diversity in fast-fading channel than a single-carrier system. In the 1990's, OFDM with forward error control coding across the subcarriers was proposed and adapted for the European Digital Audio Broadcast system, EX1036, as well as the Wireless LANs, EX1037. By the late 1990's, companies and universities were investigating using OFDM for cellular standards. EX1038; EX1039.

65. In the 1990's, OFDM was proposed for wireless LAN, e.g. EX1037 and cellular systems; EX1038; EX1039. In the 90's engineers debated the 3rd generation standard and one of the issues was CDMA versus OFDM. While the 2nd generation was the first digital voice standard, the 3rd generation cellular system was designed to allow voice, data and video.

66. This required techniques that allowed for different data rates and different delays. This is also referred to as Quality-of-Service, QoS. Allowing different QoS for different users and applications required a flexibility in the system. CDMA provides flexibility in rate through changing the number of chips per bit. OFDM can be divided into a time-frequency grid as shown in Figure 3 from Wahlquist below. EX1039. This flexibility can be used to assign different QoS resources to multiple users from the time-frequency grid. As expressed in EX1039, there is a push and pull between diversity and channel estimation. (Channel estimation is needed to compensate for different amplitudes and phases on each subcarrier.)

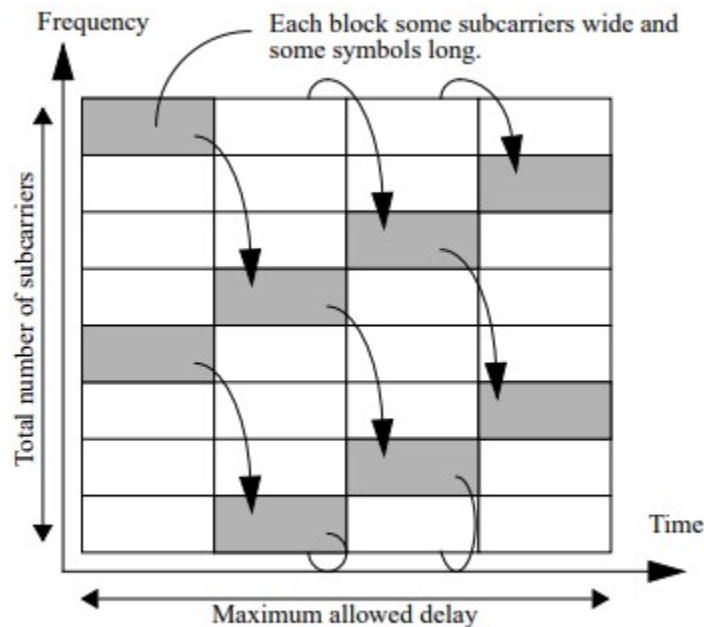


Figure 3: Example of block structure.

EX1039, FIG. 3.

67. As seen here, it was well-known to analyze OFDM communications using a time-frequency grid.

68. To provide some additional OFDM operational details, I will now discuss the structure of an OFDM signal. OFDM systems use multiple subcarriers rather than a single carrier. In a single-carrier system, the time period, T , of each signal is proportional to the inverse of the bandwidth B , i.e. T approximately $1/B$. If you divide the bandwidth into several narrow-band signals, each signal will have a wider time period; if the bandwidth B is divided into N subcarriers, the time period of each narrow band signal is proportional to N/B . This is illustrated in Figure A of my declaration below. Because an OFDM signal is comprised of several independent subsignals, the time-domain OFDM signal looks like a Gaussian random process (due to the Central Limit Theorem).

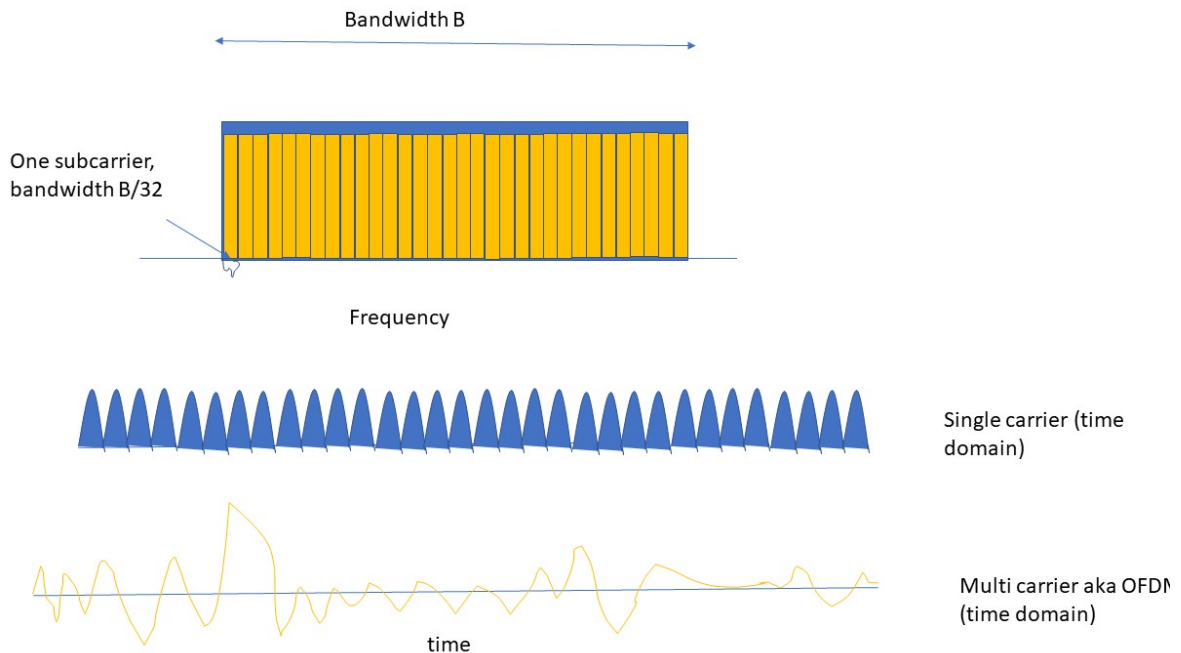


Figure A.

69. In this figure, a given bandwidth B is divided into 32 subcarriers. In time, a single-carrier system occupying the entire bandwidth will have a width, T . An OFDM symbol, comprised of the 32 carriers, will transmit 32 symbols worth of data over a period of $32T$ seconds. It should look like a Gaussian noise process due to adding up several random independent signals. As I will further explain below, it was well-known for such OFDM symbols to be communicated using multiple subcarriers and to use time-frequency planes to allocate OFDM signals.

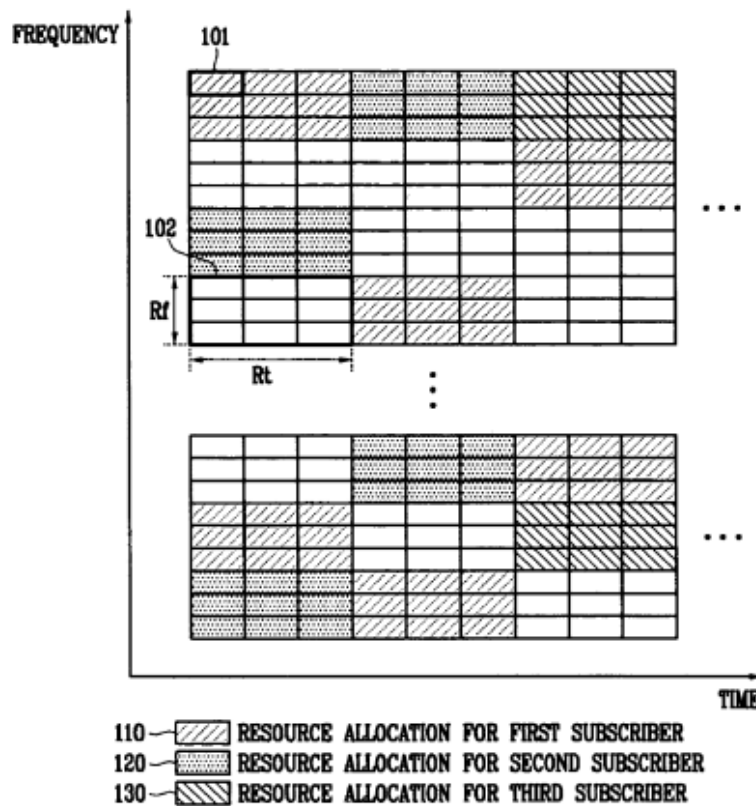
B. Using Time-Frequency Units to Allocate a Communication Segment was Well Known

70. As I further discuss below, both Vijayan089 and Vijayan475 disclose using time-frequency units to define a communication segment. See Sections

IX.B.3, X.B.3. Indeed, this concept was well known in the art and commonly applied to OFDM systems.

71. 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 demonstrated in U.S. Patent Pub. No. 2005/0135324 to Kim *et al.*, it was well-known to use “a time-frequency resource of a slot interval including OFDM symbols [] divided into traffic channels.” *Id.* Based on this time-frequency mapping, “modulated data symbols are processed by time-frequency mapping according to the resource-block-based mapping method to generate received symbols.” *Id.* Kim demonstrates also that it was well-known in the art to allocate “time-frequency resources to multiple subscribers” for OFDM communications. *Id.*, ¶¶49-50. One example of this allocation would be to use blocks of time-frequency resource units as depicted in the figure below. *Id.*, FIG. 1, ¶¶49-50.

FIG.1



EX1023, FIG. 1.

72. As seen from FIG. 1, it was well-known in the art to divide a time-frequency plane into a “time-frequency resource 101” or a “resource block 102.” EX1023, ¶50. A resource block 102 is a “minimum unit of resource allocation for transmission of a subscriber data packet” and is represented by “ R_f consecutive subcarriers in R_t consecutive OFDM symbols.” *Id.* As seen from Kim, it was well-known in the art to use time-frequency resource units to communicate in wireless networks.

73. Additionally, such time-frequency resource units have also been referred to as “allocation units” in the art. EX1024, ¶¶38, 46-47, 49. For example, U.S. Patent Pub. No. 2006/0039274 to Park *et al.* describes an “allocation unit” as a “unit for resource allocation and can be variously defined according to time, frequency, code, and direction of indexing.” *Id.*, ¶47. It was also 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. *Id.*, ¶70. “This means continuous resource allocation regions can be simply represented by assigning a start allocation unit index and a total number of the allocation units.” *Id.*, ¶¶53, 66.

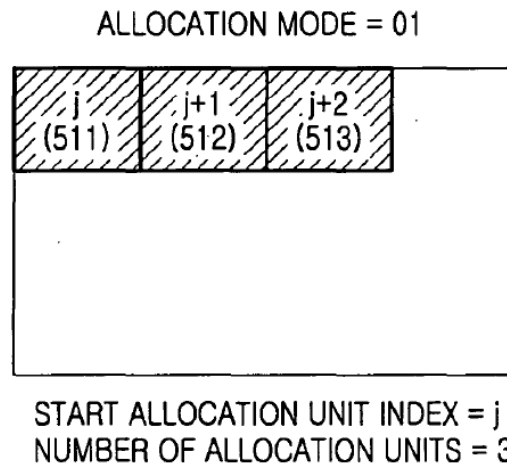


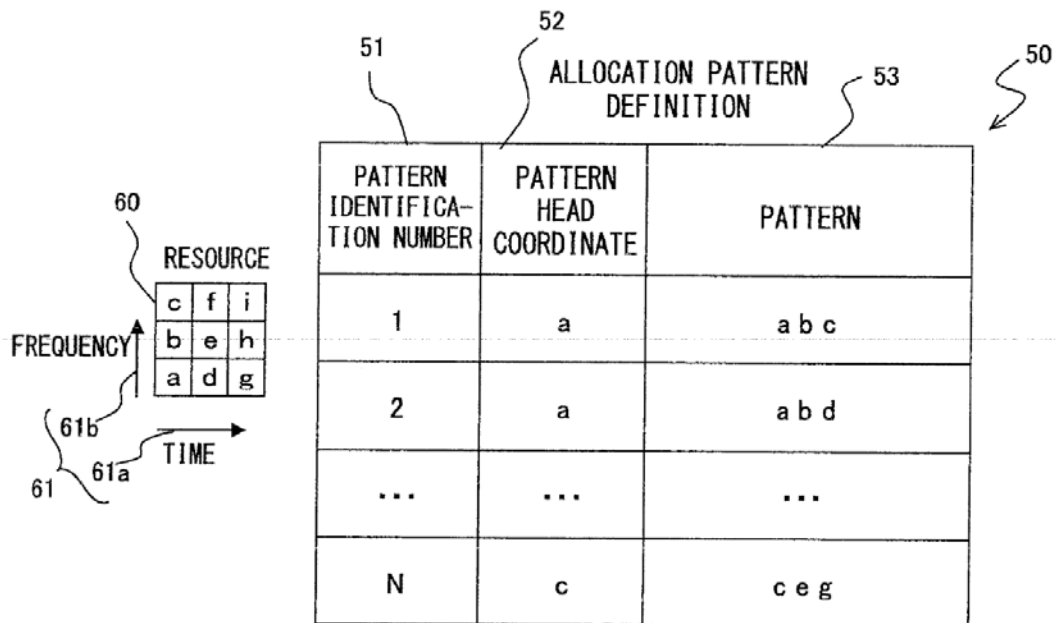
FIG.5B

EX1024, FIG. 5B.

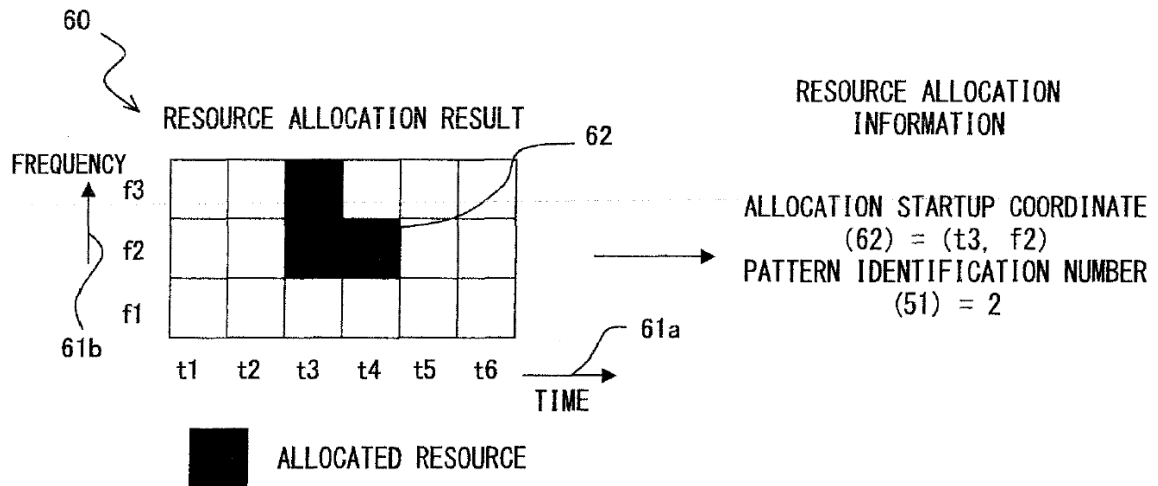
74. In addition to using a starting index and a number of units to define an allocated communication region, it was also a well-known goal to inform a

wireless device of this allocation using as little overhead or as few bits as possible.

EX1025, ¶¶15, 32, 34, 143. For example, U.S. Patent Pub. No. 2008/0123593 to Fujita *et al.* demonstrates that 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. *Id.*, ¶¶72-74. This configuration is depicted in Figures 5 and 6.



EX1025, FIG. 5.



EX1025, FIG. 6.

75. A pattern identification number specifies a pattern of allocated time-frequency units as indicated in the table from Figure 5. *Id.*, ¶¶69-74. When using such a 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.*

76. Mobile devices would store such a table—similar to the one depicted in Figure 5—in memory. *Id.*, ¶¶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.

77. In this manner, using time-frequency units was a well-known technique in the art and commonly used to allocate OFDM communication resources.

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

78. In addition to using time-frequency units, it was also well-known in the art to assign an identifier to a mobile device. As I will further discuss below, both Laroia and Wu disclose a base station assigning an identifier to a wireless device. *See* Sections IX.B.2, X.B.2. Indeed, this concept was well known in the art and commonly applied to OFDM systems.

79. For example, it was well-known in the art for base stations to assign wireless terminal identifiers when “making segment assignments.” EX1026, ¶¶43, 55, 67. As explained by U.S. Patent Pub. No. 2006/0046647 to Parikh et al., mobile device identifiers were ubiquitous in wireless communication networks including 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). As seen from these different communication networks and different identifiers, many identifiers were available and used in the art to facilitate communications with mobile devices.

80. The '450 patent describes an example identifier and discusses a “basic connection identification (BCID).” EX1001, 8:37-42, 9:4-29. A BCID, however, was also well-known in the art. EX1029, ¶¶3, 11-13; EX1030, ¶¶12-13, 53. For example, the IEEE 802.16e standard uses BCIDs to identify subscriber terminals serviced by a base station. 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 in the art.

VIII. Overview of the Applied References

81. I provide an overview of each of the applied references below.

A. U.S. Patent Pub. No. 2005/0058089 (Vijayan089)

82. Similar to the '450 patent, Vijayan089 discloses an OFDM communication system with base stations and wireless devices. EX1005, ¶¶36-37, 46-47, 107-111. Vijayan089 depicts this configuration in Figure 1.

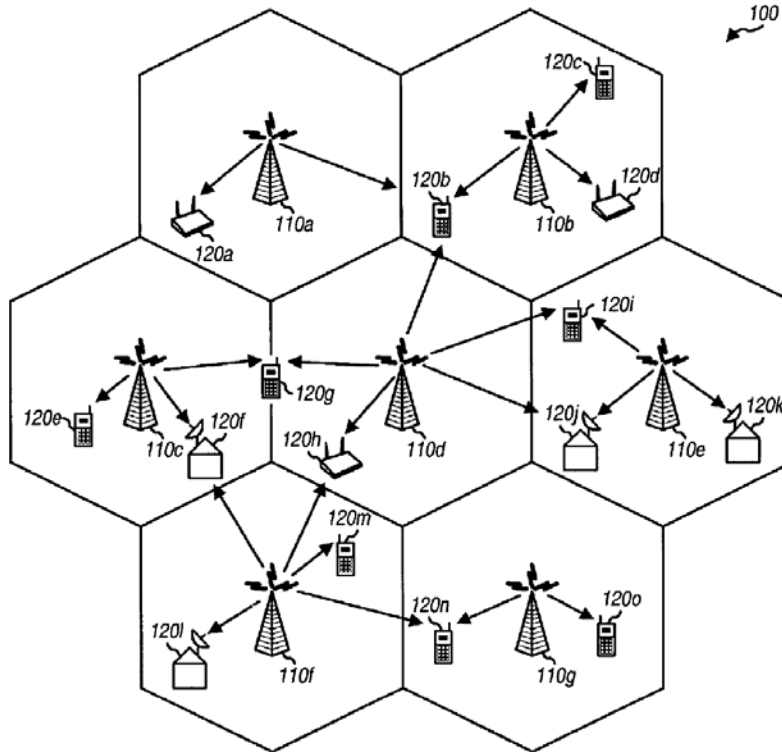


FIG. 1

EX1005, FIG. 1.

83. Within this context, Vijayan089 describes a frame structure for transmitting data from a base station to a wireless device. *Id.*, ¶¶38-45, 48-49. Specifically, a “super-frame” is composed of multiple “frames” as depicted in Figure 2. *Id.*, ¶¶38, 44-45.

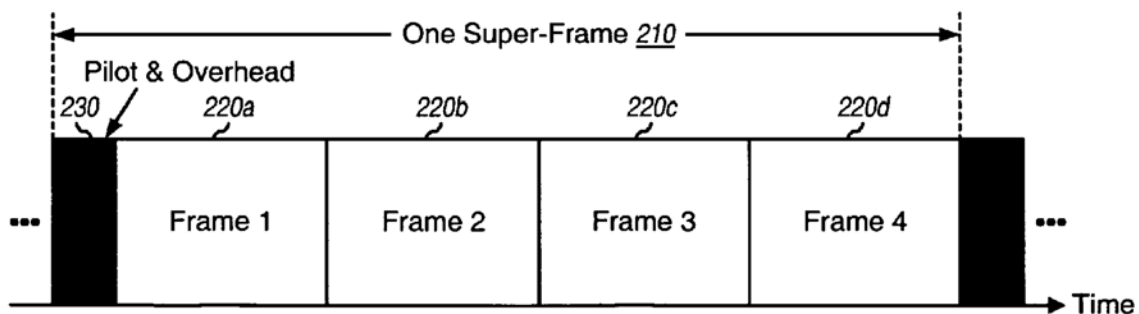


FIG. 2

EX1005, FIG. 2.

84. A frame is composed of “transmission units” that are defined as portions of a time and frequency plane. *Id.*, 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 explains that “subbands” refers to “tones, carriers, **subcarriers**, bins, and frequency channels. **With OFDM, each subband is associated with a respective subcarrier** that may be modulated with data.” *Id.*, ¶5.

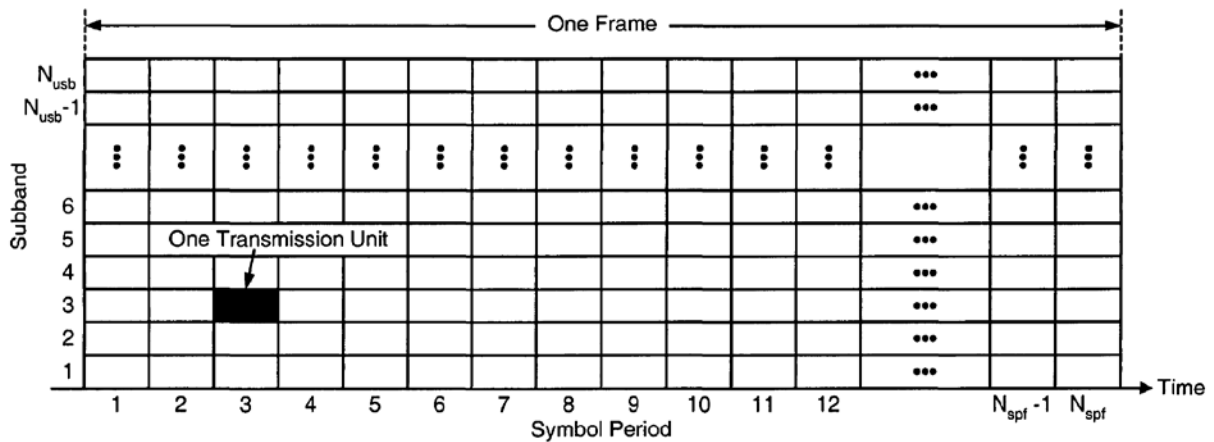


FIG. 4

EX1005, FIG. 4.

85. Vijayan089 also describes organizing transmission units into “transmission slots,” where each transmission slot includes a group of subbands. EX1005, ¶59; *see also id.*, ¶56. “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. Vijayan089 groups these transmission slots into time-frequency segments corresponding to different communication channels. *Id.*, ¶¶37, 47. A particular grouped segment corresponds to a “physical layer channel (PLC).” *Id.*, ¶¶37, 47. “Each active PLC is allocated resources from the time-frequency plane, as shown in FIG. 4. The allocated resources for each active PLC may be given in units of ‘transmission slots’ (or simply, ‘slots’).” *Id.*, ¶59. Vijayan089 depicts examples of these PLC segments in Figures 7A and 7B. *Id.*, ¶¶68-76.

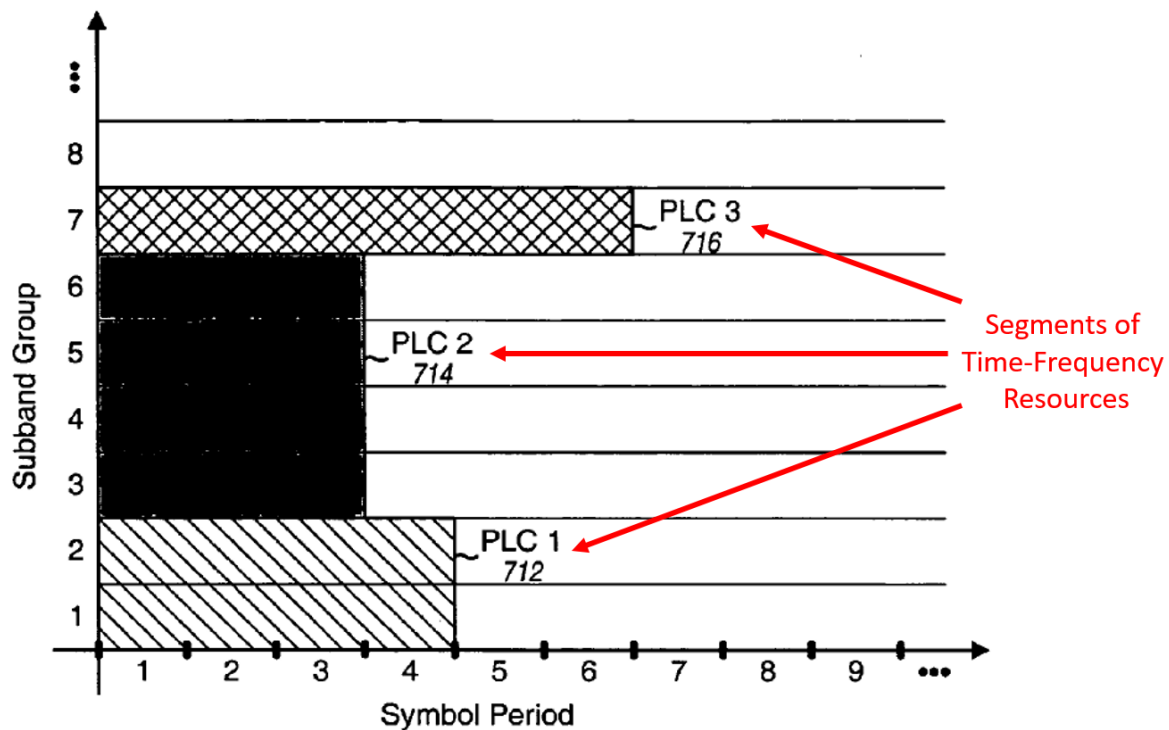


FIG. 7A

EX1005, FIG. 7A (annotated).

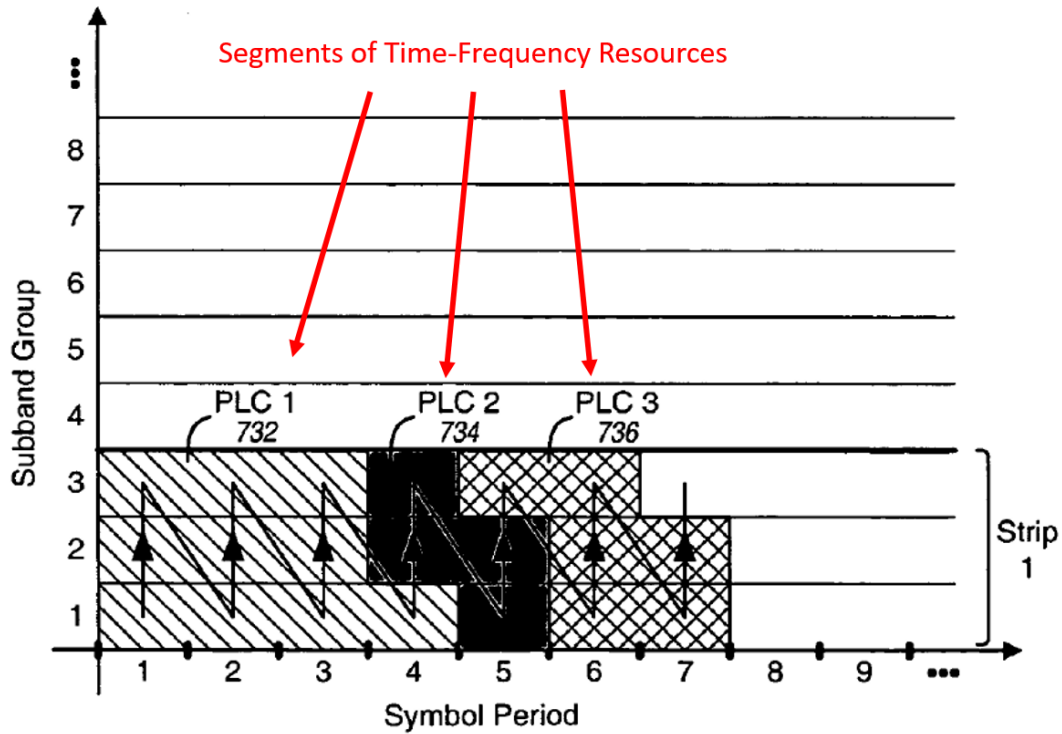
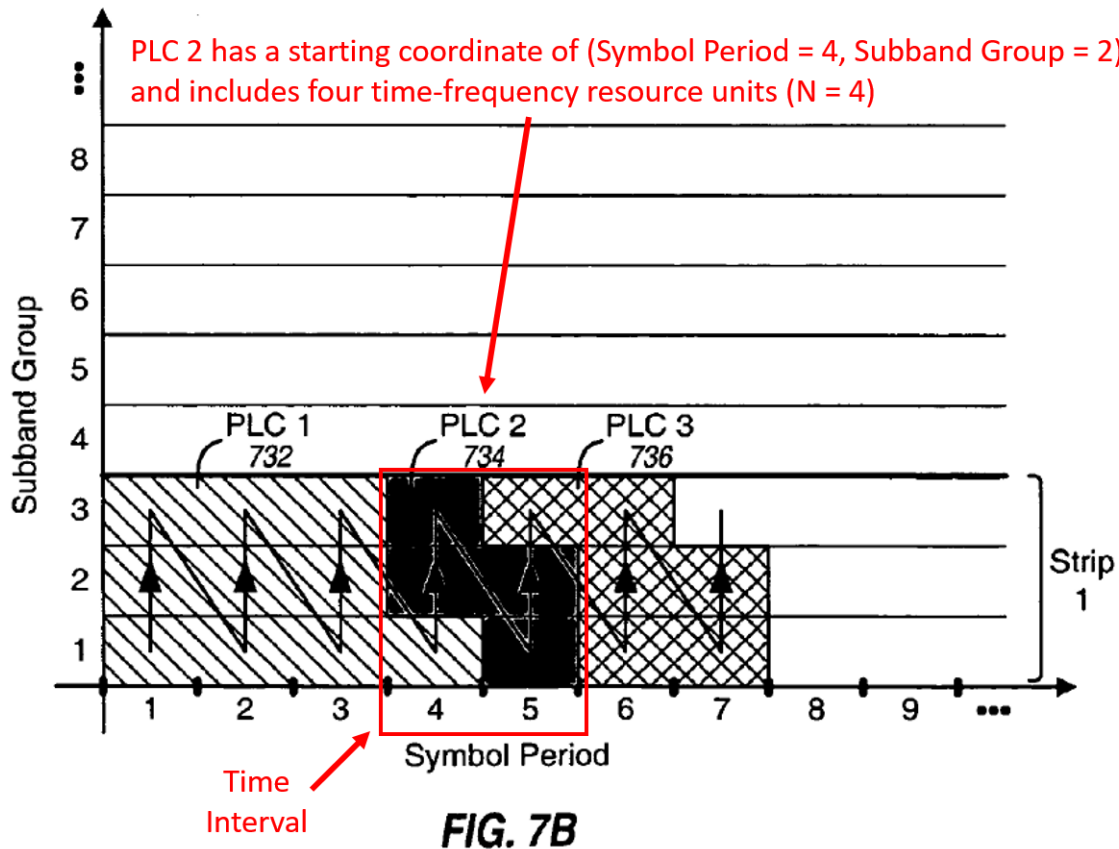


FIG. 7B

EX1005, FIG. 7B (annotated).

86. Vijayan089 describes its segments as including any number of transmission slots: “the segment assigned to each active PLC may include any number of slots.” EX1005, ¶74. For my discussion below, I will focus on segment 734 corresponding to PLC 2 as depicted in Figure 7B.



EX1005, FIG. 7B (annotated).

87. As seen from Figure 7B, segment 734 corresponding to PLC 2 includes four transmission slots within a time interval corresponding to symbol periods four and five. EX1005, ¶¶72-76. Similarly, segment 734 has a starting coordinate specified by symbol period = 4 and subband group = 2. *Id.* Vijayan089, like the '450 patent, explicitly states that a time-frequency resource segment may be defined by 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.*” *Id.*, ¶74.

88. Like the '450 patent, Vijayan089 also explains that using two parameters is beneficial to provide savings on overhead signaling bits. *Id.*, ¶76. Specifically, assigning transmission slots in this way “**reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC.**” *Id.* Using the process depicted in FIG. 7B, 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. The assignment of slots using one dimension discloses the same process described in the '450 patent and recited in its claims. *Id.*

89. In this manner and as I will further explain below with reference to the specific claim language, Vijayan089 discloses the same process of using a starting time-frequency coordinate and N-value indicating a number of time-frequency resources to inform a mobile device of an allocated time-frequency segment. *See* Section IX.B.3.

B. U.S. Patent Pub. No. 2005/0141475 (Vijayan475)

90. Vijayan475 is similar to Vijayan089 but provides a different process for conveying an allocated time-frequency resource segment and describes a “multiplexed logical channel (MLC)” rather than “physical layer channel (PLC).” EX1006, ¶¶9, 36-42. In this manner, and as I will further explain below, Vijayan475 also discloses assigning a segment using a starting time-frequency

coordinate and N-value but arrives at its definition of time-frequency resource segments differently from Vijayan089. See Sections IX.B.3, X.B.3. Vijayan475 uses parameters like “Start Offset,” “Slot Info,” and “Stream Lengths” parameters to define a starting time-frequency coordinate and N-value. See Section X.B.3; EX1006, ¶¶40, 42, 45-47, 56.

91. Like the '450 patent, Vijayan475 also discloses an OFDM communication system with base stations and wireless devices. EX1006, FIG.1, ¶¶26-27, 67-75. Within this context, Vijayan475 describes a frame structure for transmitting data from a base station to a wireless device. *Id.*, FIG. 2, Abstract, ¶¶10, 12, 29-32, 37-42, 45, 56-59. Specifically, a “super-frame” is composed of multiple “frames” as depicted in Figure 2. *Id.*, ¶¶29-31.

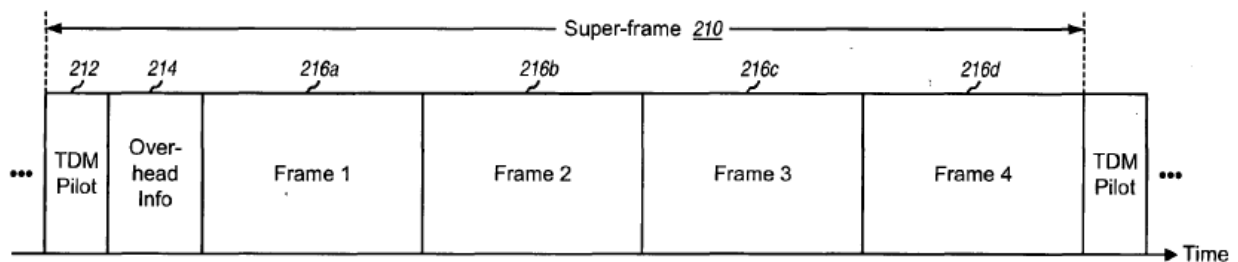


FIG. 2

EX1006, FIG. 2.

92. Each frame includes “slots” defined on a time-frequency plane. EX1006, FIG. 4, ¶¶36-42, 45-49, 56-57. Figure 4 depicts an example of a 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.” *Id.*, ¶¶40, 42, 45-49, 56.

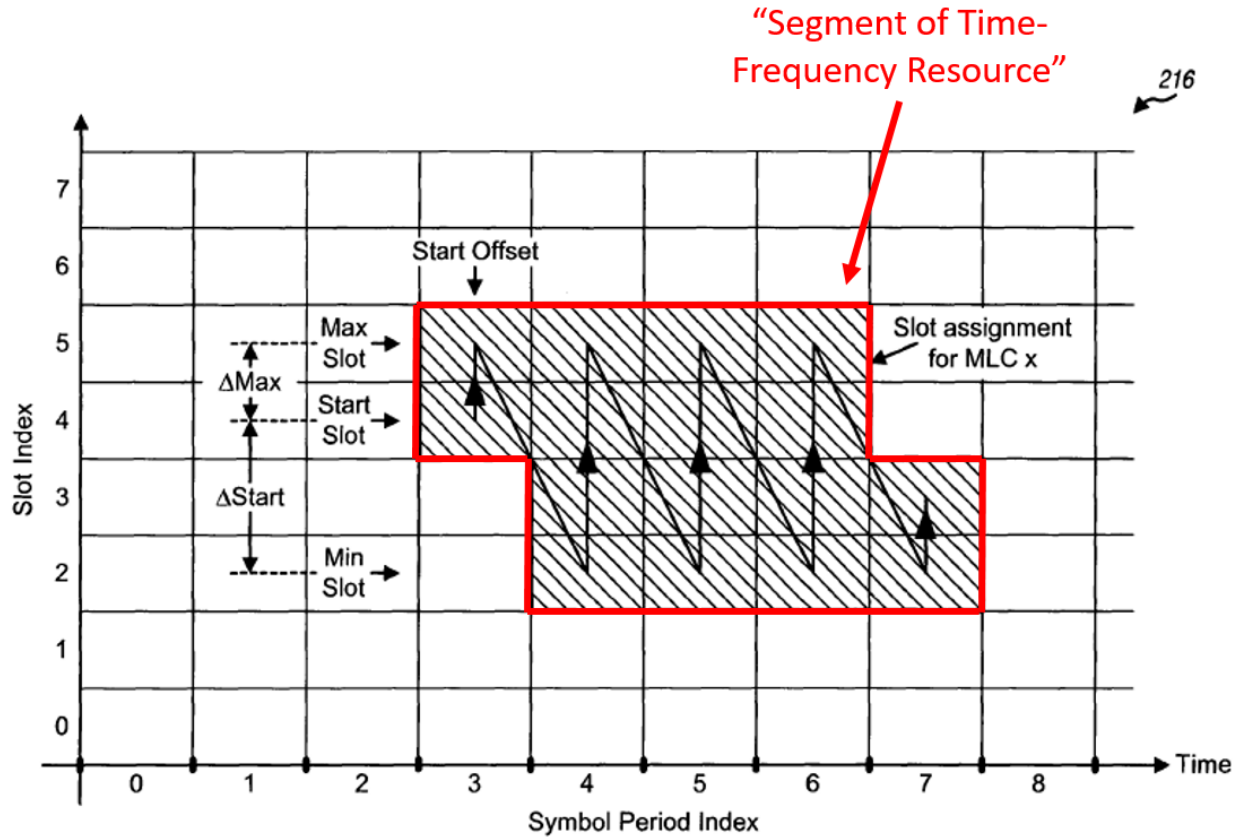


FIG. 4

EX1006, FIG. 4 (annotated).

93. Vijayan475 explains that a “fixed or variable number of slots in each super-frame” may be allocated for a multiplexed logical channel (MLC) segment “depending on the MLC’s payload, the availability of slots in the super-frame, and possibly other factors.” EX1006, ¶38. In the horizontal axis, a time value is identified based on Symbol Period Index values. *Id.*, FIG. 4, ¶40. In the vertical axis, groups of subbands or subcarriers are identified using a Slot Index value. *Id.*,

¶¶25, 36, 46. Specifically, Vijayan475 groups subcarriers into each slot: “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. “For the example shown in FIG. 4, MLC x is assigned 16 slots.” *Id.*, ¶40.

94. To define a segment, Vijayan475 uses “Start Offset” and “Slot Info” parameters to identify a starting time-frequency coordinate corresponding to “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		
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).

95. As I will further explain below, Vijayan475 also describes an encoding scheme to reduce the number of bits needed to convey the starting time-

frequency coordinate. EX1006, ¶¶40, 42, 46-49. Vijayan⁴⁷⁵ explains that the “slot information may be encoded to reduce the number of bits needed to convey this information.” *Id.*, ¶46. In this manner and like the ’450 patent, Vijayan⁴⁷⁵ also endeavors to reduce the amount of overhead signaling needed to convey a resource allocation to a wireless device. *Id.*, ¶¶38, 55.

96. As I will further explain below with reference to the specific claim language, Vijayan⁴⁷⁵ therefore discloses the same process of using a starting time-frequency coordinate and N-value indicating a number of time-frequency “slots” to inform a mobile device of an allocated time-frequency segment. *See* Section X.B.3.

C. U.S. Patent Pub No. 2005/0277429 (Laroia)

97. Laroia also describes an OFDM system where base stations service respective cells and communicate messages to wireless terminals within respective cells. EX1007, ¶¶38, 40, 53, 65, 109-111. In order to identify a particular wireless terminal to receive a transmitted message, Laroia describes its base station assigning specific wireless terminal identifications to the wireless terminals that it is servicing. *Id.*, ¶¶38, 40. For example, Laroia describes “terminal identification (ID) information” which “may be a ***base station assigned ID*** for [Wireless Terminal] WT 1.” *Id.*, ¶38. Laroia explains that the “WT identification information” may allow a wireless terminal to identify that it “is the specific intended recipient” for a particular message. *Id.*, ¶¶40, 53. The WT identification

information may include a “full WT identifier sufficient to uniquely identify the intended recipient” within a cell serviced by a base station. *Id.*, ¶40; *see also id.*, FIG. 2, FIG. 3, ¶¶38-39, 49, 53, 58. In this manner, Laroia describes assigning an identifier to a mobile station so that it can identify respective messages intended for receipt.

98. Laroia provides an example of this functionality with reference to Figure 5. In this example, a WT receives a signal (e.g., second paging signal 512) and uses a WT identifier to identify whether it is the intended recipient for the corresponding message. *Id.*, ¶¶63-65.

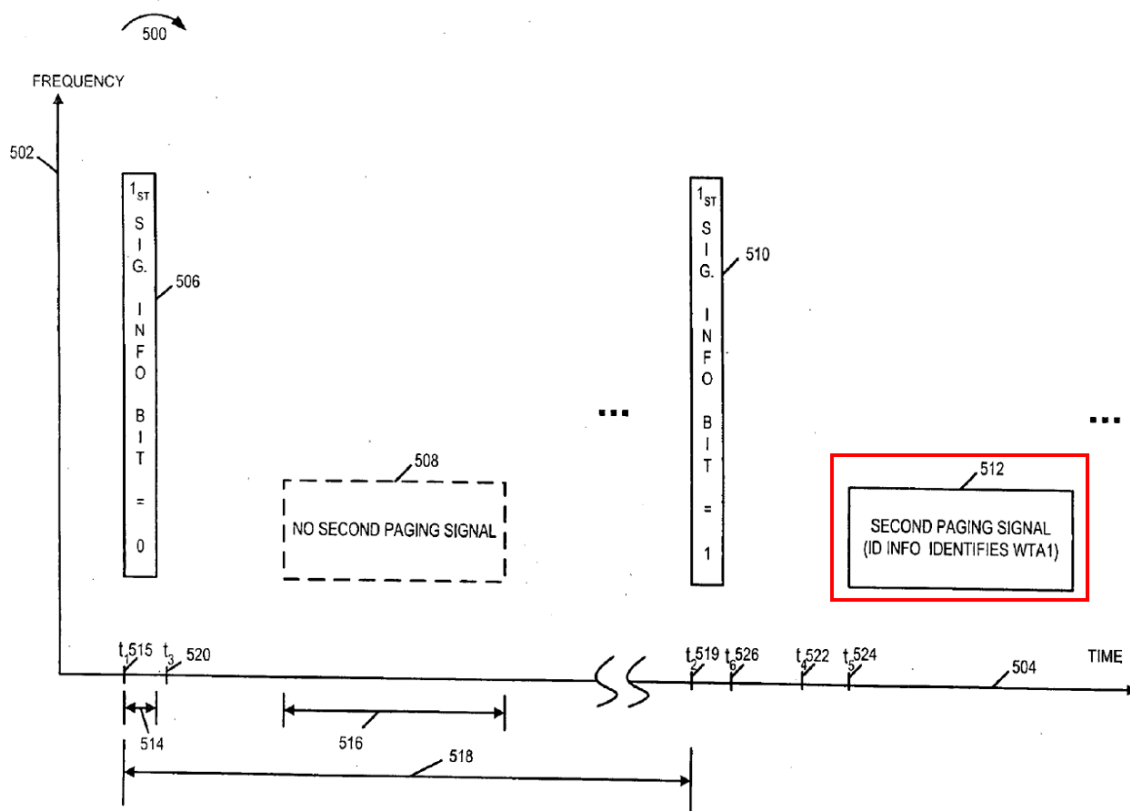


FIGURE 5

EX1007, FIG. 5 (annotated).

99. “FIG. 5 includes a graph 500 of frequency on the vertical axis 502 vs time on the horizontal axis 504.” EX1007, ¶63. In this case, there are “two users, WTA1 and WTA2, which both monitor the downlink channel” for paging signals. *Id.* At time t2 519, “both WTA1 and WTA2 wake up again and receive another first paging signal 510.” *Id.* The base station, however, may only have a message to be broadcast to WTA1 but not WTA2. *Id.* To indicate the desired WT for reception, the “**second paging signal 512 includes the paging identifier of user WTA1**. Upon the reception of the second paging signal 512, user WTA1 will follow the instruction, if any, included in the second paging signal message and **user WTA2 will return to the sleep state after determining that the identifier in signal 512 does not match WTA2's identifier.**” *Id.* In this manner, Laroia describes assigning an identifier to a wireless terminal so that (1) the base station can identify the wireless terminal intended to receive a message and (2) the wireless terminal can determine that it is the intended recipient of the message and recover the message. *Id.*, ¶¶38, 40, 53, 65, 109-11. As I explained in Section VII.C, the use of wireless device identifiers to perform this functionality was well known in the art prior to the ’450 patent.

D. U.S. Patent Pub. No. 2005/0063345 (Wu)

100. 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. In order to identify a particular wireless device to receive a transmitted OFDM message, Wu describes its base station assigning a **“sixteen bit UE identifier 165”** to each UE. *Id.*, ¶¶94, 98. The UE identifier **“identifies which receiver is to receive** the current HSDPA content.” *Id.* “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. *Id.*, ¶¶4, 87, 134. For example, FIG. 2 depicts a “downlink structure” with a corresponding “OFDM HSDPA” channel 30. *Id.*, ¶87.

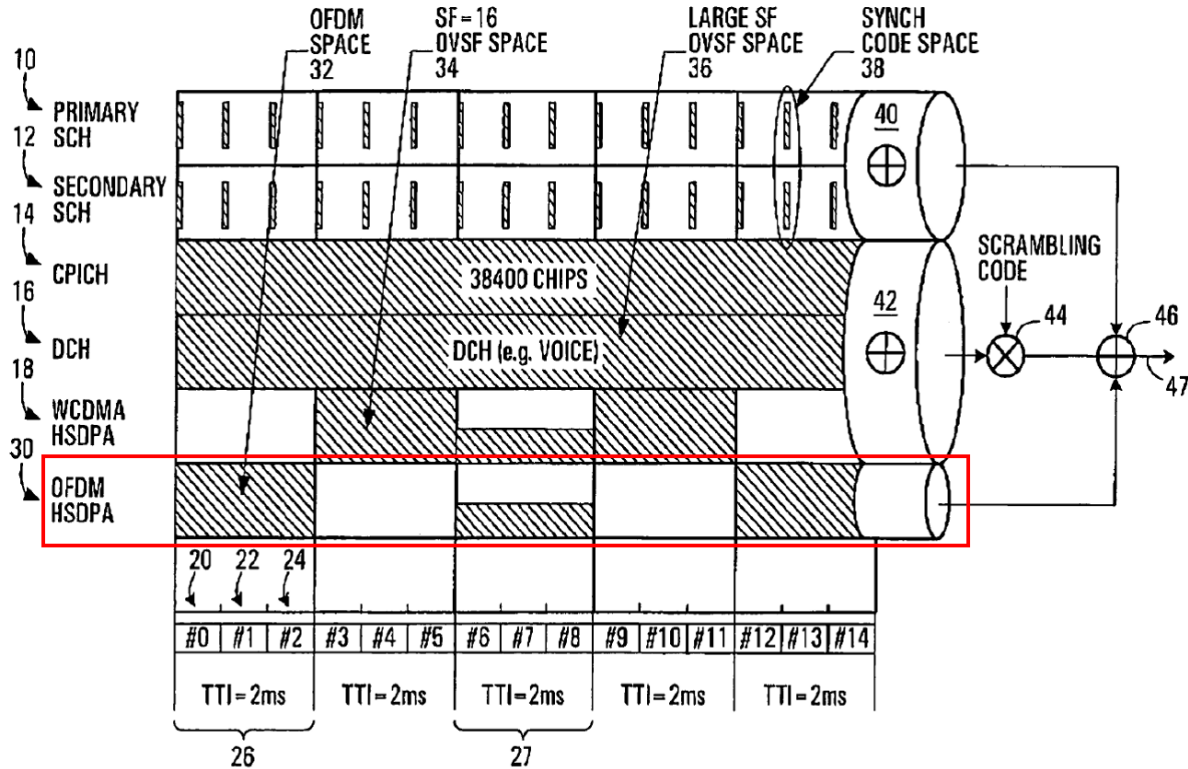


FIG. 2

EX1008, FIG. 2 (annotated).

101. Wu's base station assigns and uses the UE identifier when identifying to receivers "which OFDM slots and/or which CDMA slots are for a given receiver." 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. Using the identifier and slot information, the receiver determines whether it has a resource allocation scheduled for a particular slot and then demodulates the "OFDM slot only if scheduled during the slot." *Id.*, ¶¶25, 50. Wu also discloses a

mobile device using this identifier to recover corresponding content from specified slots in an “OFDM time-frequency plane” as well. *Id.*, ¶128.

102. In this manner, Wu describes assigning an identifier to a wireless device so that (1) the base station can identify the wireless terminal intended to receive a message and (2) the wireless device can determine that it is the intended recipient of the message and recover the message. *Id.*, Abstract, ¶¶33-34, 87, 94, 98. As I explained in Section VII.C, the use of wireless device identifiers to perform this functionality was well-known in the art prior to the ’450 patent.

E. U.S. Patent Pub. No. 2005/0243774 (Choi)

103. Choi describes a process for “transmitting data over a wireless channel.” EX1009, Abstract. Choi describes “enhancing the transmission of the data by further ***repetition encoding*** the data.” *Id.* This repetition coding may improve “error correction” and provide a “more robust data transmission scheme at reduced data rates.” *Id.*, ¶2. Choi explains this repetition coding can be applied to OFDM symbols as well. *Id.*, ¶¶16-18. When applying the repetition code, Choi explains:

The ***repetition code can be implemented either in the time domain or in the frequency domain. For time domain repetition, the OFDM symbols in the time domain*** (after the IFFT operation) ***are repeated a desired number of times***, depending on the data rate. This scheme has an advantage in

efficiency since just one guard interval is required for repeated OFDM symbols in the time domain.

Id., ¶16.

The **OFDM symbols can also be repeated in the frequency domain** (before the IFFT). The disadvantage of this scheme is that one guard interval has to be inserted between every OFDM symbol in the time-domain since the OFDM symbols with frequency-domain repetition are not periodic. However, **repetition in the frequency domain can achieve better multipath performance if the repetition pattern is configured in the frequency-domain to achieve frequency diversity.**

Id., ¶18.

104. Choi also explains that if desired, encoded data may be repeated in both the time and frequency domains: “Preferably, the values are repeated in the frequency domain, but the values may also be repeated in the time domain.” *Id.*, ¶13. When applying “repetition coding” to the time and frequency domains, Choi explains that “**the described techniques may be combined** or used separately according to specific system requirements.” *Id.*, ¶51. Thus, Choi discloses applying repetition coding in both time and frequency domains.

105. As I will further explain below with reference to Grounds 3 and 4, a POSITA would have found it obvious and would have been motivated to combine

Choi with Vijayan089-Laroia and/or Vijayan475-Wu to provide the error correction benefits of “repetition coding.” See Sections XI, XII.

IX. GROUND 1: Claims 1-5, 7-11, and 13-17 are unpatentable under 35 U.S.C. § 103 as obvious over Vijayan089 and Laroia

106. Vijayan089 and Laroia disclose each and every limitation of claims 1-5, 7-11, and 13-17. Vijayan089 explicitly discloses the majority of the claim elements recited claim 1. For example, Vijayan089 expressly discloses using time-frequency “transmission units” or “transmission slots” to allocate resources as well as using a starting time-frequency coordinate and an N-value of transmission slots to inform a wireless device of an allocation. See Section IX.B.3.

107. Laroia teaches that it would have been obvious to also include a wireless device identifier with this information to specifically identify or designate a wireless device to receive such information. Such a technique was well known in the art and often used to identify a particular wireless device from among multiple wireless devices. See Section VII.C. Laroia expressly discloses such a technique and describes assigning an identifier to a wireless terminal so that it can discern its own messages intended for reception. As I explain in further detail below, a POSITA would have found it obvious and would have been motivated to combine Vijayan089 and Laroia prior to the earliest filing date of the ’450 patent to also provide this capability.

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

108. A POSITA would have recognized that combining Vijayan089 and Laroia would have amounted to combining well-known prior art elements to yield predictable results. As I explained in Section VII.C, assigning a wireless device identifier was a well-known technique in the art prior to the '450 patent. With respect to the Vijayan089 and Laroia combination, a POSITA would have applied Laroia's wireless terminal identification information with Vijayan089's system to allow its wireless devices to differentiate and identify its own respective messages for reception. EX1005, ¶¶6-7, 35; EX1007, ¶¶38, 40, 53, 63. The combined wireless device would then use the identification information to identify its respective resource allocation parameters, as I explain further below. *See* Section IX.B.5. In this manner, combining Laroia with Vijayan089 would improve the functionality of Vijayan089's base stations and wireless devices by allowing the base stations to discern between different wireless devices.

109. At the outset, Vijayan089 already suggests the use of an identifier to differentiate between multiple wireless devices as I further explain in Section IX.B.2. For example, Vijayan089 describes transmitting data to "specific wireless devices" when performing "unicast" communications. EX1005, ¶¶6-7, 35. This is particularly relevant because Vijayan089 describes its base station as being able to "simultaneously transmit multiple data streams for broadcast, multicast, and/or

unicast services.” *Id.*, ¶6. To implement unicast transmissions or to communicate data to a specific wireless device, a POSITA would have found it obvious to use an identifier to specifically identify that wireless device. *See* Section VII.C. As I previously explained, this process was ubiquitous in wireless communications and OFDM systems when delivering data or messages to intended recipient devices. *Id.*

110. Despite this understanding, I note that Vijayan089 does not explicitly discuss the type of identifiers that could be used, nor does Vijayan089 expressly disclose how such identifiers would be implemented in its system. A POSITA would have therefore sought references teaching or describing techniques for implementing wireless device identifiers. Laroia is such a reference. Laroia confirms that it was well-known in the art to use wireless device identifiers and explicitly describes assigning an identifier to a wireless terminal to “uniquely identify the intended recipient.” EX1007, ¶40; Section IX.B.2. The wireless terminal is able to use this identifier to subsequently recover data intended for reception. *Id.*, ¶¶40, 53, 63. In view of Vijayan089’s suggestion of delivering data and resource allocations to specific wireless devices, a POSITA would have found it obvious and would have been motivated to also use such an identifier with Vijayan089’s system.

111. Implementing Laroia’s wireless terminal identifier would similarly allow for differentiation between wireless devices and to identify data intended for

a particular wireless device. *Id.*, ¶¶40, 53, 63. For example, the combined system would use the identifier to specify the resource allocation parameters for a particular wireless device. EX1005, ¶¶11, 44, 74, 76. For example, Vijayan089's wireless device would use the identifier to discern its own starting time-frequency coordinate and N-value as I further explain below. See Section IX.B.5. Using these values, Vijayan089's wireless device would identify its assigned transmission slots to receive and recover the data transmitted in those slots. EX1005, ¶¶11, 44, 74, 76, 106, 110. The identifier would be included in the existing overhead signaling described in Vijayan089. *Id.*, ¶¶11, 44, 74, 76. In this manner, a POSITA would have been motivated to combine Vijayan089 and Laroia to differentiate between data or control messages sent to different wireless devices.

112. As an additional benefit, combining Laroia and Vijayan089 would further Vijayan089's stated goal of conserving power at a wireless device. EX1005, ¶¶7-9, 11, 44, 61. In fact, both references describe this same goal. See EX1007, Abstract, ¶¶3, 6, 63-64. For example, Vijayan089 describes the goal of informing a particular wireless device of its respective data allocation to save on power consumption: "The wireless device may power on only when the desired data stream is transmitted, using the embedded overhead signaling, and thereby minimize power consumption." EX1005, ¶11. Laroia also describes using its identifier to inform only the intended recipient of a message so that when that

recipient is not receiving a message, it remains powered off to reduce battery power consumption. See EX1007, Abstract, ¶¶2-3, 5-7, 39, 63-64. In this manner, a POSITA would have been motivated to combine Laroia with Vijayan089 to further provide these power saving benefits. For example, when implementing an identifier to inform a wireless device of its resource allocation parameters, the wireless device will know to turn on during its allocated time interval to receive and process the data while remaining off during the other times. EX1005, ¶¶11, 44, 61; EX1007, ¶63.

113. A POSITA would have also known how to combine Vijayan089 and Laroia and would have had a reasonable expectation of success in implementing the combination. Both Vijayan089 and Laroia describe base stations and wireless devices communicating using OFDM. See EX1005, FIG. 1, FIG. 11, FIG. 12, ¶¶5, 36-37, 107-11; EX1007, FIG. 1, FIG. 2, FIG. 3, ¶¶32-35, 38-42. A POSITA would have easily implemented the communication protocols described in both Vijayan089 and Laroia to facilitate wireless transmissions from a base station to a wireless device to perform a combined algorithm. This combined algorithm would include Vijayan089's allocation of transmission slots and use of a starting time-frequency coordinate and N-value with Laroia's use of an identifier to signal specific communications to a particular wireless device. See Sections IX.B.3-IX.B.5. The combined system would transmit this information from the base

station to the wireless device using the overhead signaling described in Vijayan089. *Id.*

114. Both Vijayan089 and Laroia also describe conventional base stations and wireless devices and implementing software algorithms to perform OFDM communications. See EX1005, FIG. 1, FIG. 11, FIG. 12, ¶¶5, 36-37, 107-11; EX1007, FIG. 1, FIG. 2, FIG. 3, ¶¶32-35, 38-42. In this manner, a POSITA would have easily combined the references using well-known computer programming techniques to perform a combined algorithm. Combining Vijayan089 and Laroia would have been predictable and would simply amount to updating Vijayan089's protocol and overhead signaling to include Laroia's wireless device identifier to generate a combined wireless communication system. EX1005, ¶¶11, 44, 74, 76; EX1007, ¶¶40, 53, 63. This combination would operate to perform its intended purposes.

115. In this manner, a POSITA would have easily combined Vijayan089 and Laroia. Combining Vijayan089 and Laroia would amount to nothing more than combining known prior art elements according to known methods to yield predictable results and applying a known technique to a known device ready for improvement to yield predictable results. Thus, in view of the conventional OFDM base station and wireless device configurations described in Vijayan089 and

Laroia, a POSITA would have easily combined the references and would have found it predictable to form such a combination.

116. Thus, a POSITA would have been motivated to combine Vijayan089 and Laroia to differentiate between different wireless devices and would have had a reasonable expectation of success in forming the combination.

B. Vijayan089 in view of Laroia Renders Obvious Claim 1.

- 1. Claim 1 Preamble (Element [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:”**

117. Vijayan089 discloses the preamble of claim 1. As I will further explain in detail below, Vijayan089 describes the same operating method and wireless network having a base station and a mobile station that is recited in claim 1.

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

118. 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. Figure 1 depicts a wireless network connecting the base stations 110 and wireless devices 120.

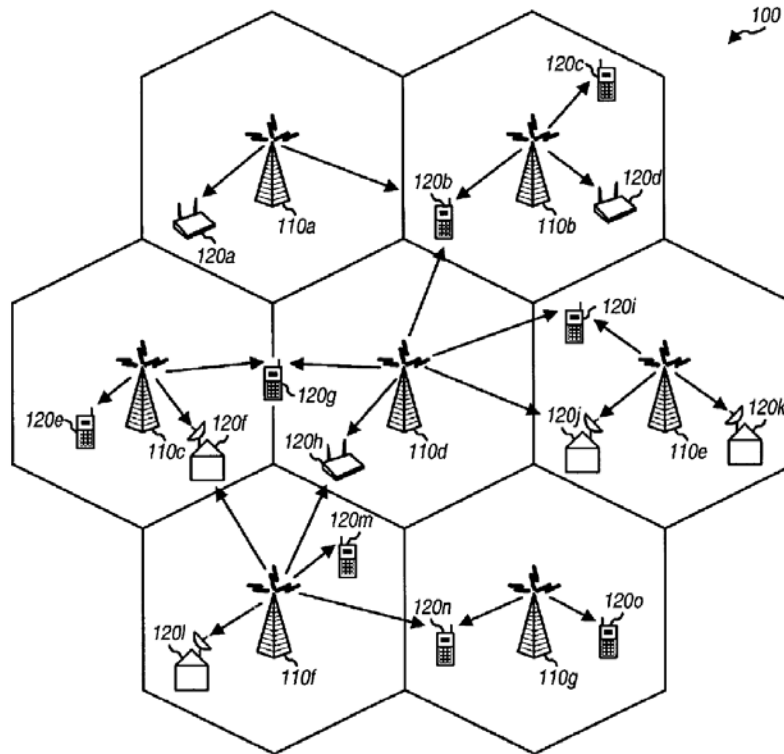


FIG. 1

EX1005, FIG. 1.

119. Vijayan089 also describes the components of its base stations with reference to Figure 11 and the components of its mobile stations with reference to Figure 12. EX1005, ¶¶107-111.

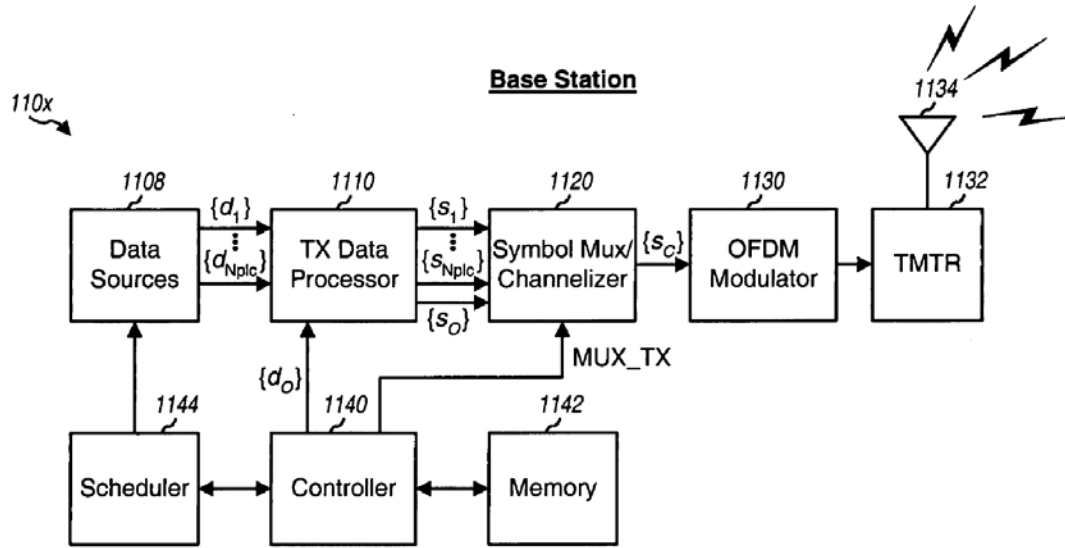


FIG. 11

EX1005, FIG. 11.

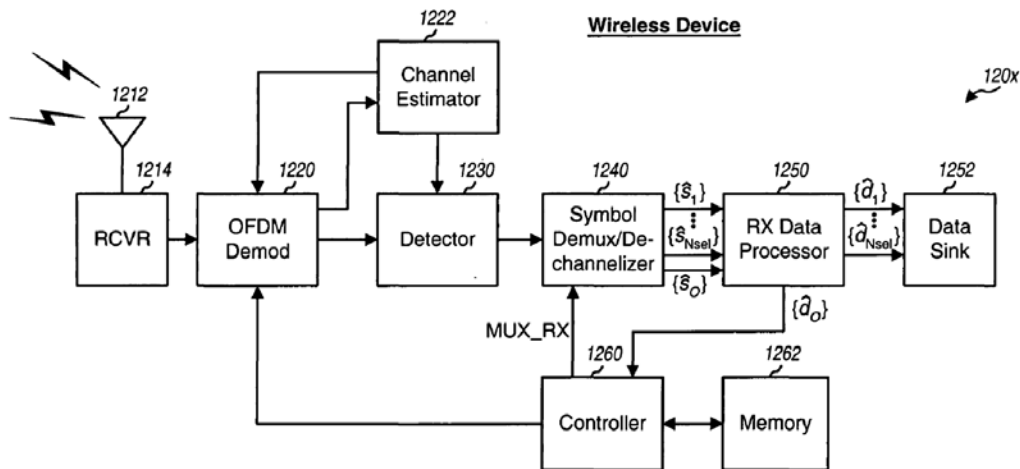


FIG. 12

EX1005, FIG. 12.

120. In view of this description, Vijayan089's base station 110 discloses the claimed "base station." Similarly, Vijayan089's wireless device 120 discloses the claimed "mobile station." In particular, Vijayana089 states that a "wireless device may be fixed or mobile and may also be referred to as a user terminal, a

mobile station, user equipment, or some other terminology.” EX1005, ¶36. The base stations and mobile stations communicate wirelessly to disclose the claimed “wireless network” as depicted in Figure 1.

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

121. Vijayan089 utilizes a frame structure of multiple frames for transmission. EX1005, ¶¶38-45, 48-49. For example, as seen in FIG. 2, Vijayan089 utilizes multiple frames in a “Super-Frame 210” configuration to communicate OFDM signals. *Id.*, ¶¶38, 44-45; *see also id.*, ¶¶40-41, 58-59.

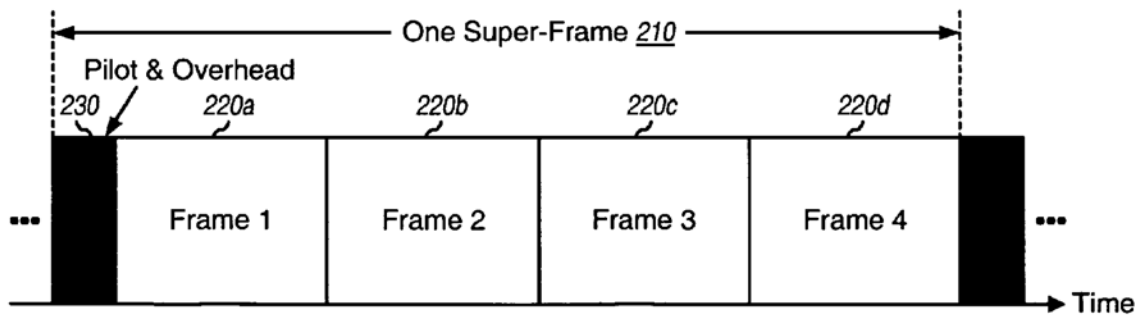


FIG. 2

EX1005, FIG. 2.

122. As seen in Figure 2, Vijayan089’s super-frame structure includes multiple frames used for transmissions *Id.*, ¶¶38, 44-45. Figure 4 depicts the structure of a frame with time and frequency (“subband”) components. *Id.*, ¶¶46-47. I will discuss Vijayan089’s specific frame structure further in the following section (Section IX.B.1.c).

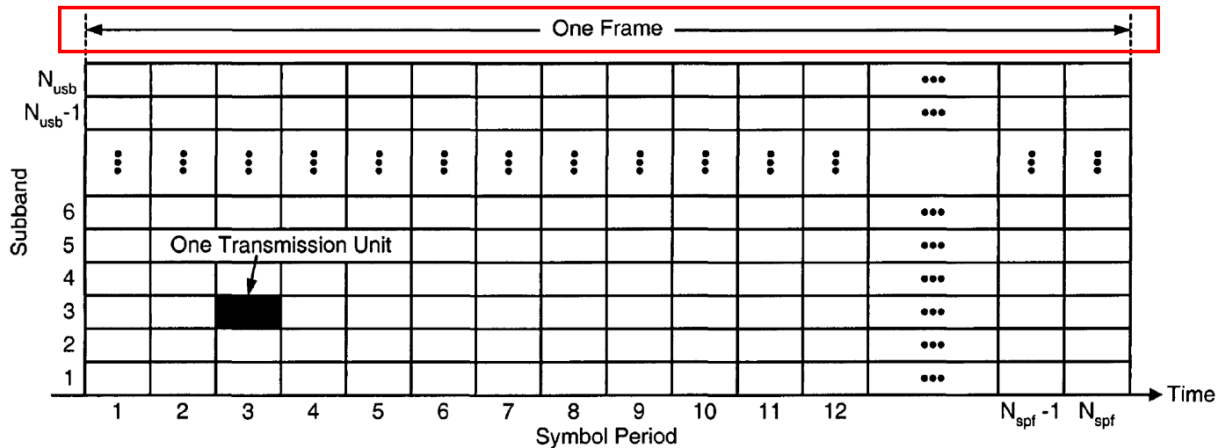


FIG. 4

EX1005, FIG. 4 (annotated).

123. Returning to Vijayan089’s use of multiple frames, Vijayan089 explains each super-frame is “divided into multiple (e.g., two, four, or some other number of) frames.” EX1005, ¶¶10, 38. When transmitting data in a data stream, data blocks are processed to “generate a corresponding code block.” *Id.*, ¶¶48-49. “Each code block is transmitted in one super-frame, and the multiple subblocks for the code block are transmitted in the multiple frames of the super-frame, one subblock per frame.” *Id.*, ¶10. In this manner, Vijayan089 describes transmitting data using multiple frames.

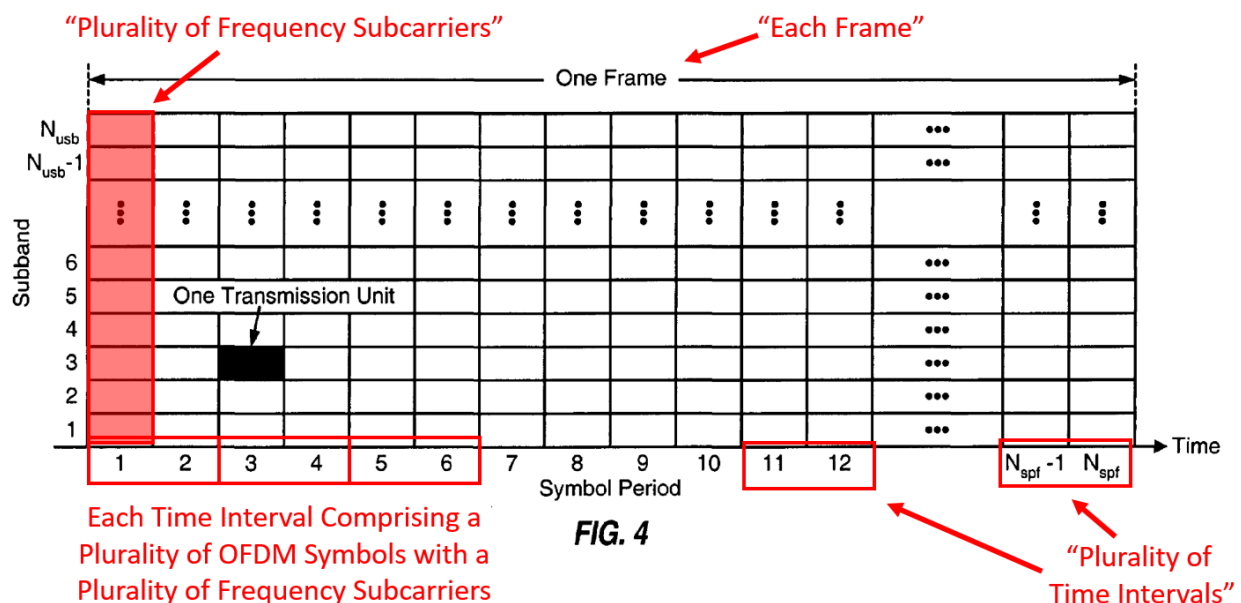
124. As I will further explain below, Vijayan089 also describes using time-frequency “transmission units” within the super-frame structure to transmit data as well. See Section IX.B.3. Vijayan089 explains that “[e]ach data stream may be ‘allocated’ a variable number of transmission units in each super-frame.” EX1005, ¶11. Vijayan089 assigns “specific transmission units within each super-frame

using an assignment scheme that attempts to (1) pack the transmission units for all data streams as efficiently as possible, (2) reduce the transmission time for each data stream, (3) provide adequate time-diversity, and (4) minimize the amount of signaling to indicate the specific transmission units assigned to each data stream.”

Id.; see also *id.*, ¶¶59-67. Vijayan089 further signals to the wireless device information allowing the “wireless device to determine the time-frequency location of each desired data stream in the upcoming super-frame.” *Id.*, ¶11.

- 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”***

125. Vijayan089’s frame discloses each of the frame elements recited in the preamble. I have annotated Figure 4 below to demonstrate how Vijayan089’s frame discloses these elements. EX1005, FIG. 4, ¶¶46-47, 59-67.



EX1005, FIG. 4 (annotated).

126. Vijayan089 explains that “FIG. 4 shows the structure of one frame on a time-frequency plane. The horizontal axis represents time, and the vertical axis represents frequency.” *Id.*, ¶46. I note that the specification of the ’450 patent does not provide any specific definition for the term “time interval.” A POSITA would have therefore understood the term to generally refer to an interval of time. For example, in the context of Vijayan089, a time interval would refer to a group of symbol periods as I have annotated above. *Id.*, ¶¶59, 70-77 (describing “contiguous symbol periods”). Any grouping of symbol periods in Figure 4 would therefore disclose the claimed “time interval.” *Id.*

127. Vijayan089 explains that “[e]ach frame has a predetermined time duration.” *Id.*, ¶46. Within the time duration of the frame, time intervals are provided and measured “in units of OFDM symbol periods (or simply, symbol periods). Each OFDM symbol period is the time duration to transmit one OFDM symbol.” *Id.*, ¶46. When reviewing Vijayan089, a POSITA would have understood that a time interval would encompass any number of OFDM symbol periods as described. *Id.*, FIG. 4, ¶¶59, 70-77. For example, a time interval encompassing two symbol periods would encompass two OFDM symbols. A time interval encompassing four symbol periods would encompass four OFDM symbols. In FIG. 4, a first example of a time interval is the length of time encompassing

symbol periods (OFDM symbols) 1 and 2. I have annotated other examples of time intervals in FIG. 4 above. With this understanding, Vijayan089 describes time intervals that may encompass multiple “symbol periods” and therefore encompass a plurality of OFDM symbols as I have annotated above.

128. Within each time interval, Vijayan089 also describes the claimed “plurality of OFDM symbols” with “each OFDM symbol containing a plurality of frequency subcarriers.” For example, Vijayan089 explains that within “each OFDM symbol period, N_{dsb} data symbols may be sent on the N_{dsb} data subbands.” EX1005, ¶47. Vijayan089 explains that the term “subbands” refers to “tones, *carriers, subcarriers*, bins, and *frequency channels*. *With OFDM, each subband is associated with a respective subcarrier* that may be modulated with data.” *Id.*, ¶5. In this manner, within each OFDM symbol or OFDM symbol period, Vijayan089 discloses a plurality of subbands or frequency subcarriers. *Id.*, ¶¶5, 46-47, 59. As I will further explain below, the “ N_{dsb} data symbols in each OFDM symbol may be for one or multiple PLCs” or physical layer channels. *Id.*, ¶¶37, 47.

* * *

129. In view of these teachings, Vijayan089 discloses the same wireless network and OFDM frame structure recited in the preamble of claim 1.

2. Element [1A]: “*assigning an identifier to the mobile station;*”

130. At the outset, I note that the ’450 patent does not provide a specific definition for the term “identifier.” EX1001, 8:37-42, 9:4-29. Rather, the ’450 patent generally describes assigning a “basic connection identification (BCID),” which may be assigned to downlink or uplink transmissions. *Id.*, 8:37-42. “The BCID for downlink may or may not be the same as that of the uplink.” *Id.*, 8:41-42. Additionally, the “BCID can be used for control messages or generic (unclassified) application connections.” *Id.*, 8:39-41. Based on this description as well as the use of the general term “identifier” in the claim, a POSITA would have understood the claimed identifier to be satisfied by an identification corresponding to a mobile station.

131. Vijayan089 describes allocating transmission units for specific wireless devices and also describes a “unicast transmission [that] is sent to a specific wireless device.” EX1005, ¶¶6-7, 35. In both of these scenarios, a POSITA would have found it obvious for the wireless device to be assigned an identifier so that the wireless device is capable of discerning its own intended data streams and received data. *Id.*, ¶¶6, 35. Further, Vijayan089 describes the express goal of allowing a wireless device “to recover each data stream independently, without having to process the other data streams being transmitted simultaneously.” *Id.*,

¶¶9, 106. This further suggests providing unique identifications to the wireless devices so that they can discern their own allocated data streams.

132. As I previously explained, Vijayan089 describes allocating specific resources—or “transmission units”—for wireless devices to receive data transmissions from a base station. See Section IX.B.1.b. Specifically, a “wireless device can select and receive individual data streams” where “[e]ach data stream is allocated a number of transmission units in each super-frame.” EX1005, Abstract, ¶11. Vijayan089 explains that once transmission units are assigned for communications with a particular wireless device, a base station informs the particular wireless device of the allocation:

Overhead signaling for various parameters of the data streams (e.g., the coding and modulation scheme used for each data stream, ***the specific transmission units assigned to each data stream***, and so on) may be transmitted prior to each super-frame and may also be embedded within the data payload of each data stream. ***This allows a wireless device to determine the time-frequency location of each desired data stream in the upcoming super-frame.*** The ***wireless device may power on only when the desired data stream is transmitted***, using the embedded overhead signaling, and thereby minimize power consumption.

EX1005, ¶11; see also *id.*, ¶44.

133. Based on the overhead signaling, Vijayan089's base station informs a particular wireless device of its allocated transmission units so that the wireless device can power on during its allocation to receive data. EX1005, ¶¶11, 44. Specifically, "the wireless devices may initially use the overhead OFDM symbols to determine the time-frequency location of each desired data stream." *Id.*, ¶44. This is particularly relevant to the "unicast transmission" context where data will be "sent to a specific wireless device." *Id.*, ¶¶6-7, 35. In order to provide this direct communication and allocation, a POSITA would have found it obvious for Vijayan089 to assign an identifier to the specific wireless device to provide the wireless device's allocation of transmission units and to provide unicast transmissions specifically targeted to individual wireless devices. *Id.*, ¶¶6-7, 9, 11, 35. Without such an identifier, it would have been more difficult for each wireless device to discern its own assigned data and corresponding transmission units, especially in the unicast context.

134. To the extent that it is argued that Vijayan089 does not render obvious assigning an identifier to a mobile station, Laroia explicitly discloses assigning 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. Laroia explains that the "WT identification information" may allow a wireless terminal to identify that it

“is the specific intended recipient” for a particular message. *Id.*, ¶¶40, 53. The WT identification information may include a “full WT identifier sufficient to uniquely identify the intended recipient” within a cell serviced by a base station. *Id.*, ¶40; *see also id.*, FIG. 2, FIG. 3, ¶¶38-39, 49, 53, 58. In this manner, Laroia describes assigning an identifier to a mobile station so that it can identify respective messages intended for receipt.

135. To provide additional details on how Laroia uses its identifier, Laroia describes an example with respect to Figure 5 where a WT receives a signal and uses the WT identifier to identify a corresponding message. *Id.*, ¶¶63-65.

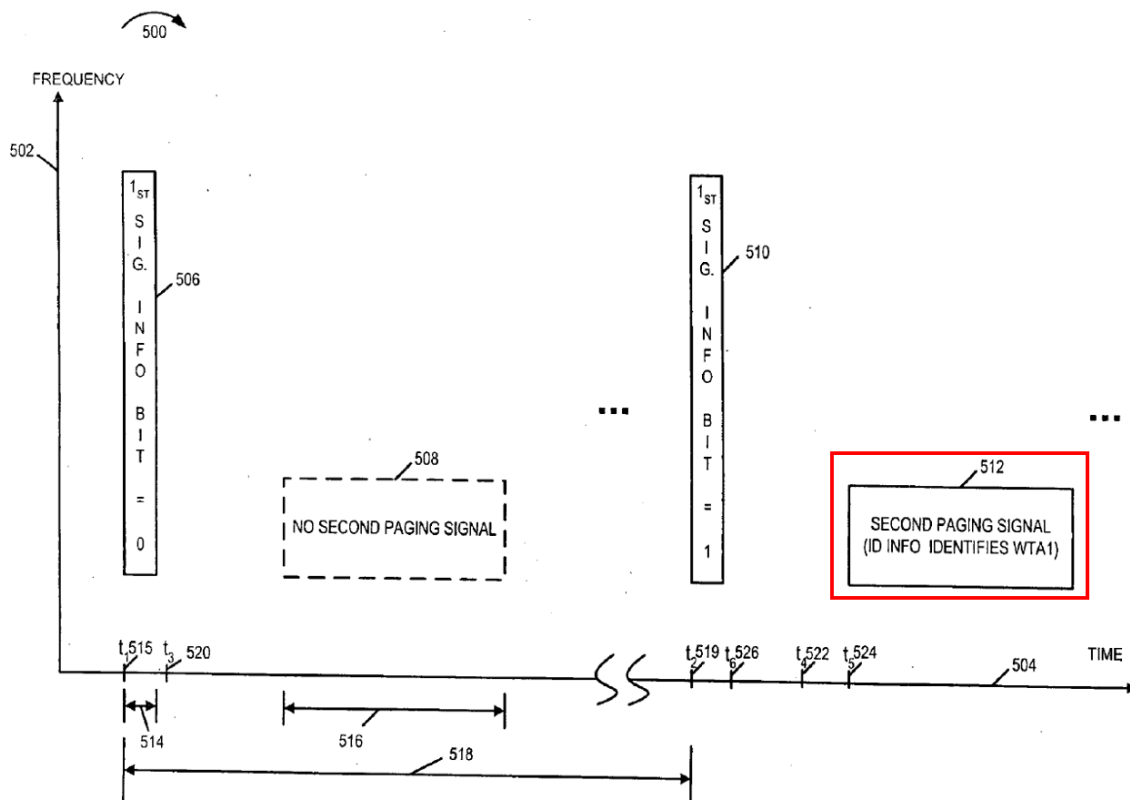


FIGURE 5

EX1007, FIG. 5 (annotated).

136. “FIG. 5 includes a graph 500 of frequency on the vertical axis 502 vs time on the horizontal axis 504.” *Id.*, ¶63. In this case, there are “two users, WTA1 and WTA2, which both monitor the downlink channel” for paging signals. *Id.* At time t2 519, “both WTA1 and WTA2 wake up again and receive another first paging signal 510.” *Id.* The base station, however, may only have a message to be broadcast to WTA1 but not WTA2. *Id.* To indicate the desired WT for reception, the “**second paging signal 512 includes the paging identifier of user WTA1**. Upon the reception of the second paging signal 512, user WTA1 will follow the instruction, if any, included in the second paging signal message and **user WTA2 will return to the sleep state after determining that the identifier in signal 512 does not match WTA2’s identifier.**” *Id.* In this manner, Laroia describes assigning an identifier to identify a particular wireless terminal to receive data transmitted from a base station.

137. A POSITA would have been motivated to combine Vijayan089 and Laroia for the reasons I previously explained. *See* Section IX.A. A POSITA would have applied Laroia’s wireless terminal identification information with Vijayan089’s system to allow its wireless devices to differentiate and identify its own respective messages for reception. *Id.*; EX1005, ¶¶6-7, 35; EX1007, ¶¶38, 40, 53, 63.

3. **Element [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 $N=2, 4, \text{ or } 8$; and”**

138. Vijayan089 discloses transmitting a signal in the same manner and using the same “time-frequency resource unit” organization as recited in the claims. See EX1005, FIG. 4, ¶¶11, 59, 72-76. In fact, as I explained in Section VII.B, this type of resource allocation scheme was well known in the art. Further, Vijayan089 discloses the same use of a “starting time-frequency coordinate” and an “ N ”-value to signal the resource allocation to a wireless device. EX1005, ¶74. Vijayan089 explains that this provides the same overhead reduction benefits described in the ’450 patent: “The 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.**” *Id.* This scheme “reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active [communication channel].” *Id.*, ¶76. Thus, as I will further explain below, Vijayan089 discloses the same process and the same alleged benefits provided by the ’450 patent.

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

139. As I described with reference to the preamble of claim 1, Vijayan089 describes the same base station and mobile station configuration described in claim 1. *See* Section IX.B.1. Vijayan089 describes its base station as transmitting “data streams to be individually recovered” by a wireless device. EX1005, ¶9. Specifically, “transmitter unit 1132”—which is located on the base station—transmits an “OFDM symbol stream” via a “modulated signal that then is transmitted from an antenna 1134.” *Id.*, ¶108. The base station transmits this signal to a wireless device. “At wireless device 120x, an antenna 1212 receives the modulated signal transmitted by base station 110x and provides a received signal to a receiver unit (RCVR) 1214.” *Id.*, ¶109. The wireless device then performs additional processing to identify the OFDM symbols in the signal transmitted by the base station. *Id.*, ¶¶109-110.

140. Vijayan089’s base station also transmits the OFDM symbol information “over a segment of time-frequency resources” as recited in the claim. *See Id.*, FIG. 4, ¶¶9, 11, 59, 72-76. Specifically, Vijayan089 describes transmitting data using “transmission units” or “transmission slots,” which disclose the claimed “time-frequency resources.” *Id.* “[E]ach transmission unit corresponds to one subband in one symbol period and may be used to transmit one data symbol.” *Id.*,

¶9. In view of this definition, each transmission unit is a resource having a time component (symbol period) and frequency component (subband). Vijayan089 depicts a transmission unit in Figure 4. *Id.*, ¶¶46, 59-60, 67.

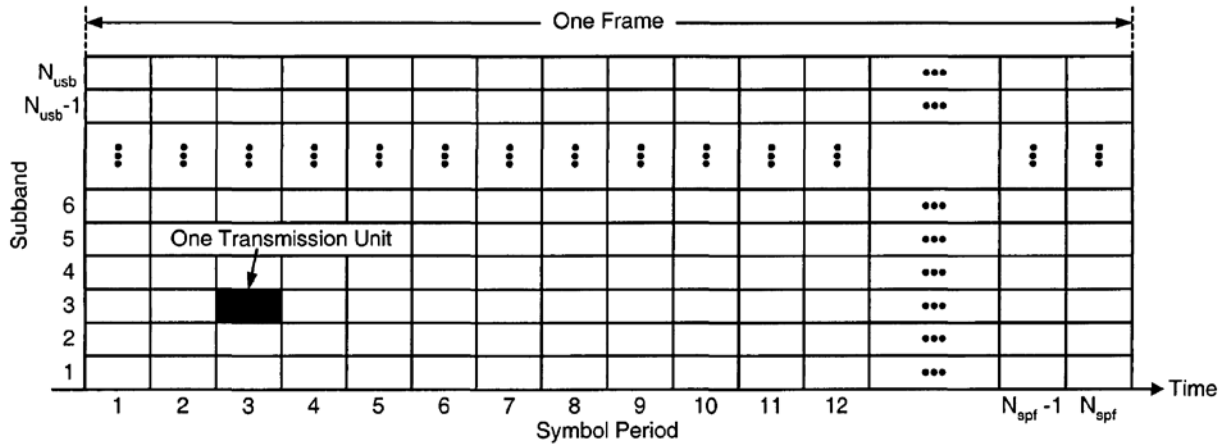


FIG. 4

EX1005, FIG. 4.

141. Vijayan089 also groups “transmission units” or “transmission slots” into a “physical layer channel (PLC).” EX1005, ¶37. “Each active PLC is allocated resources from the time-frequency plane, as shown in FIG. 4. The allocated resources for each 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. Examples of transmission units or transmission slots being grouped into PLC segments corresponding to individual data streams are depicted in Figures 7A and 7B. *Id.*, ¶¶68-76.

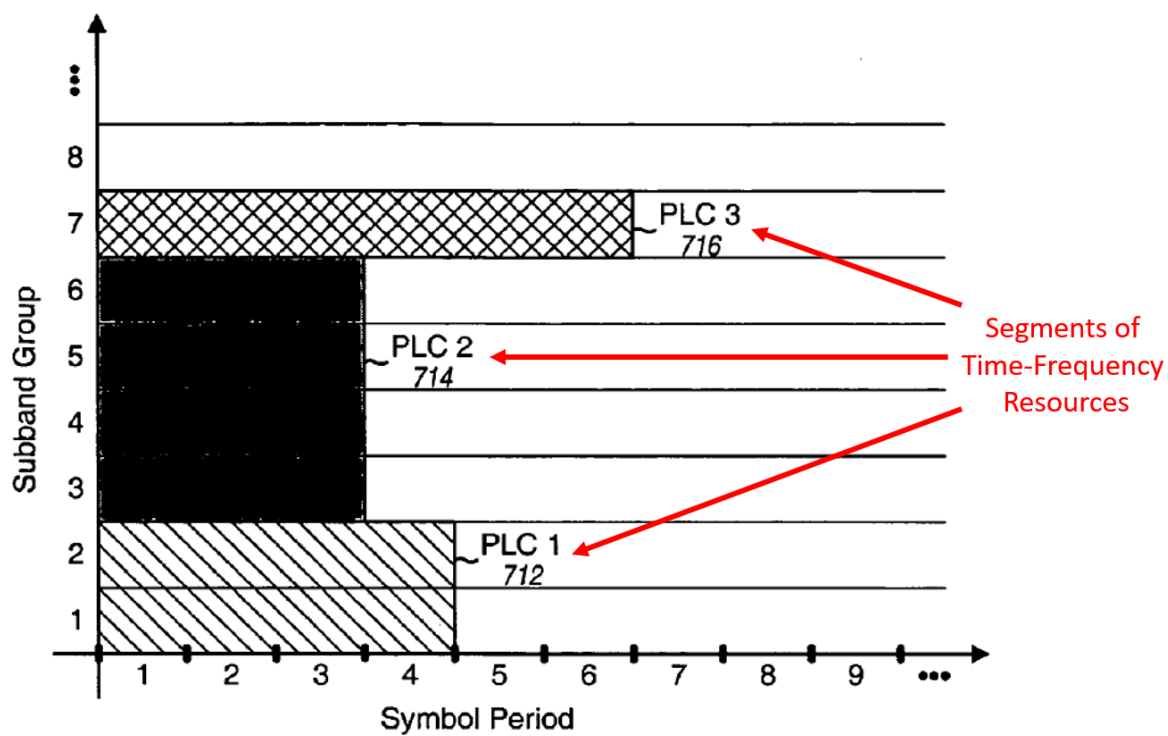


FIG. 7A

EX1005, FIG. 7A (annotated).

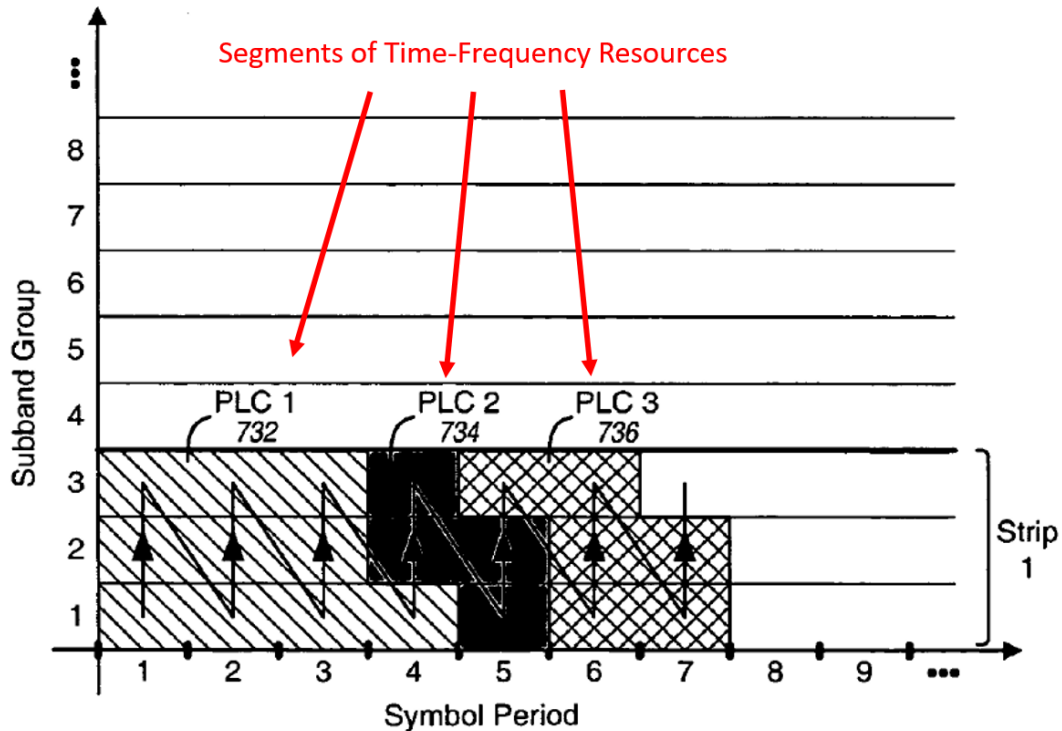


FIG. 7B

EX1005, FIG. 7B (annotated).

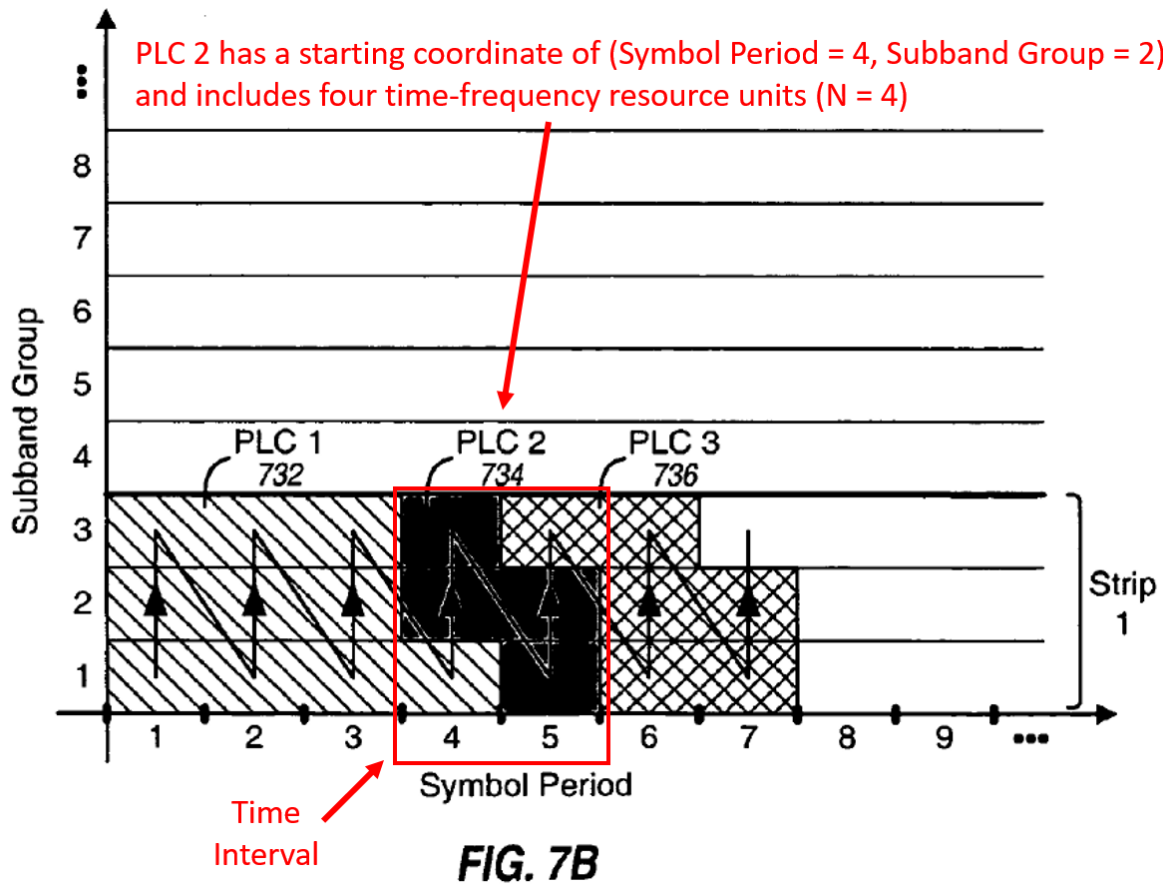
142. In this manner, Vijayan089's PLC segment discloses the claimed "segment of time-frequency resources." *See, e.g.*, EX1005, ¶73. Vijayan089 goes on to state: "[E]ach data stream is sent on a separate physical layer channel (PLC). There is thus a one-to-one relationship between data streams and PLCs. A PLC may also be called a data channel, a traffic channel, or some other terminology." *Id.*, ¶37. 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 resources. *Id.*, FIG. 4, FIG. 7A, FIG. 7B, ¶¶9, 11, 59, 68-76. Vijayan089 explains that "[e]ach data stream is also allocated certain amount

of resources for transmission of that stream. The allocated resources are given in ‘transmission units’ on a time-frequency plane.” *Id.*, ¶¶9, 46, 59. “The data symbols for each data stream are mapped directly onto the transmission units allocated to the stream. This allows the wireless devices to recover each data stream independently, without having to process the other data streams being transmitted simultaneously.” *Id.*, ¶9.

143. Thus, Vijayan089 discloses transmitting a signal containing information from the base station to the mobile station over a segment of time-frequency resources.

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 $N=2, 4, \text{ or } 8$ ”

144. As I previously explained, a PLC segment as described in Vijayan089 discloses the claimed “segment.” See Section IX.B.3.a. PLC segments are composed of time-frequency resource units (“transmission units” or “transmission slots”) as seen in Figures 4, 7A, and 7B. EX1005, FIG. 4, FIG. 7A, FIG. 7B, ¶¶9, 11, 59, 68-76. One example PLC segment that discloses the claimed “segment” is “segment 734” corresponding to “PLC 2” as depicted in FIG. 7B. *Id.*, ¶¶72-76.



EX1005, FIG. 7B (annotated).

145. While I will focus my discussion on PLC 2 as depicted in FIG. 7B, I note that Vijayan089 renders obvious the use of a starting time-frequency coordinate as well as any number of time-frequency units N. EX1005, ¶¶67, 74, 76. In particular, 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.*” *Id.*, ¶74. The “length of the segment” discloses the N-value recited in the claims. *Id.* Additionally, Vijayan089 explains that a particular segment corresponding to a

PLC “may include any number of slots,” such as the 2, 4, or 8 specified in the claim. *Id.* “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.” *Id.*

146. This description discloses the same process and same benefits described in the ’450 patent. *See* EX1001, Abstract, 2:45-57, 5:24-31. Specifically, using the slot assignment scheme described in Vijayan089 “**reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC.**” EX1005, ¶76. Using the process depicted in FIG. 7B, 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. The assignment of slots using one dimension discloses the same N-value determination recited in the claims. *Id.*

147. As I explained in Section VI.B, I note that the Board also highlighted this feature of the ’450 patent in the previous IPR challenge against the ’450 patent. EX1014, 25-26. Specifically, I note that the Board referenced Patent Owner’s following arguments:

By effectively transforming the two independent dimensions of time and frequency **into one time-frequency dimension measured by a basic resource unit** having a fixed number of symbols in a fixed number of subcarriers that fits the resource

requirements of a given application, the inventors achieved an advantageous ***reduction in the amount of data required to allocate resources.***

EX1014, 25 (citing EX1012, 8).

Just as in the IEEE 802.16 standard expressly distinguished in the background of the patent, these two references merely describe time units (symbols) and frequency units (subchannels) and suggest no ***“time-frequency” resource unit that transforms the time and frequency units into one combined dimension*** as disclosed and claimed by the '450 patent.

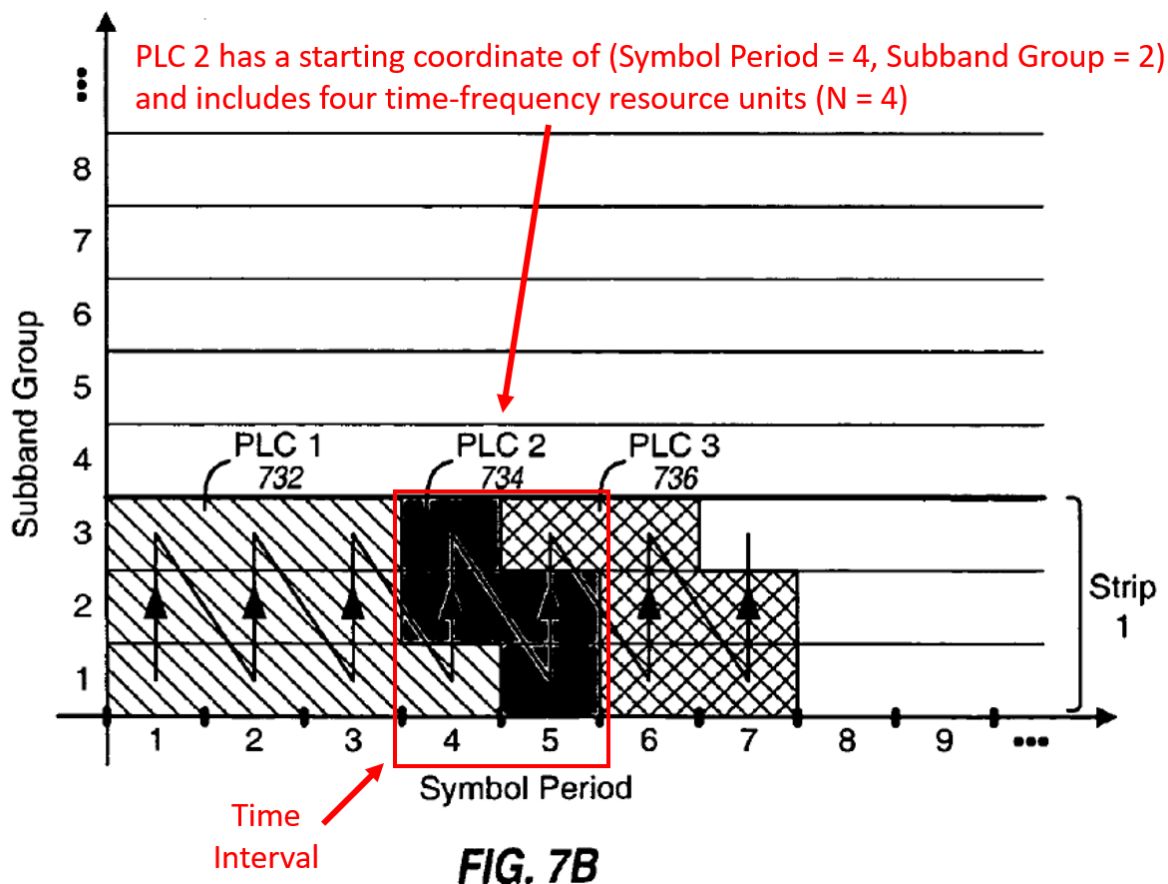
EX1014, 25 (citing EX1012, 10).

[B]y transforming time and frequency to a single dimension—time-frequency—measured in time-frequency resource units, the invention can use ***two parameters to map a packet stream: the starting time-frequency coordinate and N, the number of time-frequency resource units.*** Ex. 1001[,] 6:3–21, 7:7–39. Because there is no time-frequency dimension taught in Kim or IEEE802.16-2004, the combination lacks both innovative parameters. Instead, the combination of Kim and IEEE802.16-2004 uses an independent time dimension and an independent frequency dimension and requires four parameters to map a packet stream, just like the prior art distinguished in the Background of the '450 patent.

EX1014, 25-26 (citing EX1012, 10).

148. Vijayan089, however, discloses these same concepts and also discloses using “two parameters” to assign a segment and to inform a wireless device of the assignment. EX1005, ¶74. Vijayan089 also describes the same benefit of reducing the amount of overhead signaling needed to inform the wireless device. *Id.*, ¶76. Therefore, Vijayan089 also discloses these aspects of the ’450 patent as well.

149. With this understanding, I return to the claim language and to FIG. 7B from Vijayan089, which I have again reproduced below.



EX1005, FIG. 7B (annotated).

150. As I have annotated in FIG. 7B, segment 734 corresponding to PLC 2 is an example segment from Vijayan089 that discloses the claimed “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.” EX1005, ¶73. Here, “PLC 2 is assigned a segment 734 containing 4 slots from subband group 2 in symbol period 4 through subband group 2 in symbol period 5.” *Id.* As I have indicated in the figure, segment 734 corresponding to PLC 2 has a starting time-frequency coordinate where the symbol period is “4” and the subband group is “2.” *Id.* Segment 734 also has four (i.e., N = 4) time-frequency resource units depicted as four transmission slots. *Id.* These four transmission slots are also located within the time interval defined by symbol periods 4 and 5. *Id.* In this manner, segment 734 corresponding to PLC 2 discloses the claimed “segment.”

151. While I have focused on segment 734 corresponding to PLC 2, a POSITA would have also found it obvious for Vijayan089’s description to also render obvious a segment of any size because its PLC segments “may include any number of slots.” *Id.*, ¶74. FIG. 7B depicts segments with other sizes, which would render obvious other groups, such as N = 2 or N = 8. *Id.*, ¶¶72-74 (describing segments with 2 or 4 slots).

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

152. As I previously explained, Vijayan089 discloses “transmission units” and “transmission slots,” which are grouped and assigned as segments for PLCs. See Section IX.B.3.b. Vijayan089’s “transmission slot” discloses the claimed “unit” when analyzing PLCs. *Id.* Each transmission slot also contains a “set of frequency subcarriers in a group of OFDM symbols” as recited in the claim. For example, as seen in Figure 7B, each transmission slot has a corresponding “subband group.” EX1005, ¶¶56, 59, 87.

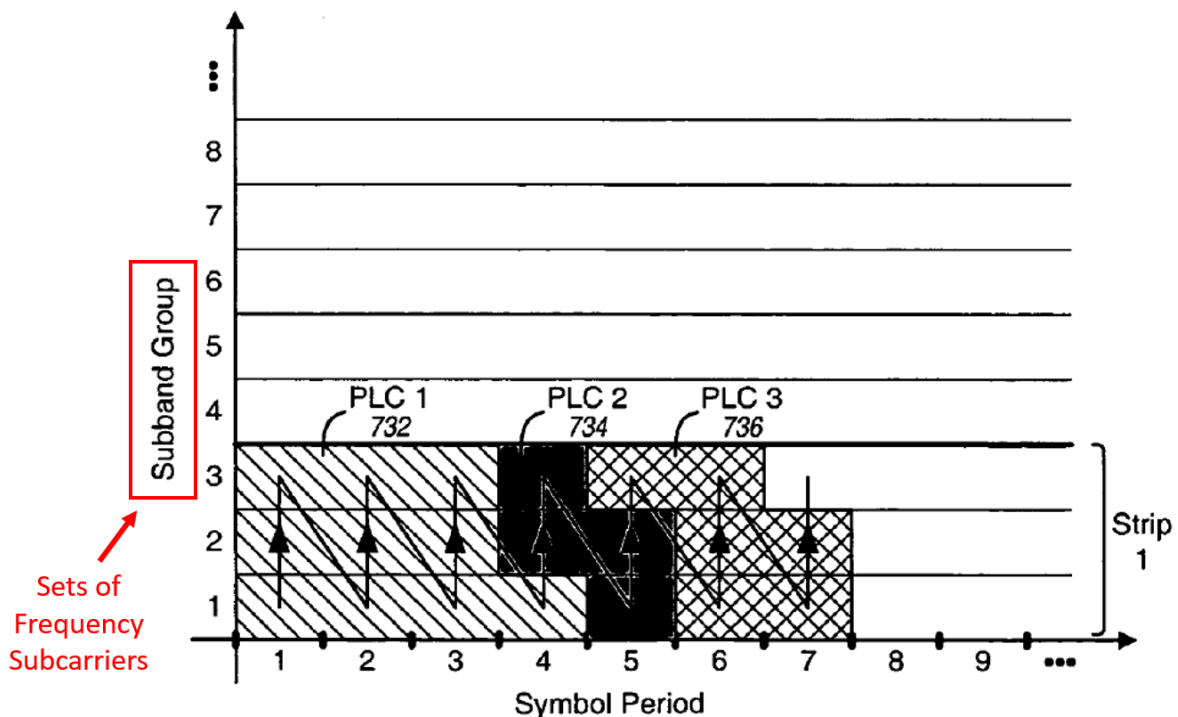


FIG. 7B

EX1005, FIG. 7B (annotated).

153. Each subband group includes a set of frequency subcarriers. EX1005, ¶59. For example, a particular transmission slot or subband group may include **“one group of (e.g., 500) data subbands.”** *Id.*; see also *id.*, ¶56. In one example embodiment, Vijayan089 describes a “coded packet [that] contains 3000 code bits and may be transmitted on **1500 data subbands (or three subband groups)** using QPSK, which can carry two code bits per data symbol.” *Id.*, ¶87. In this manner, Vijayan089’s subband group contains a set of frequency subcarriers.

154. Vijayan089 also describes each transmission slot including a group of subbands used to transmit OFDM symbols. *Id.*, ¶¶5, 59; see also Section IX.B.1.c (discussing Vijayan089’s teachings of OFDM). For example, Vijayan089 explains that “[w]ith OFDM, one modulation symbol may be sent on each subband in each symbol period.” *Id.*, ¶47. When using transmission slots, each slot may transmit a “group of [] data subbands or, equivalently, **one group of modulation symbols** in one symbol period.” *Id.*, ¶59. In this manner, Vijayan089 discloses each slot containing a set of frequency subcarriers in a group of OFDM symbols. *Id.*, ¶¶5, 47, 59; see also Section IX.B.1.c (discussing Vijayan089’s teachings of OFDM).

4. Element [1C]: “receiving by the mobile station the transmitted signal; and”

155. As I previously explained, Vijayan089 discloses a wireless device (*i.e.*, the claimed “mobile station”) receiving transmitted information signals from a base station. *Id.*, FIG. 12, ¶¶109-111; see also Section IX.B.1.a. As depicted in

Figure 12, wireless device 120x includes an antenna 1212 and receiver unit 1214 configured to receive the transmitted signal. *Id.*, ¶109.

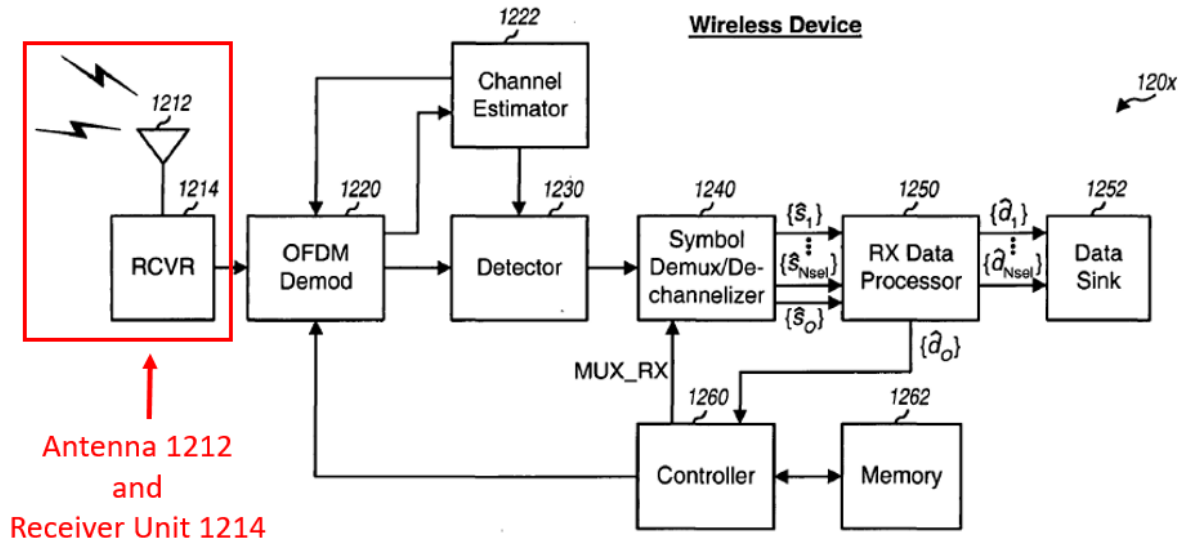


FIG. 12

EX1005, FIG. 12 (annotated).

156. In describing the receipt of a transmission from the base station, Vijayan089 provides the following description:

At wireless device 120x, *an antenna 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* and provides a sample stream to an OFDM demodulator 1220. OFDM demodulator 1220 performs OFDM demodulation on the sample stream and provides ... received data symbols and received overhead symbols to a detector 1230. ... Detector 1230 provides to a symbol demultiplexer (Demux)/dechannelizer 1240 “detected” data and overhead

symbols, which are estimates of the transmitted data and overhead symbols, respectively.

EX1005, ¶109.

157. 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; see Section IX.B.3. Thus, Vijayan089 discloses a mobile station receiving the PLC segment signal transmitted from the base station.

EX1005, ¶¶109-110.

5. Element [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.”

158. At the outset, Vijayan089 discloses a wireless device recovering data from the received OFDM signal. EX1005, FIG. 12, ¶¶109-111. As I described in Section IX.B.4 with reference to Figure 12, Vijayan089 describes a wireless device with a receiver unit and additional components configured to recover symbol data from a received OFDM signal. *Id.*, FIG. 12, ¶¶65, 109-11. For example, after the receiver unit 1214 “conditions, digitizes, and processes the received signal,” it provides the sample stream to “an OFDM demodulator 1220.” *Id.*, ¶109.

Vijayan089 continues and explains that:

OFDM demodulator 1220 performs OFDM demodulation on the sample stream and provides ... received data symbols and

received overhead symbols to a detector 1230. ... Detector 1230 provides to a symbol demultiplexer (Demux)/dechannelizer 1240 “detected” data and overhead symbols, which are *estimates of the transmitted data and overhead symbols, respectively.*

Id.

159. Vijayan089 continues by explaining the functionality of controller 1260 to recover the relevant information:

A controller 1260 obtains an indication of (e.g., user selection for) *one or more specific data streams/PLCs to be recovered. Controller 1260 then determines the resource allocation and assignment for each selected PLC.* If wireless device 120x is acquiring the signal for the first time (e.g., initial acquisition), then *the signaling information is obtained from the overhead OFDM symbols* decoded by a receive (RX) data processor 1250. If wireless device 120x is successfully receiving data blocks in super-frames, then *the signaling information may be obtained through the embedded overhead signaling* that is part of at least one data block sent in each super-frame. *This embedded overhead signaling indicates the allocation and assignment of the corresponding data stream/PLC* in the next super-frame.

Id., ¶110.

160. As seen from this description, Vijayan089 describes its controller
1260 recovering data streams or PLC segments using overhead signaling
information. *Id.* As I previously explained, this overhead signaling information
includes a starting time-frequency coordinate and an N-value. See Section IX.B.3;
Id., ¶¶9, 11, 44, 59, 72-74. As Vijayan089 explains, the “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.” *Id.*, ¶74. With
these parameters, the wireless device can “**use the overhead OFDM symbols to**
determine the time-frequency location of each desired data stream.” *Id.*, ¶¶11, 44.
Vijayan089 further explains that:

The multiplexing and transmission techniques described herein
allow the multiple data streams sent in each super-frame to be
independently recoverable by a wireless device. A given data
stream of interest may be recovered by (1) performing OFDM
demodulation on all subbands or just the subbands used for
the data stream, (2) demultiplexing the detected data symbols
for the data stream, and (3) decoding the detected data
symbols for the data stream. ... Depending on the allocation
and assignment scheme selected for use, the wireless device
may ***perform partial demodulation and/or partial decoding of***
another data stream in order to recover the data stream of
interest.

EX1005, ¶106.

161. In view of this description, Vijayan089 describes a wireless device recovering information from the received signal based on the starting time-frequency coordinate and N-value.

162. A POSITA would have also found it obvious for Vijayan089 to use an identifier corresponding to the wireless device when recovering the data from the signal as well. For example, as I explained in Sections IX.A and IX.B.2, a POSITA would have found it obvious to assign an identifier to a particular wireless device and to signal a specific starting time-frequency coordinate and N-value for that particular wireless device. This identifier would allow the particular wireless device to identify its own respective resource allocation parameters from among those provided to other wireless devices. *See* Section IX.A, IX.B.2. This identifier would be particularly relevant for a “unicast transmission [that] is sent to a specific wireless device.” EX1005, ¶¶6-7, 35. Laroia confirms this understanding and explicitly describes the use of identifiers to differentiate between multiple wireless devices as I explained in Section IX.B.2.

163. Specifically, Laroia describes “terminal identification (ID) information” which “may be a **base station assigned ID** for WT 1.” EX1007, ¶38. The “WT identification information” may allow a wireless terminal to identify that it “is the specific intended recipient” for a particular message. *Id.*, ¶¶40, 53. When transmitting a message, Laroia includes this identification information. *Id.*, ¶¶63-

65. When the identification is received by its corresponding wireless terminal (e.g., WTA1), the wireless terminal is informed that it is the intended recipient of the message and will operate to receive and process the data in the message. *See, e.g., Id.*, ¶63. Other terminals will not perform processing of the message because they are not the intended recipients. *Id.* In this manner, Laroia describes using an identifier assigned to a particular wireless terminal to recover information intended for that wireless terminal. *See* Section IX.B.2.

164. In view of Vijayan089's suggestion of using an identifier, a POSITA would have found it obvious and would have been motivated to implement the identifier described in Laroia with Vijayan089's system for the reasons that I explained in Section IX.A. This identifier would allow a wireless device to differentiate its own allocation parameters from other allocation parameters intended for other wireless devices. EX1007, ¶¶40, 53, 63. Additionally, a POSITA would have found it obvious to transmit such identifier information with Vijayan089's overhead signaling. EX1005, ¶¶11, 44, 74, 76; EX1007, ¶¶40, 53, 63. The overhead signaling includes the resource allocation parameters for the wireless device, including the starting time-frequency coordinate and the N-value.

165. Using the identifier, Vijayan089's wireless device would identify its own starting time-frequency coordinate and N-value in the overhead signaling. EX1005, ¶¶11, 44, 74, 76; EX1007, ¶¶40, 53, 63. The wireless device would then

recover the information corresponding to its allocated transmission slots or PLC segment in the manner described above. EX1005, FIG. 12, ¶¶109-111. In this manner, a POSITA would have been motivated to combine Vijayan089 and Laroia, would have known how to combine them, and would have had a reasonable expectation of success in forming the combination. Thus, the combination of Vijayan089 and Laroia discloses “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.”

C. Vijayan089 in view of Laroia renders obvious claim 7.

166. The limitations of independent claim 7 are substantially similar to those recited in claim 1. As I further outline below, Vijayan089 in view of Laroia discloses all of the limitations of claim 7 for the reasons that I have explained for claim 1. *See* Section IX.B.

167. At the outset, I note that claim 1 recites a method describing the functionality and interaction between both a base station and a mobile device. EX1001, 12:47-54. Specifically, claim 1 describes a “method for a wireless network comprising at least a base station and a mobile station.” *Id.* Claim 7 refers to substantially the same functionality but claims the functionality from the perspective of the “***mobile device.***” *Id.*, 13:15-21. Thus, the combination of

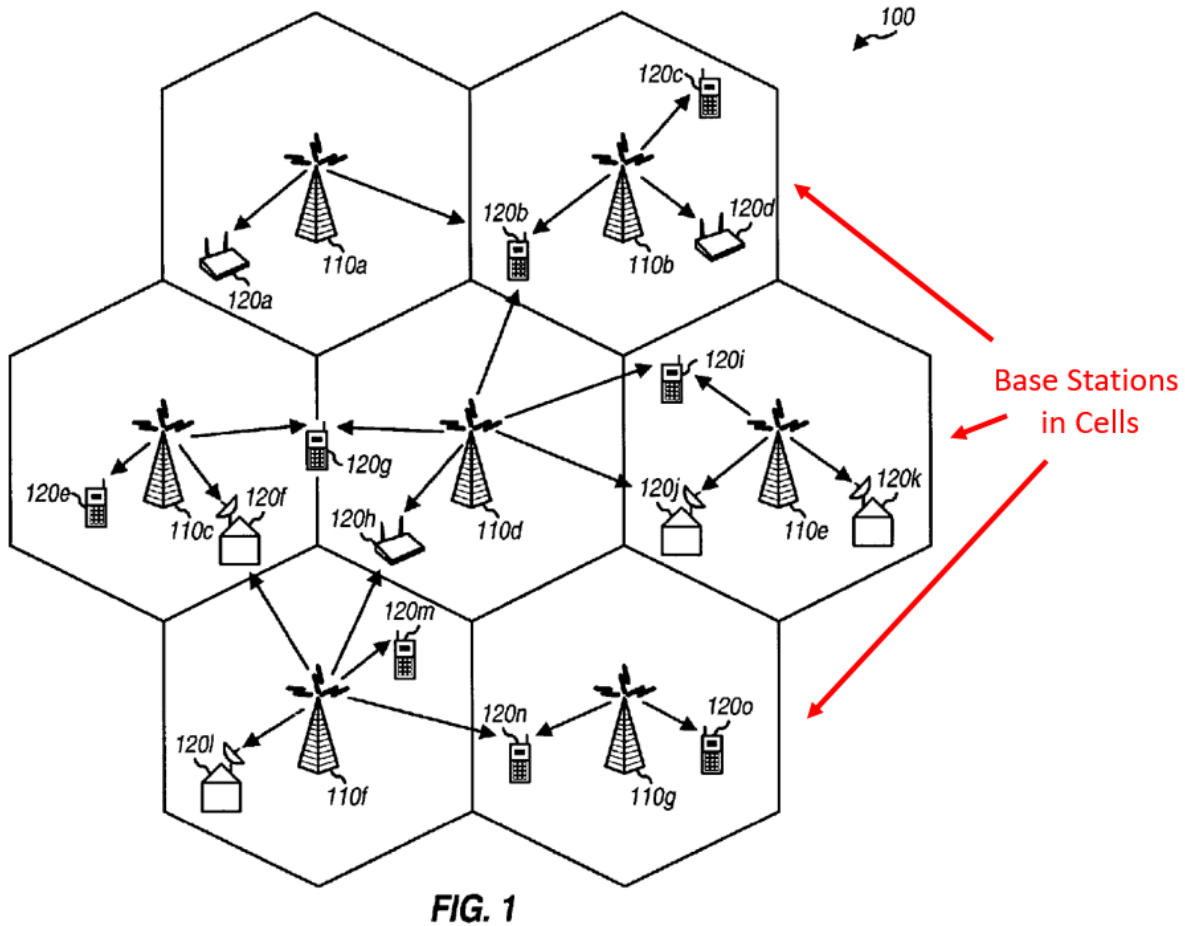
Declaration of Sarah Kate Wilson
U.S. Patent No. 10,447,450

Vijayan089 and Laroia still discloses this same functionality for the reasons that I have provided above for claim 1 and as I discuss further below.

U.S. Pat. No. 10,447,450	Obviousness in view of Vijayan089 and Laroia
[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:	See Claim Element [1-pre] ; Section IX.B.1.
[7A] receive an identifier from a base station in a cell in which the mobile device is operating; and	See Claim Elements [1A] , [1C] , and [1D] ; Sections IX.B.2, IX.B.4, IX.B.5.
[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	See Claim Elements [1B] and [1C] ; Sections IX.B.3, IX.B.4.
[7C] recover the information from the received signal using the starting time-frequency coordinate and N in conjunction with the received identifier.	See Claim Element [1D] ; Sections IX.B.5.

168. I note that there are only minor differences between claim 7 and claim 1, none of which change the outcome that the combination of Vijayan089 and Laroia discloses each and every claim feature for the reasons that I presented for claim 1. To address some of the minor differences, I note that the preamble of claim 7 introduces the concept of a “wireless packet system.” While Vijayan089 discloses the preamble of claim 7 for the reasons that I explained with respect to the preamble of claim 1, Vijayan089 also 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 includes a configuration mapping “the number of slots needed to transmit one packet” based on a particular mode or modulation scheme used for transmission. *Id.*, ¶86. For example, coded packets may be transmitted using the transmission slots that I described above. *Id.*, ¶87. (“The four coded packets for each subblock may be sent in 12 slots.”) In this manner, Vijayan089 also describes using packets for wireless communications as well.

169. Additionally, claim [7A] also recites the mobile device operating within a cell serviced by base station. Vijayan089 also describes this same configuration with base station cells in Figure 1. *Id.*, ¶¶36-37. This configuration also applies when the “wireless device” described in Vijayan089 is a “cellular phone.” *Id.*, ¶36.



EX1005, FIG. 1 (annotated).

170. To the extent that this is unclear, Laroia also describes this same cell-based configuration. EX1007, FIG. 1, ¶¶32-34. Thus, the combination of Vijayan089 and Laroia renders obvious claim 7 for substantially the same reasons that I provided for claim 1.

D. Vijayan089 in view of Laroia renders obvious claim 13.

171. The limitations of independent claim 13 are substantially similar to those recited in claim 1. As I further outline below, Vijayan089 in view of Laroia

discloses all of the limitations of claim 13 for the reasons that I have explained for claim 1. *See* Section IX.B.

172. At the outset, I note that claim 1 recites a method describing the functionality and interaction between both a base station and a mobile device. EX1001, 12:47-54. Specifically, claim 1 describes a “method for a wireless network comprising at least a base station and a mobile station.” *Id.* Claim 13 refers to substantially the same functionality but claims the functionality from the perspective of the “**base station.**” *Id.*, 14:7-13. Thus, the combination of Vijayan089 and Laroia still discloses this same functionality for the reasons that I have provided above for claim 1 and as I discuss further below.

U.S. Pat. No. 10,447,450	Obviousness in view of Vijayan089 and Laroia
[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:	<i>See</i> Claim Element [1-pre] ; Section IX.B.1.
[13A] provide an identifier to a mobile device in the cell;	<i>See</i> Claim Elements [1A] , [1C] , and [1D] ; Sections IX.B.2, IX.B.4, IX.B.5.
[13B] allocate a segment of time-frequency resource for carrying information to the mobile device, the	<i>See</i> Claim Element [1B] and [1C] ; Sections IX.B.3, IX.B.4.

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.	See Claim Elements [1B] , [1C] and [1D] ; Sections IX.B.3, IX.B.4, IX.B.5.

173. I note that there are only minor differences between claim 13 and claim 1, none of which change the outcome that the combination of Vijayan089 and Laroia discloses each and every claim feature for the reasons that I presented for claim 1. To address some of the minor differences, I note that like claim 7, the preamble of claim 13 recites a “wireless packet system.” While Vijayan089 discloses the preamble of claim 13 for the reasons that I explained with respect to the preamble of claim 1, Vijayan089 also describes communications using “packets” as I explained with reference to claim 7. EX1005, Abstract, ¶¶83, 85-87, 114; Section IX.C.

174. Additionally, claim element [13A] also recites the mobile device operating within a cell serviced by a base station. As I explained with reference to claim 7, Vijayan089 also describes this same configuration with wireless devices

receiving data from base station cells as depicted in Figure 1. EX1005, ¶¶36-37; Section IX.C.

E. Vijayan089 in view of Laroia renders obvious claims 2, 8, and 14.

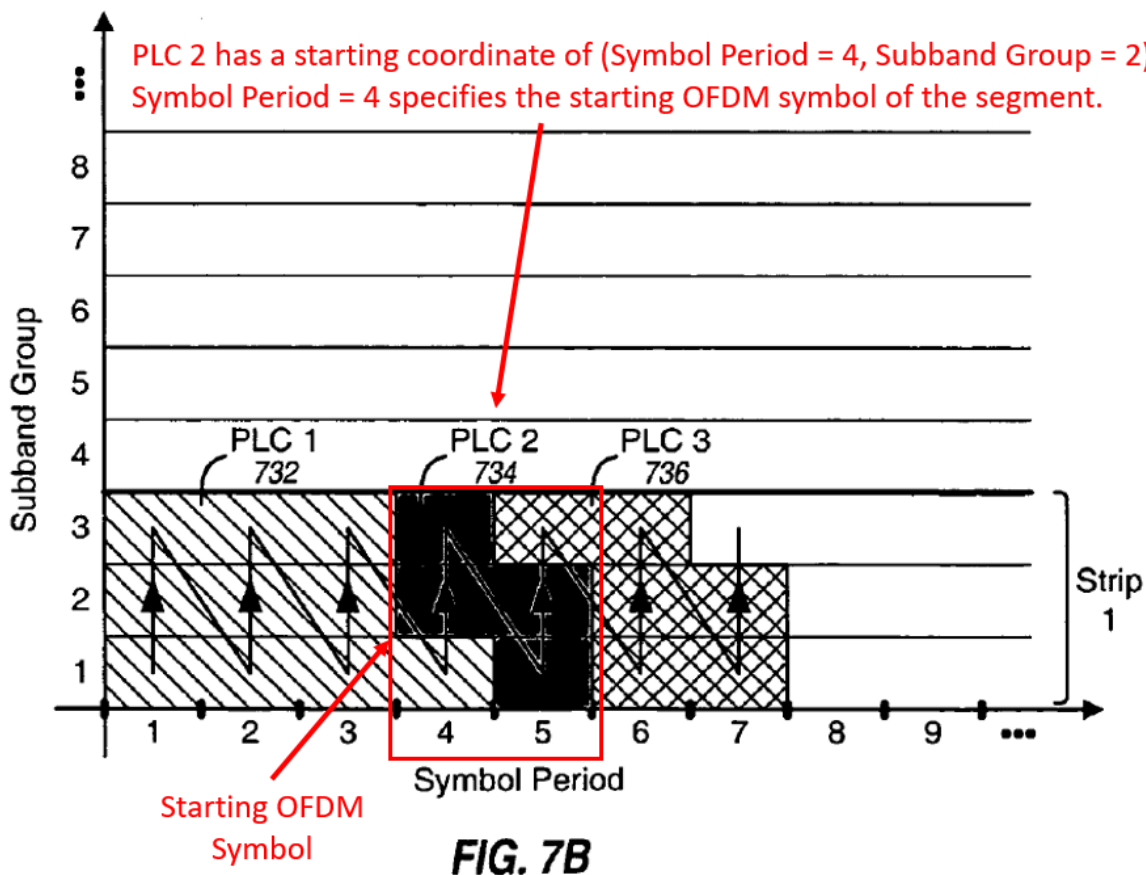
175. Claim 2, 8, and 14 respectively recites:

- 2. The method of claim 1, wherein the starting time-frequency coordinate indicates a starting OFDM symbol of the segment of time-frequency resource.
- 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.
- 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.

176. Vijayan089 discloses a “starting time-frequency coordinate” indicating a starting OFDM symbol. As I explained with reference to the preamble of claim 1, Vijayan089 discloses the transmission of OFDM symbols. See Section IX.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 is “given in units of OFDM symbol periods.” EX1005, ¶46. Within a frame, “[e]ach OFDM symbol period is the time duration to transmit one OFDM symbol.” *Id.* “With OFDM, one modulation symbol may be sent on each subband in each symbol period, i.e., each transmission unit.” *Id.*, ¶47. In this manner, when

Vijayan089 specifies a starting symbol period for a segment, Vijayan089 also identifies a starting OFDM symbol of the time-frequency resource segment. *Id.*, ¶¶46-47, 74.

177. Vijayan089 depicts examples of this configuration in Figures 4 and 7B. *Id.*, FIG. 4, FIG. 7B, ¶¶9, 11, 59, 72-76.



EX1005, FIG. 7B (annotated).

178. As I previously explained, Vijayan089 discloses a starting time-frequency coordinate: 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.” *Id.*, ¶74. When viewed in the context of Figure 7B, Vijayan089’s starting time-frequency coordinate also specifies the particular starting OFDM symbol for the segment. *Id.*, ¶¶72-76. Vijayan089’s identification of a starting transmission slot indicates a “one group of modulation symbols in one symbol period.” *Id.*, ¶59. Thus, Vijayan089’s indication of the starting symbol period of a segment also identifies a starting OFDM symbol of the segment.

F. Vijayan089 in view of Laroia renders obvious claims 3, 9, and 15.

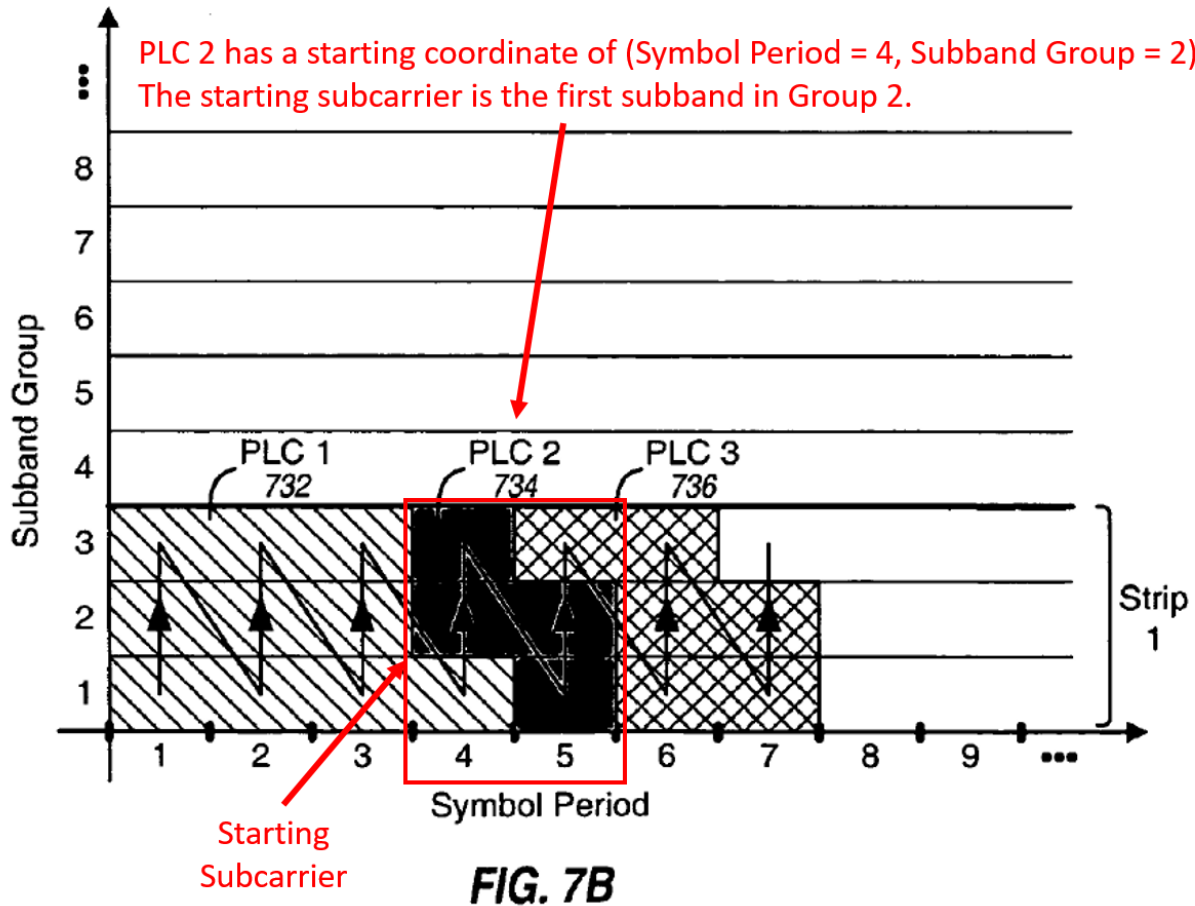
179. Claim 3, 9, and 15 respectively recites:

- 3. The method of claim 1, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.
- 9. The mobile device of claim 7, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.
- 15. The base station of claim 13, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.

180. Vijayan089 discloses a “starting time-frequency coordinate” indicating a starting subcarrier of the segment of time-frequency resource. As I previously explained, Vijayan089 discloses a starting time-frequency coordinate: 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. As seen from this description, the starting time-frequency coordinate specified in Vijayan089 indicates a “starting subband” of the segment. *Id.*, ¶59. Vijayan089 explains that “subbands” refers to “tones, carriers, *subcarriers*, bins, and frequency channels. ***With OFDM, each subband is associated with a respective subcarrier*** that may be modulated with data.” *Id.*, ¶5. In this manner, Vijayan089’s use of a starting subband to identify the start of the segment indicates a starting subcarrier for the segment.

181. This identification is also applicable when the start of the segment identifies a starting transmission slot. *Id.*, ¶59. Specifically, Vijayan089 describes specifying the “starting subband” when transmission slots are used as well. *Id.*, ¶¶73-74. For example, as I have annotated in Figure 7B below, the starting subcarrier for segment 734 corresponding to PLC 2 would be the first subband in Subband Group 2. *Id.*, ¶¶72-74.



EX1005, FIG. 7B (annotated).

182. Thus, Vijayan089 discloses the starting time-frequency coordinate indicating a starting subcarrier of the segment of time-frequency resource.

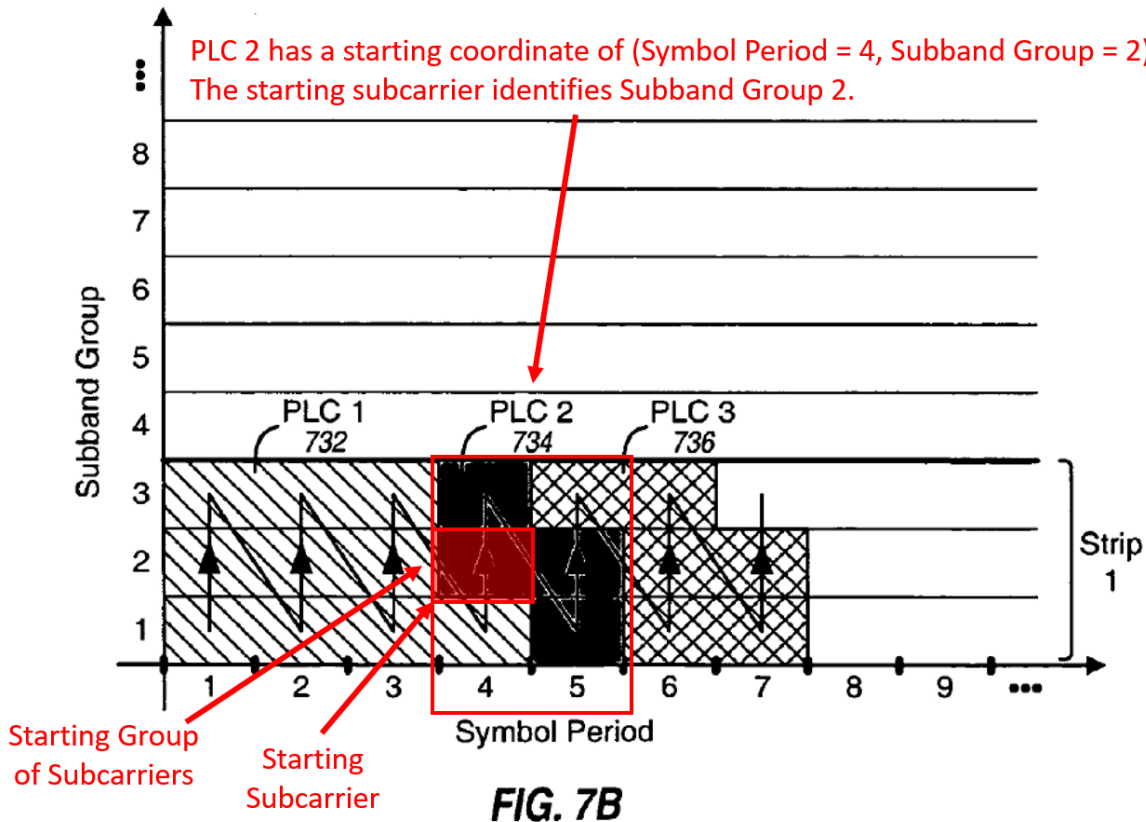
G. Vijayan089 in view of Laroia renders obvious claims 4, 10, and 16.

183. Claim 4, 10, and 16 respectively recites:

- 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.
- 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.

- 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.

184. Vijayan089 discloses a “starting time-frequency coordinate” indicating a starting group of subcarriers of the segment of time-frequency resource. As I previously explained, Vijayan089 discloses a starting time-frequency coordinate: 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. As seen from this description, the starting time-frequency coordinate specified in Vijayan089 indicates a “starting subband” of the segment. *Id.*, ¶59; *see also* Section IX.F. By virtue of being the first subband in a “subband group,” this starting subband also identifies a starting group of subcarriers as well. Figure 7B depicts an example of the starting subband identifying a particular subband group (i.e., Subband Group 2). *Id.*, ¶¶59, 72-74.



EX1005, FIG. 7B (annotated).

185. For example, when examining 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. Indeed, Vijayan089 explicitly refers to “subband group 2” to define the start of segment 734. *Id.*, ¶73. This can also be seen in Figure 7B where the vertical axis identifies starting Subband Groups. Thus, the starting time-frequency coordinate described in Vijayan089 also indicates a starting group of subcarriers for a segment. *Id.*, ¶¶59, 70, 72-74.

H. Vijayan089 in view of Laroia renders obvious claims 5, 11, and 17.

186. Claim 5, 11, and 17 respectively recites:

- 5. The method of claim 1, wherein modular coding is applied to the time-frequency resource units in the segment of time-frequency resource.
- 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.
- 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.

187. At the outset, I note that the '450 patent appears to use 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. For example, the '450 patent provides Table 1, which “sets forth representative modulation and forward-error correction (FEC) coding schemes (MCS).” *Id.*

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).

188. Vijayan089 discloses these same modulation schemes and applying “modular coding” to the time-frequency resource units of a segment. EX1005, ¶¶69, 84-88. 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.*” *Id.*, ¶39. Similar to the “MCSI” value identified in the ’450 patent, Vijayan089 uses a “mode” value to specify a modulation scheme (and a coding scheme) applied to a segment corresponding to a PLC. EX1005, ¶¶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.

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).

189. Vijayan089 explains that each mode in the Table 1 is “associated with a *specific modulation scheme (e.g., QPSK or 16-QAM)* and a specific inner code rate $R_{in}(m)$ (e.g., $\frac{1}{3}$, $\frac{1}{2}$, or $\frac{2}{3}$).” EX1005, ¶85. This modulation scheme is applied to the time-frequency slots of a PLC segment. *Id.*, FIG. 10, ¶¶86, 89, 102-108. Thus, Vijayan089 discloses the claimed application of “modular coding” to the segment of time-frequency resource units.

X. GROUND 2: Claims 1-5, 7-11, and 13-17 are unpatentable under 35 U.S.C. § 103 as obvious over Vijayan475 and Wu

190. Vijayan475 and Wu disclose each and every limitation of claims 1-5, 7-11, and 13-17. Vijayan475 explicitly discloses the majority of the claim elements recited claim 1. For example, 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 teaches that it would have been obvious to also include a user equipment (UE) identifier with this information to specifically identify or designate a wireless device to receive such information. EX1008, ¶¶33-34, 92, 94, 98. Such a technique was well known in the art and often used to identify a particular wireless device from among multiple wireless devices. *See* Section VII.C. Wu expressly discloses such a technique and describes assigning an identifier to a user device so that it can discern its own messages intended for reception. As I explain in further detail below, a POSITA would have found it

obvious and would have been motivated to combine Vijayan475 and Wu prior to the earliest filing date of the '450 patent to also provide this capability.

191. Vijayan475 is similar to Vijayan089 but provides a different process for conveying an allocated time-frequency resource segment and describes a “multiplexed logical channel (MLC)” rather than “physical layer channel (PLC).” EX1006, ¶¶9, 36-42. In this manner, and as I will further explain below, Vijayan475 also discloses assigning a segment using a starting time-frequency coordinate and N-value but arrives at its definition of time-frequency resource segments differently from Vijayan089. *See* Sections IX.B.3, X.B.3. Vijayan475 uses parameters like “Start Offset,” “Slot Info,” and “Stream Lengths” parameters to define a starting time-frequency coordinate and N-value. *See* Section X.B.3; EX1006, ¶¶40, 42, 45-47, 56.

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

192. A POSITA would have recognized that combining Vijayan475 and Wu would have amounted to combining well-known prior art elements to yield predictable results. As I explained in Section VII.C, assigning a wireless device identifier was a well-known technique in the art prior to the '450 patent. With respect to the Vijayan475 and Wu combination, a POSITA would have applied Wu's UE identifier with Vijayan475's system to allow its wireless devices to differentiate and identify its own respective messages for reception. EX1006, ¶¶5,

25-26, 44; EX1008, ¶¶33-34, 87, 92, 94, 98. The combined wireless device would then use the UE identifier to identify its respective resource allocation parameters, as I explain further below. *See* Section X.B.5. In this manner, combining Wu with Vijayan475 would improve the functionality of Vijayan475’s base stations and wireless devices by allowing the base stations to discern between different wireless devices.

193. At the outset, Vijayan475 already suggests the use of an identifier to differentiate between multiple wireless devices as I explain in Section X.B.2. For example, Vijayan475 describes transmitting data to “specific wireless devices” when performing “unicast” communications. EX1006, ¶¶5, 25-26. This is particularly relevant because Vijayan475 describes its base station as being able to “simultaneously transmit multiple data streams for broadcast, multicast, and/or unicast services.” *Id.*, ¶5. To implement unicast transmissions or to communicate data to a specific wireless device, a POSITA would have found it obvious to use an identifier to specifically identify that wireless device. *See* Section VII.C. As I previously explained, this process was ubiquitous in wireless communications and OFDM systems when delivering data or messages to intended recipient devices. *See* Section VII.C.

194. Despite this understanding, I note that Vijayan475 does not explicitly discuss the type of identifiers that could be used, nor does Vijayan475 expressly

disclose how such identifiers would be implemented in its system. A POSITA would have therefore sought references teaching or describing techniques for implementing wireless device identifiers. Wu is such a reference. Wu confirms that it was well-known in the art to use wireless device identifiers and explicitly describes assigning a UE identifier to a mobile terminal to identify the “given receiver” intended to receive OFDM content. EX1008, ¶¶33-34; *see also id.*, ¶¶92, 94, 98; Section X.B.2. The UE receiver uses this identifier to determine “how each OFDM slot is partitioned between receivers such that each receiver can obtain its content.” *Id.*, ¶32; *see also id.*, ¶¶33-34. In view of Vijayan475’s suggestion of delivering data and resource allocations to specific wireless devices, a POSITA would have found it obvious and would have been motivated to also use Wu’s UE identifier with Vijayan475’s system.

195. Implementing Wu’s UE identifier would similarly allow for differentiation between wireless devices and to identify data intended for a particular wireless device. EX1008, Abstract, ¶¶32-34, 87, 94, 98. For example, as I further explain below, the combined system would use the UE identifier to specify the resource allocation parameters for a particular wireless device. *See* Section X.B.5. For example, Vijayan475’s wireless device would use the identifier to discern its own slot allocation parameters and/or stream lengths as I further explain below. EX1006, ¶¶42, 45-55. Using these values, Vijayan475’s wireless

device would identify its assigned transmission slots to receive and recover the data transmitted in those slots. EX1006, ¶¶9-10, 44. The identifier would be included in the existing overhead information described in Vijayan475. *Id.*, ¶¶9-12, 38, 43, 55, 62, 64. In this manner, a POSITA would have been motivated to combine Vijayan475 and Wu to differentiate between data or control messages sent to different wireless devices.

196. A POSITA would have also known how to combine Vijayan475 and Wu and would have had a reasonable expectation of success in implementing the combination. Both Vijayan475 and Wu describe base stations and wireless devices communicating using OFDM as well as 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. A POSITA would have easily implemented the communication protocols described in both Vijayan475 and Wu to facilitate wireless transmissions from a base station to a wireless device to perform a combined algorithm. This combined algorithm would include Vijayan475's allocation of time-frequency transmission slots and use of slot identification parameters with Wu's use of a UE identifier to signal specific communications to a particular wireless device. *See* Sections X.B.3-X.B.5. The combined system would transmit this information from the base station to the wireless device using the overhead information described in Vijayan475. *Id.*

197. Both Vijayan⁴⁷⁵ and Wu also describe conventional base stations and wireless devices and implementing software algorithms to perform OFDM communications and time-frequency slot allocations. See EX1006, FIG. 1, FIG. 8, FIG. 9, ¶¶25-27, 36, 39-42, 67-75; EX1008, FIG. 6, ¶¶101, 134, 137. In this manner, a POSITA would have easily combined the references using well-known computer programming techniques to perform a combined algorithm. Combining Vijayan⁴⁷⁵ and Wu would have been predictable and would simply amount to updating Vijayan⁴⁷⁵'s protocol and overhead signaling to include Wu's wireless device identifier to generate a combined wireless communication system. EX1006, ¶¶9-12, 38, 55, 62, 64; EX1008, ¶¶33-34, 87, 92, 94, 98. This combination would operate to perform its intended purposes.

198. In this manner, a POSITA would have easily combined Vijayan⁴⁷⁵ and Wu. Combining Vijayan⁴⁷⁵ and Wu would amount to nothing more than combining known prior art elements according to known methods to yield predictable results and applying a known technique to a known device ready for improvement to yield predictable results. Thus, in view of the conventional OFDM base station and wireless device configurations described in Vijayan⁴⁷⁵ and Wu, a POSITA would have easily combined the references and would have found it predictable to form such a combination.

199. Thus, a POSITA would have been motivated to combine Vijayan475 and Wu to differentiate between different wireless devices and would have had a reasonable expectation of success in forming the combination.

B. Vijayan475 in view of Wu Renders Obvious Claim 1.

- 1. Claim 1 Preamble (Element [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:*”**

200. Vijayan475 discloses the preamble of claim 1. As I will further explain in detail below, Vijayan475 describes the same operating method and wireless network having a base station and a mobile station that is recited in claim 1.

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

201. 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. Figure 1 depicts a wireless network connecting the base stations 110 and wireless devices 120. *Id.*

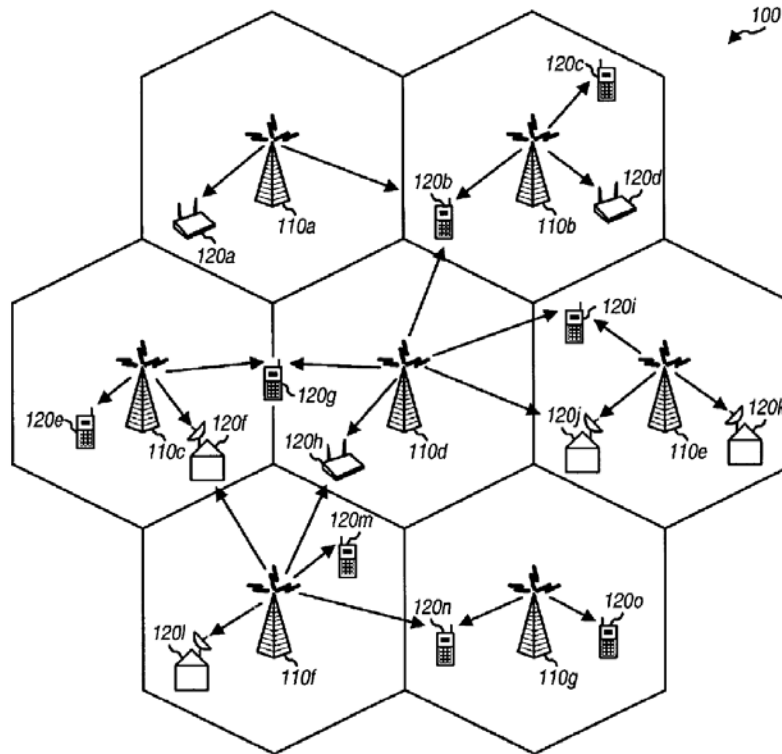


FIG. 1

EX1006, FIG. 1.

202. Vijayan475 also describes the components of its base stations with reference to Figure 8 and the components of its mobile stations with reference to Figure 9. EX1006, ¶¶67-75.

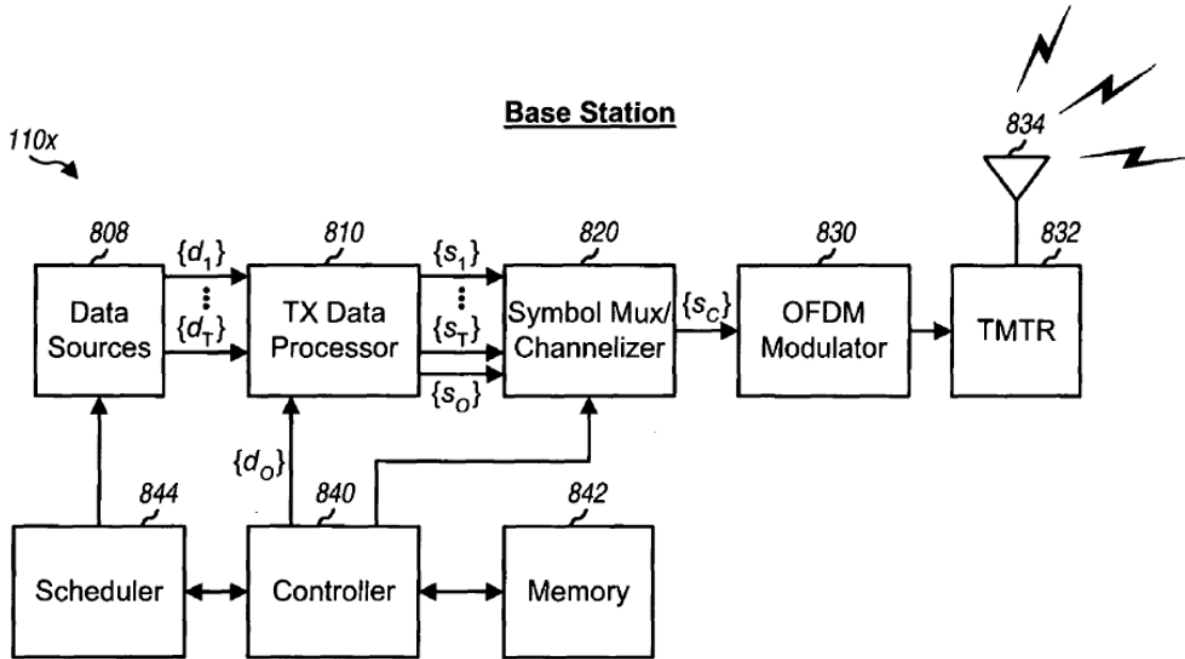


FIG. 8

EX1006, FIG. 8.

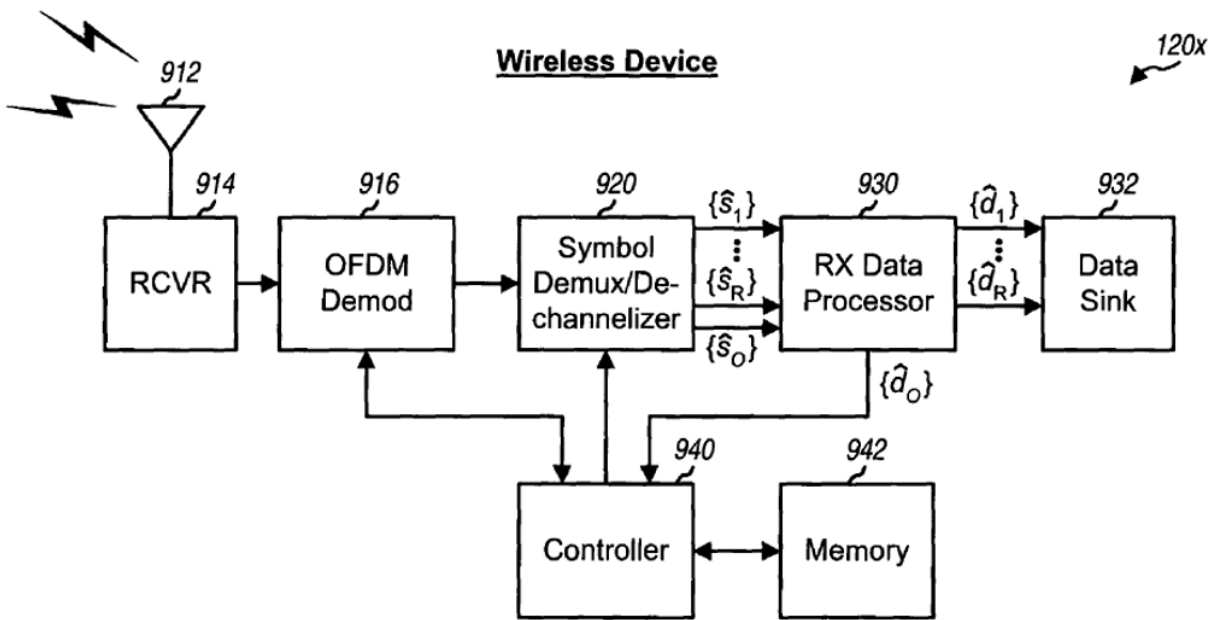


FIG. 9

EX1006, FIG. 9.

203. In view of this description, Vijayan475's base station 110 discloses the claimed "base station." Similarly, Vijayan475's wireless device 120 discloses the claimed "mobile station." In particular, Vijayana475 states that a "wireless device may be fixed or mobile and may also be referred to as a user terminal, a **mobile station**, user equipment, or some other terminology." EX1006, ¶26. The base stations and mobile stations communicate wirelessly to disclose the claimed "wireless network" as depicted in Figure 1.

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

204. Vijayan475 utilizes a frame structure of multiple frames for transmission. See EX1006, Abstract, ¶¶10, 12, 29-32, 37-42, 45. For example, as seen in Figure 2, Vijayan475 utilizes multiple frames in a "Super-Frame 210" configuration to communicate OFDM signals. *Id.*, ¶¶29-31; *see also id.*, FIG. 6, ¶¶56-59.

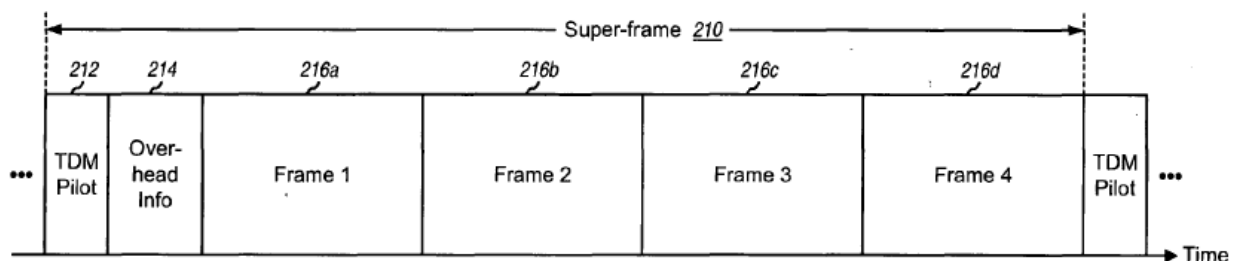


FIG. 2

EX1006, FIG. 2.

205. As seen in Figure 2, Vijayan⁴⁷⁵'s super-frame structure includes multiple frames used for transmissions. *Id.*, ¶¶29-31.

“FIG. 2 shows an exemplary **super-frame structure** that may be used for system 100. Data transmission occurs in units of super-frames 210. **Each super-frame spans a predetermined time duration** which may be selected based on various factors such as, for example, the desired statistical multiplexing for the data streams, the amount of time diversity desired for the data streams, the acquisition time for the data streams, buffer requirements for the wireless devices, and so on.”

Id., ¶29 (emphasis added).

206. The super-frame depicted in Figure 2 includes “four equal-sized frames 216a through 216d,” but Vijayan⁴⁷⁵ explains that “a super-frame may span any time duration, include any number and any type of fields, and have any number of frames. The system may also use other frame structures for transmission.” *Id.*, ¶¶30-31.

207. Figure 4 depicts an example of a 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.” *Id.*, ¶¶39-40, 57. I will further explain the structure of this frame below.

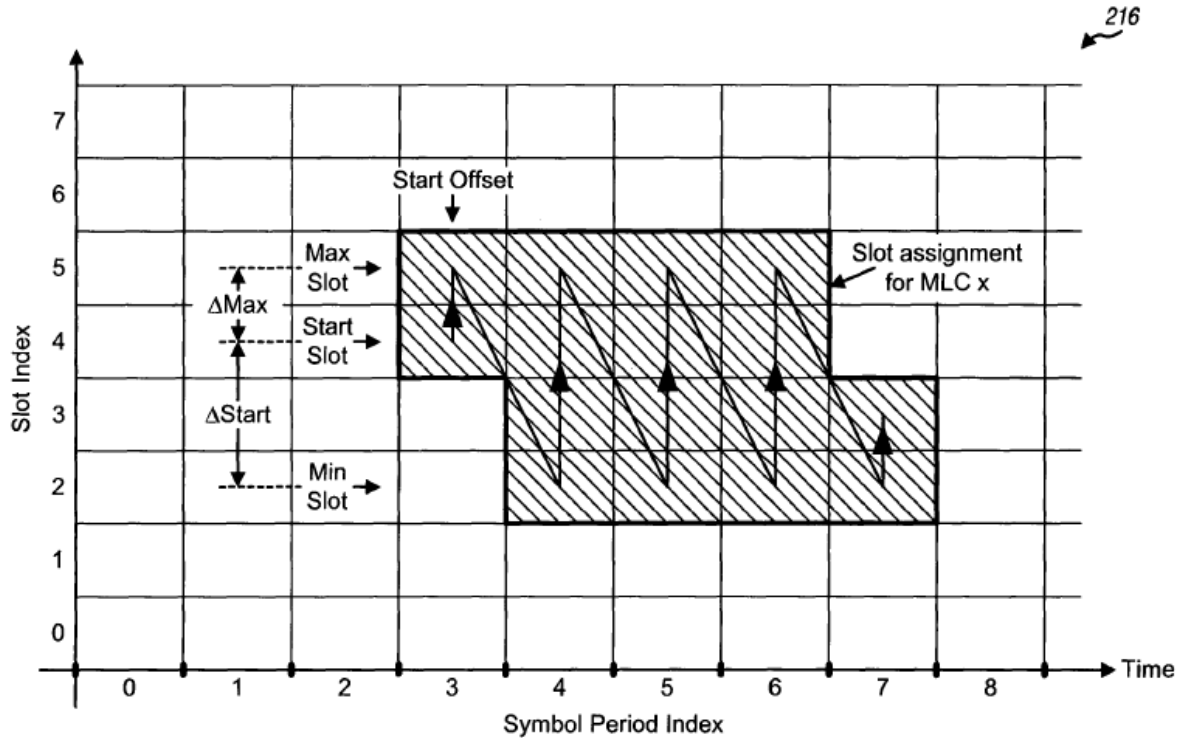


FIG. 4

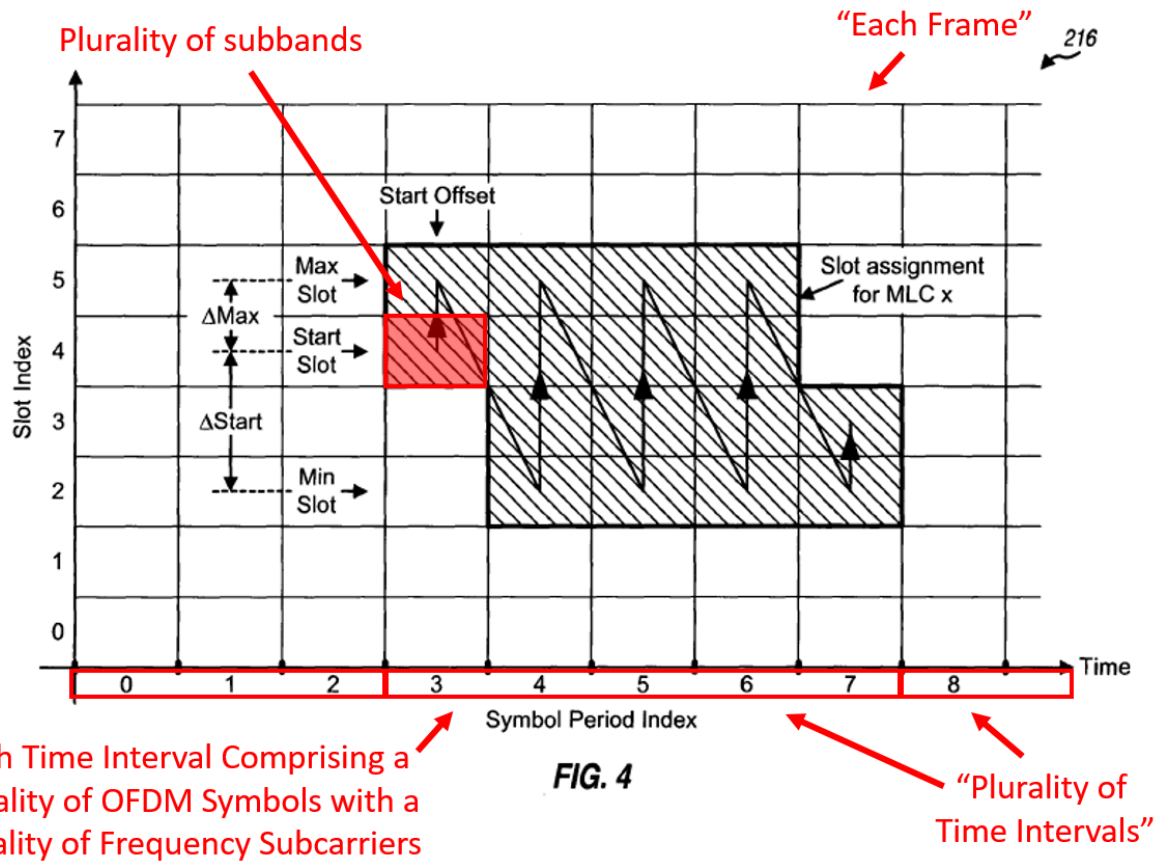
EX1006, FIG. 4.

208. As I will further explain below, Vijayan475 also describes using time-frequency “slots” within the super-frame structure to transmit data as well. *Id.*, ¶¶36-41, 45-49, 57. Vijayan475 explains that a “fixed or variable number of slots in each super-frame” may be allocated for a multiplexed logical channel (MLC) segment “depending on the MLC’s payload, the availability of slots in the super-frame, and possibly other factors.” *Id.*, ¶38. Vijayan089 assigns “specific slots within the super-frame based on an assignment scheme that attempts to (1) pack the slots for all active MLCs as efficiently as possible, (2) reduce the transmission time for each MLC, (3) provide adequate time-diversity for each MLC, and (4)

minimize the amount of signaling needed to indicate the slots assigned to each MLC.” *Id.* Vijayan475 further 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.

- 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”***

209. Vijayan475’s frame discloses each of the elements recited in the preamble. EX1006, FIG. 4, ¶¶39-42. I have annotated Figure 4 below to demonstrate how Vijayan475’s frame discloses these elements.



EX1006, FIG. 4 (annotated).

210. "FIG. 4 also shows the assignment of slots to a given MLC x for one frame 216." EX1006, FIG. 4, ¶40. The frame 216 is defined using a time value in the horizontal axis given by Symbol Period Index values. *Id.* Regardless of size, multiple groupings of these symbol periods disclose the claimed "plurality of time intervals" as I have annotated in FIG. 4. *Id.* For my analysis below, I will focus on a time interval spanning Symbol Period Indices 3 through 7. *Id.*

211. Vijayan475 discloses “each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols” as recited in claim 1. Vijayan475 first explains that “[m]ultiple carriers may be provided by orthogonal frequency division multiplexing (OFDM).” EX1006, ¶25. “OFDM effectively partitions the overall system bandwidth into multiple (N) orthogonal subbands. ... With OFDM, each subband is associated with a respective subcarrier that may be modulated with data.” *Id.* In this manner, Vijayan475 discloses the transmission of OFDM symbols. *Id.*, ¶¶69-71. In Figure 4, the OFDM symbols are represented by Symbol Period Indices 0-8. Each time interval also comprises these OFDM symbols as specified and seen in Figure 4. For example, each “slot” has a duration of one OFDM “symbol period.” *Id.*, FIG. 4, ¶¶36, 39-42. From these descriptions, Vijayan475 therefore discloses each time interval comprising a plurality of OFDM symbols. For example, the time interval spanning Symbol Period Indices 3-7 includes five OFDM symbols.

212. Vijayan475 also discloses “each OFDM symbol containing a plurality of frequency subcarriers.” *Id.*, ¶¶25, 36. As I previously indicated, Vijayan475 explains that “[*m*]ultiple *carriers* may be provided by orthogonal frequency division multiplexing (OFDM).” *Id.*, ¶25. Vijayan475 further explains:

OFDM effectively partitions the overall system bandwidth into **multiple (N) orthogonal subbands**. These subbands are also referred to as tones, carriers, **subcarriers**, bins, and frequency

channels. With OFDM, each subband is associated with a respective subcarrier that may be modulated with data. . . . For clarity, these techniques are described below for an exemplary wireless ***multi-carrier*** broadcast system.

Id., ¶25.

213. As seen from this description, within each OFDM symbol, Vijayan⁴⁷⁵ discloses a plurality of subbands or frequency carriers. *Id.*, ¶¶25, 36. Therefore, Vijayan⁴⁷⁵ discloses “each OFDM symbol containing a plurality of frequency subcarriers.”

* * *

214. In view of these teachings, Vijayan⁴⁷⁵ discloses the same wireless network and OFDM frame structure recited in the preamble of claim 1.

2. Element [1A]: “*assigning an identifier to the mobile station;*”

215. As I previously explained, the ’450 patent does not provide a specific definition for the term “identifier.” See Section IX.B.2; EX1001, 8:37-42, 9:4-29. Rather, the ’450 patent generally describes assigning a “basic connection identification (BCID),” which may be assigned to downlink or uplink transmissions. EX1001, 8:37-42. “The BCID for downlink may or may not be the same as that of the uplink.” *Id.*, 8:41-42. Additionally, the “BCID can be used for control messages or generic (unclassified) application connections.” *Id.*, 8:39-41. Based on this description as well as the use of the general term “identifier” in the

claim, a POSITA would have understood the claimed identifier to be satisfied by an identification corresponding to a mobile station. .

216. Vijayan475 describes allocating transmission units or “slots” for specific wireless devices and also describes a “unicast transmission [that] is sent to a specific wireless device.” EX1006, ¶¶5, 25. In both of these scenarios, a POSITA would have found it obvious for the wireless device to be assigned an identifier so that the wireless device is capable of discerning its own intended data streams and received data. *Id.*, ¶¶5, 25-26. Further, Vijayan475 describes the express goal of allowing a wireless device to “quickly find and extract” or recover “individual data streams of interest.” *Id.*, ¶¶8-9, 44. This suggests providing unique identification to wireless devices so that they can discern their own allocated data streams or streams of interest. *Id.* This is especially relevant in unicast communications directed specifically to a particular wireless device. *Id.*, ¶¶5, 25.

217. As I previously explained, Vijayan475 describes allocating specific resources or “slots” for wireless devices to receive data transmissions from a base station. *Id.*, ¶¶36-42. Vijayan475 uses a group of slots to deliver a segment of data corresponding to a “multiplexed logical channel (MLC).” *Id.*, ¶9. “Each MLC may carry one or more data streams and may be transmitted at different times, on different frequency subbands, and so on.” *Id.* The wireless device may use received overhead information to identify the “time-frequency location where each MLC is

transmitted.” *Id.*, ¶¶9-10, 60. Vijayan⁴⁷⁵ uses this overhead information to inform the wireless device of this allocation:

In an embodiment, the composite overhead information includes location information for all MLCs and is sent periodically at the start of each super-frame of a predetermined time duration, as described below. The composite overhead information for each super-frame contains location information for each MLC for that super-frame, and this location information indicates the time-frequency location where the MLC will be transmitted in the super-frame. A **wireless device** *may* receive the composite overhead information for a current super-frame, **determine the time-frequency location of each MLC of interest based on the location information for the MLC, and receive each MLC of interest in the current super-frame at the indicated time-frequency location.**

EX1006, ¶10.

218. Based on the overhead signaling, Vijayan⁴⁷⁵’s base station informs a particular wireless device of its allocated transmission units so that the wireless device can power on during its allocation to receive data. *Id.*, ¶¶6-8, 38, 62. This is particularly relevant to the “unicast transmission” context where data will be “sent to a specific wireless device.” *Id.*, ¶¶5, 25. In order to provide this direct communication and allocation, a POSITA would have found it obvious for Vijayan⁴⁷⁵ to assign an identifier to the specific wireless device to provide the

wireless device's allocation of transmission units and to provide unicast transmissions specifically targeted to individual wireless devices. *Id.*, ¶¶5, 25, 37-42. Without such an identifier, it would have been more difficult for each wireless device to discern its own assigned data and corresponding transmission units, especially in the unicast context.

219. To the extent that it is argued that Vijayan⁴⁷⁵ does not render obvious assigning an identifier to a mobile station, Wu explicitly discloses a base station assigning a user equipment (UE) identifier to 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; *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. *Id.*, ¶¶4, 87, 134. For example, FIG. 2 depicts a “downlink structure” with a corresponding “OFDM HSDPA” channel 30. *Id.*, ¶87.

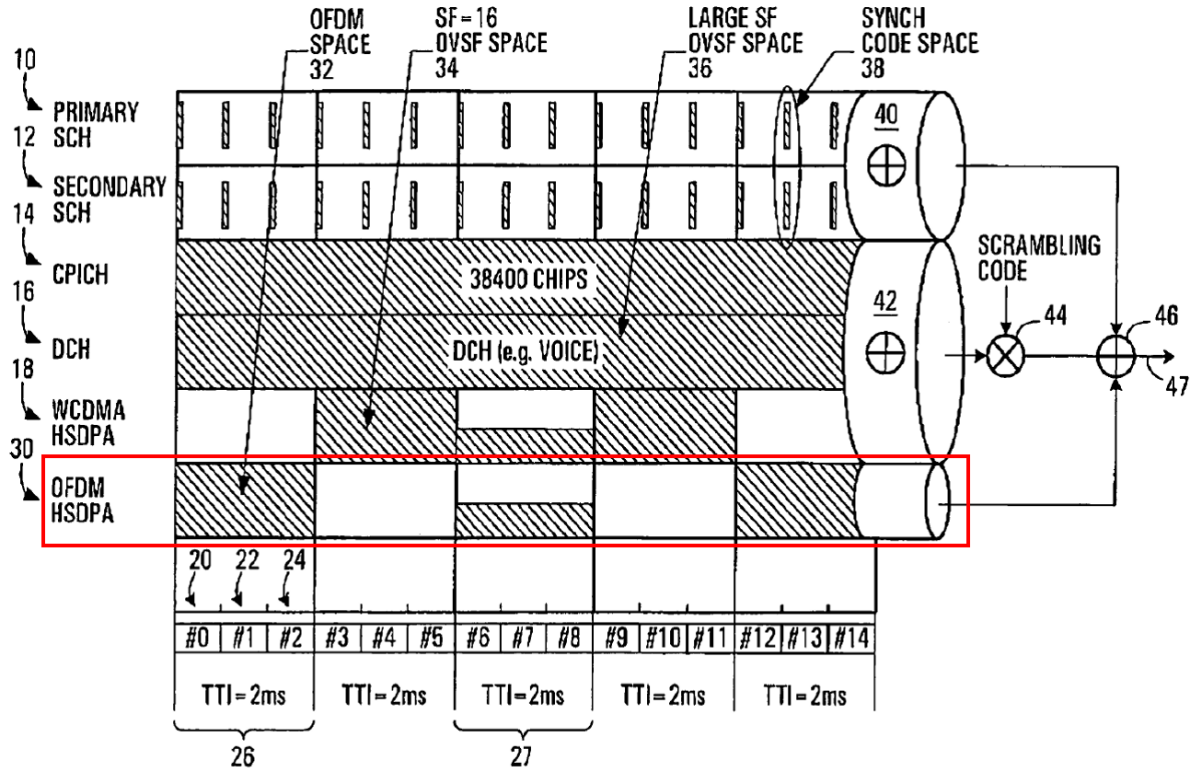


FIG. 2

EX1008, FIG. 2 (annotated).

220. Wu's base station assigns and uses the UE identifier when identifying to receivers "which OFDM slots and/or which CDMA slots are for a given receiver." *Id.*, ¶¶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. Using the identifier and slot information, the receiver determines whether it has a resource allocation scheduled for a particular slot and then demodulates the "OFDM slot only if scheduled during the slot." *Id.*, ¶¶25, 50. Wu also explains that

an example of the UE identifier may be a “MAC-ID” that can identify “particular users for which capacity is [] allocated.” *Id.*, ¶128; *see also id.*, ¶¶129-133.

221. In this manner, Wu describes assigning an identifier to identify a particular wireless terminal to receive data transmitted from a base station. As I will further explain in Section X.B.5, Wu also discloses a mobile device using this identifier to recover corresponding content from specified slots in an “OFDM time-frequency plane” as well. *Id.*, ¶128 (“the OFDM time-frequency plane is allocable dynamically to one or more users/receivers during a given slot.”)

222. A POSITA would have been motivated to combine Vijayan⁴⁷⁵ and Wu for the reasons I previously explained. *See* Section X.A. A POSITA would have applied Wu’s UE identifier with Vijayan⁴⁷⁵’s system to allow its wireless devices to differentiate and identify its own respective messages for reception. *Id.*; EX1006, ¶¶5, 25-26, 44; EX1008, ¶¶33-34, 87, 92, 94, 98.

3. ***Element [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”***

223. Vijayan⁴⁷⁵ discloses transmitting a signal in the same manner and using the same “time-frequency resource unit” organization as recited in the claims. *See* EX1006, FIG. 4, ¶¶38-42, 45-55. In fact, as I explained in Section

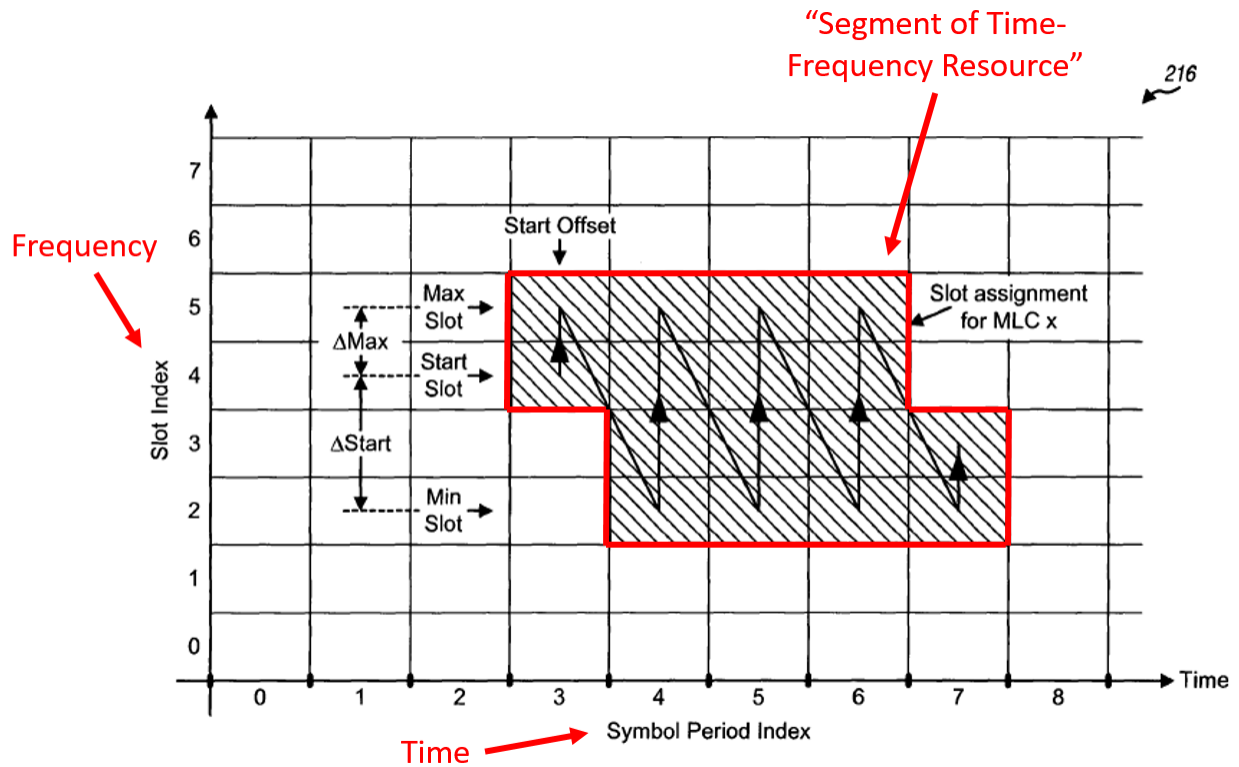
VII.B, this type of resource allocation scheme was well known in the art. Further, Vijayan475 discloses conveying a “starting time-frequency coordinate” and an “N”-value to signal the resource allocation to a wireless device using encoded starting “slot information” and “stream length” parameters. *Id.*, FIG. 4, ¶¶38-42, 45-55. Vijayan475 explains that this provides the same overhead reduction benefits described in the ’450 patent: “Since overhead information is sent periodically and since overhead bits are relatively expensive, it is desirable to **minimize the number of overhead bits as much as possible for greater efficiency.**” *Id.*, ¶55. Vijayan475’s process is able to “minimize the amount of signaling needed to indicate the slots assigned.” *Id.*, ¶38. With this same goal in mind, I will further explain below how Vijayan475 discloses the same process and the same alleged benefits provided by the ’450 patent.

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

224. As I described with reference to the preamble of claim 1, Vijayan475 describes the same base station and mobile station configuration described in claim 1. See Section X.B.1. Vijayan475 describes its base station as transmitting “multiple data streams on multiple data channels” which may be recovered by wireless devices. EX1006, Abstract, ¶¶9, 60. Specifically, “transmitter unit 832”—which is located on the base station—transmits an “OFDM symbol stream” via a

“modulated signal that is transmitted from an antenna 834.” *Id.*, ¶69. The base station transmits this signal to a wireless device. At wireless device 120x, an “antenna 912 receives the modulated signal transmitted by base station 110x and provides a received signal to a receiver unit (RCVR) 914.” *Id.*, ¶71. The wireless device then performs additional processing to identify the OFDM symbols in the signal transmitted by the base station. *Id.*, ¶¶71-73.

225. Vijayan475’s base station also transmits the OFDM symbol information “over a segment of time-frequency resources” as recited in the claim. *Id.*, FIG. 4, ¶¶36-42. Specifically, Vijayan475 describes transmitting data using “slots,” which disclose the claimed “time-frequency resources.” *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. In view of this definition, each slot is a resource having a time component (symbol period) and frequency component (subband). “Each MLC may be ‘allocated’ a fixed or variable number of slots in each super-frame depending on the MLC’s payload, the availability of slots in the super-frame, and possibly other factors.” *Id.*, ¶38. As I previously explained, Vijayan475 uses 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. Vijayan089 depicts an example slot assignment for an MLC “x” (i.e., segment of time-frequency resources) in Figure 4.



EX1006, FIG. 4 (annotated).

226. Vijayan475 further explains that that in this example, MLC x is assigned 16 slots:

FIG. 4 also shows the assignment of slots to a given MLC x for one frame 216. MLC x is assigned slots starting from a start slot index (Start Slot) at a designated symbol period index (Start Offset) and going to a highest slot index (Max Slot), then starting from a lowest slot index (Min Slot) in the next symbol period index and going to the highest slot index, and so on, until the number of slots allocated to MLC x has been reached. ***For the example shown in FIG. 4, MLC x is assigned 16 slots***

starting at slot index 4 in symbol period index 3, zigzagging between the lowest slot index 2 and the highest slot index 5, and concluding at slot index 3 in symbol period index 7.

EX1006, ¶40.

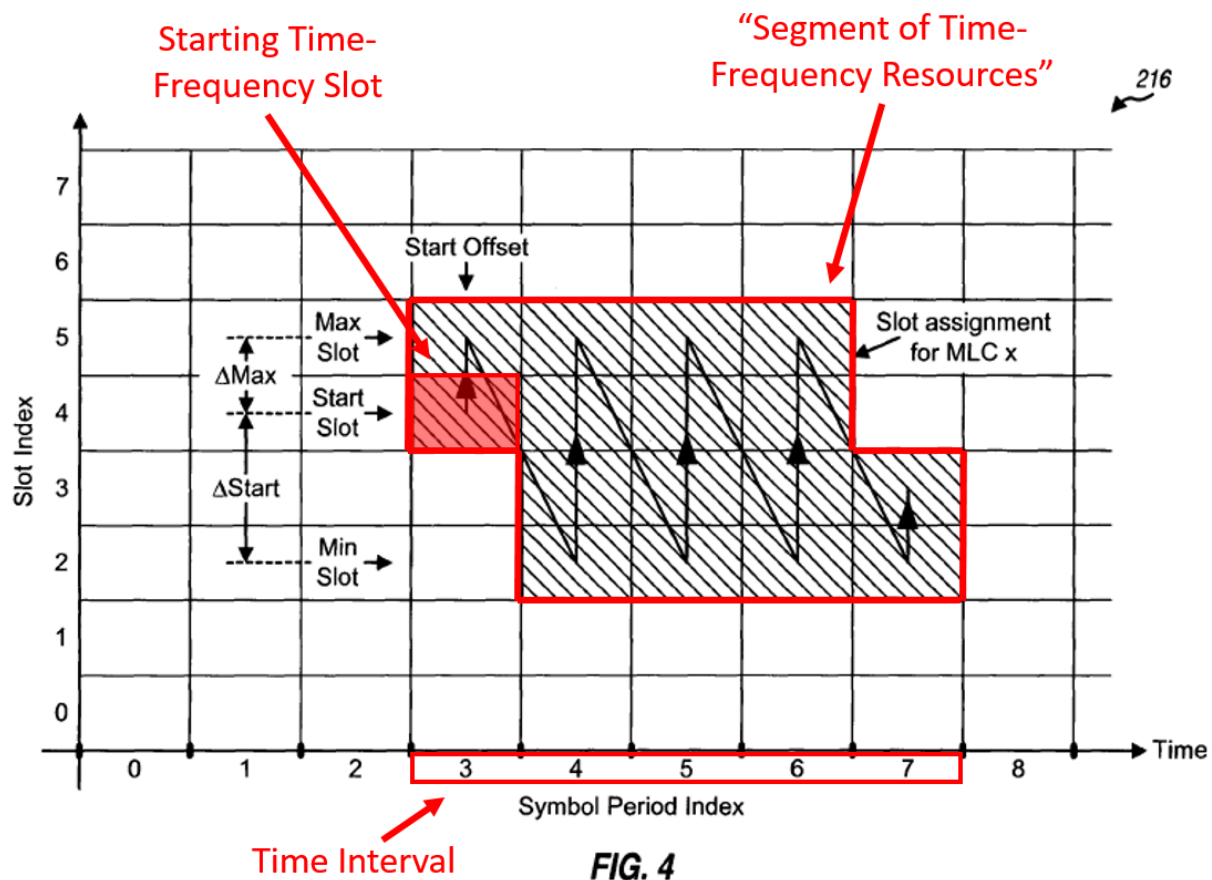
227. Each MLC may carry a data stream to a wireless device. *Id.*, ¶¶9, 27-28, 51-52. For example, an MLC may carry a data stream, video stream, or an audio stream: “These data streams may carry multimedia content such as video, audio, teletext, data, video/audio clips, and so on. The data streams are sent on data channels or MLCs.” *Id.*, ¶¶27-28. In this manner, Vijayan475 discloses transmitting a signal via an MLC corresponding to a group of slots. EX1006, ¶¶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.

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”

228. As I previously explained, a MLC segment as described in Vijayan475 discloses the claimed “segment.” See Section X.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.” To define a segment, Vijayan475 discloses the use of:

- (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.”***

Id., ¶¶40, 42, 45-47, 56.



EX1006, FIG. 4 (annotated).

229. To define a starting time-frequency coordinate for a segment, Vijayan475 discloses the collective use of “Start Offset” and “Slot Info” parameters. EX1006, ¶¶40, 42, 45-49, 56. Vijayan475 defines these parameters in Table 1. *Id.*, ¶45.

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).

230. As seen from Table 1, the “Start Offset” indicates the “starting symbol period index for the slots assigned to the MLC.” EX1006, ¶45. The slot information or “Slot Info” parameter includes “parameters describing the slots assigned to the MLC.” *Id.* This slot information may include “Min Slot, Start Slot, and Max Slot” parameters as seen in Figure 4. *Id.*, ¶¶40, 42, 46-49. Vijayan475 explains that one way to convey these parameters is to use nine bits: “If the maximum slot index is 7, then the parameters Min Slot, Start Slot, and Max Slot

may each be conveyed with 3 bits, and the slot information for each MLC may be conveyed with 9 bits for the three parameters.” *Id.*, ¶49. This discloses a starting time-frequency coordinate as recited in the claims.

231. Additionally, Vijayan⁴⁷⁵ also discloses a second way to convey this information to reduce overhead signaling costs. *Id.*, ¶¶40, 42, 46-49. Vijayan⁴⁷⁵ explains that the “slot information may be encoded to reduce the number of bits needed to convey this information.” *Id.*, ¶46. This encoding uses “ Δ Start” and “ Δ Max” parameters along with the Min Slot parameter as seen in Figure 4 to convey the starting time-frequency coordinate. *Id.*, FIG. 4, ¶¶46-49. Vijayan⁴⁷⁵ defines Δ Start as the difference between the Start Slot and the Min Slot and defines Δ Max as the difference between the Max Slot and the Start Slot. *Id.* Vijayan⁴⁷⁵ encodes these parameters as shown in Table 2. *Id.*, ¶48.

232. Table 2 provides an exemplary encoding scheme that uses a simple “Slot Info Code” to convey the Min Slot, Δ Start, and Δ Max parameters to a wireless device. *Id.*, ¶48. A base station transmits the Slot Info Code to a wireless device to convey the corresponding Min Slot, Δ Start, and Δ Max parameters. *Id.*, FIG. 4, ¶¶46-49. The wireless device may then derive the starting time-frequency coordinate using the Slot Info Code and the Start Offset value. *Id.*, ¶¶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).

233. Using this Slot Info Code, Vijayan475 explains that the slot information can be conveyed using even fewer bits:

If the maximum slot index is 7, then the parameters Min Slot, Start Slot, and Max Slot may each be conveyed with 3 bits, and the slot information for each MLC may be conveyed with 9 bits for the three parameters. The ***Slot Info Code may be conveyed with 7 bits*** for the 84 possible code values shown in Table 2. ***The encoding scheme described above thus reduces the***

*number of bits needed to convey the slot information for each
MLC.*

EX1006, ¶49.

234. In view of this disclosure, Vijayan⁴⁷⁵ discloses conveying slot information in two ways (with encoding or without encoding). *Id.*, ¶49. Vijayan⁴⁷⁵ therefore discloses transmitting the slot information along with the “Start Offset” value to convey a starting time-frequency coordinate to a wireless device. *Id.*, ¶¶40, 42, 45-49, 56.

235. Additionally, Vijayan⁴⁷⁵ also discloses conveying a number of slots corresponding to a segment. *Id.*, ¶¶40, 45, 51-52, 54-55. For example, Vijayan⁴⁷⁵ discloses using a “Stream Lengths” parameter to convey the number of slots corresponding to an MLC segment:

The Stream Lengths field carries the length of each stream layer packet carried by the MLC in the current super-frame (e.g., N0, N1, and N2 for the three stream layer packets in FIG. 3). ***The number of slots allocated to the MLC may be determined based on the stream lengths and the transmission parameters (e.g., the code rate and modulation scheme) used for the MLC.***

Id., ¶45.

236. In this manner, the Stream Lengths parameter allows the wireless device to determine the number of slots allocated to an MLC segment. EX1006, ¶¶40, 45, 51-52, 54-55.

237. The Stream Lengths parameter may be used to convey the number of slots regardless of the number of slots assigned to a segment. *Id.*, FIG. 4, ¶¶36, 38, 40. Specifically, Vijayan⁴⁷⁵ discloses or otherwise renders obvious a segment having N time-frequency resources units within a time interval where N=2, 4, or 8. At a minimum, Vijayan⁴⁷⁵ discloses using any number of slots between 1 and 16 to convey an MLC segment. *Id.*, FIG. 4, ¶¶36, 40. For example, MLC x as seen in Figure 4 is “assigned 16 slots.” *Id.*, FIG. 4, ¶40. Vijayan⁴⁷⁵ also explains that each MLC may be assigned “***M slots ... where $M \geq 1$*** .” *Id.*, ¶36. “Each ‘active’ MLC, which is an MLC to be transmitted in a given super-frame, ***is allocated at least one slot***.” *Id.*, ¶38. “Each MLC may be ‘allocated’ a fixed or variable number of slots in each super-frame depending on the MLC’s payload, the availability of slots in the super-frame, and possibly other factors.” *Id.* Based on this description, Vijayan⁴⁷⁵ discloses, at a minimum, using any number of slots between one and sixteen to convey a segment corresponding to an MLC. *Id.*, FIG. 4, ¶¶36, 38, 40. Thus, Vijayan⁴⁷⁵ discloses or otherwise renders obvious a segment having N time-frequency resources units where N=2, 4, or 8.

238. A POSITA would have understood that Vijayan475's indication of assigning "at least one slot" as well as an example of assigning 16 slots would render obvious the use of any number of slots between those two values, such as 2, 4, or 8 slots. Additionally, these values align with the number of bits that would be used to convey the number of slots. For example, one bit would convey up to 2 slots, two bits would convey up to 4 slots, and three bits would convey up to 8 slots. Thus, for efficiency in optimizing the number of bits used to convey the allocated number of slots, a POSITA would have found it obvious to use 2, 4, or 8 slots. *See, e.g.*, EX1005, ¶74 ("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"). In this manner, a POSITA would have found it to be a simple design choice to use any number of slots between one and sixteen (including 2, 4, or 8) to convey a segment corresponding to an MLC. EX1006, FIG. 4, ¶¶36, 38, 40.

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

239. As I previously explained, Vijayan475 uses MLC segments and their corresponding slots to convey OFDM symbols. *See* Section X.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. Vijayan475 explains that these "subbands" are "subcarriers." *Id.*,

¶25. Therefore, each slot corresponding to a set of subbands discloses each slot containing a set of frequency subcarriers. *Id.*, FIG. 4, ¶¶25, 36.

240. Vijayan475 also discloses conveying data using OFDM symbols, which also use sets of subcarriers. *Id.*, FIG. 4, ¶¶25, 36, 69-71. When transmitting OFDM symbols, “[m]ultiple carriers may be provided by orthogonal frequency division multiplexing (OFDM).” *Id.*, ¶25. “OFDM effectively partitions the overall system bandwidth into multiple (N) orthogonal subbands. ... With OFDM, each subband is associated with a respective subcarrier that may be modulated with data.” *Id.* As I previously indicated, Vijayan475 explains that “[**m**]ultiple carriers may be provided by orthogonal frequency division multiplexing (OFDM).” *Id.*

Vijayan475 further explains:

OFDM effectively partitions the overall system bandwidth into **multiple (N) orthogonal subbands**. These subbands are also referred to as tones, carriers, **subcarriers**, bins, and frequency channels. With OFDM, each subband is associated with a respective subcarrier that may be modulated with data. . . . For clarity, these techniques are described below for an exemplary wireless **multi-carrier** broadcast system.

Id.

241. Thus, Vijayan475 discloses each slot including a set of frequency subcarriers in a group of OFDM symbols. *Id.*, FIG. 4, ¶¶25, 36, 69-71.

4. Element [1C]: “receiving by the mobile station the transmitted signal; and”

242. As I previously explained, 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 X.B.1.a. As depicted in Figure 9, wireless device 120x includes an antenna 912 and receiver unit 914 configured to receive the transmitted signal. EX1006, FIG. 9, ¶71.

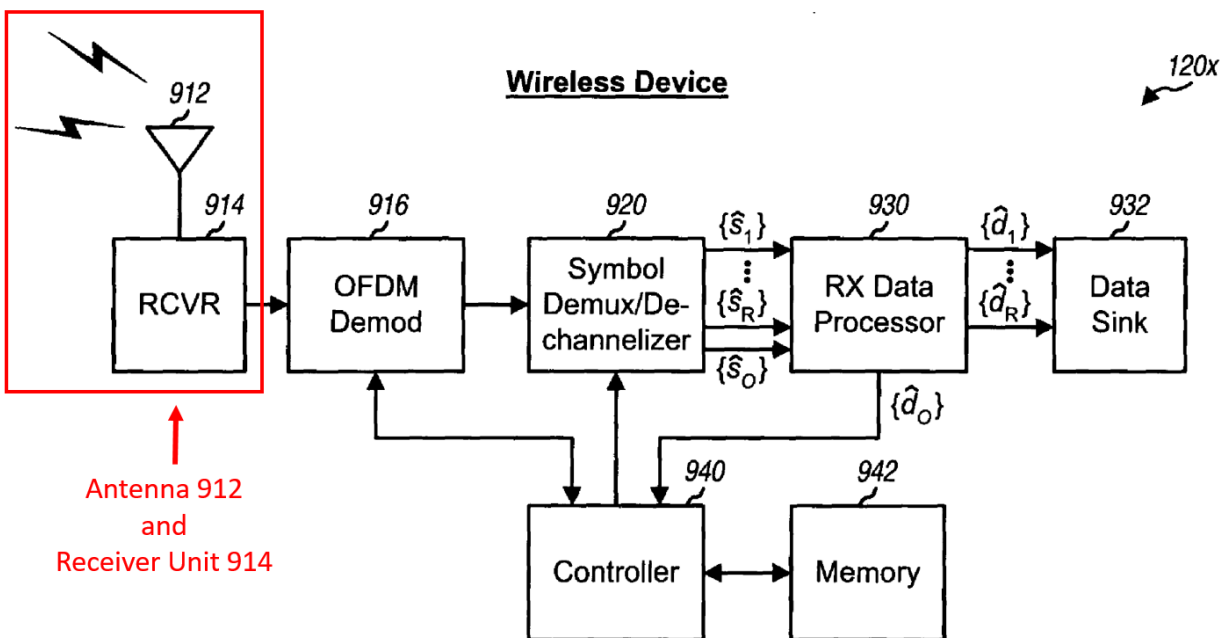


FIG. 9

EX1006, FIG. 9 (annotated).

243. In describing the receipt of a transmission from the base station, Vijayan475 provides the following description:

FIG. 9 shows a block diagram of a wireless device 120x, which is one of the wireless devices in system 100. **An antenna 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 provides a sample stream to an OFDM demodulator 916. OFDM demodulator 916 performs OFDM demodulation on the sample stream to obtain received pilot symbols and received data and overhead symbols. ... OFDM demodulator 916 further ... provides to a symbol demultiplexer (Demux)/dechannelizer 920 “detected” data and overhead symbols, which are estimates of the transmitted data and overhead symbols, respectively.

EX1006, ¶71.

244. 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 X.B.3. Thus, Vijayan⁴⁷⁵ discloses a mobile station receiving the MLC segment signal transmitted from the base station. *Id.*, FIG. 4, ¶¶36, 38-42.

5. **Element [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.”**

245. At the outset, Vijayan⁴⁷⁵ discloses a wireless device recovering data from the received OFDM signal. EX1006, FIG. 9, ¶¶71-73. As I described in Section X.B.4 with reference to Figure 9, Vijayan⁴⁷⁵ describes a wireless device

with a receiver unit and additional components configured to recover symbol data from a received OFDM signal. *Id.* For example, after the receiver unit 914 “conditions, digitizes, and processes the received signal,” it provides the sample stream to “an OFDM demodulator 916.” *Id.*, ¶71. Vijayan475 continues and explains that:

OFDM demodulator 916 performs OFDM demodulation on the sample stream to obtain received pilot symbols and received data and overhead symbols. ... OFDM demodulator 916 further ... provides to a symbol demultiplexer (Demux)/dechannelizer 920 “detected” data and overhead symbols, which are *estimates of the transmitted data and overhead symbols, respectively.*

Id.

246. Vijayan475 continues by explaining the functionality of controller 940 and RX Data Processor 930 to recover the relevant information:

Controller 940 obtains an indication of (e.g., user selection for) *one or more MLCs to be received by the wireless device. Controller 940 then determines the slot assignment for each selected MLC based on either (1) the composite overhead information sent at the start of the current super-frame or (2) the embedded overhead information* sent in the MAC capsule header received in a previous super-frame for the MLC. Controller 940 then provides a control signal to dechannelizer 920. Dechannelizer 920 performs demultiplexing of the detected data and overhead symbols for each symbol period

based on the control signal and ***provides one or more detected data symbol streams*** and/or a detected overhead symbol stream to RX data processor 930. ***RX data processor 930 processes (e.g., symbol demaps, deinterleaves, and decodes) the detected overhead symbol stream*** in accordance with the mode used for the composite overhead data and provides decoded overhead data to controller 940. ***RX data processor 930 also processes each detected data symbol stream for each MLC of interest***, in accordance with the mode used for that stream, and provides a corresponding decoded data stream to a data sink 932.

Id., ¶72.

247. As seen from this description, Vijayan⁴⁷⁵ describes its controller 940 operating with RX Data Processor 930 to recover data streams or MLC segments using overhead signaling information. *Id.*, ¶72. As I previously explained, 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. *Id.*, ¶¶40, 42, 44-47, 56. With these parameters, the wireless device can determine the “time-frequency location of each MLC.” *Id.*, Abstract, ¶¶9-10, 60. “A wireless device may receive the composite overhead information for a current super-frame, ***determine the time-frequency location of each MLC of interest based on the location information for the MLC***, and receive each MLC of interest in the current super-frame at the indicated time-frequency location.” *Id.*, ¶10. In

view of this description, Vijayan⁴⁷⁵ describes a wireless device recovering information from the received signal based on a derived starting time-frequency coordinate and N-value determined from the Start Offset, Slot Info, and Stream Length parameters. *Id.*, ¶¶40, 42, 44-55; Section X.B.4.

248. A POSITA would have also found it obvious for Vijayan⁴⁷⁵ to use an identifier corresponding to the wireless device when recovering the data from the signal as well. For example, as I explained in Sections X.A and X.B.2, a POSITA would have found it obvious for a base station to assign and provide an identifier to a particular wireless device. It would have also been obvious to provide an identifier when using the Start Offset, Slot Info, and Stream Length parameters to signal a starting time-frequency coordinate and N-value for that particular wireless device. EX1006, ¶¶5, 25-26, 42, 45-55; EX1008, ¶¶33-34, 87, 92, 94, 98. This identifier would have been provided by the base station to the wireless device to allow the particular wireless device to recover an MLC segment from among those provided to other wireless devices. The wireless device would have also identified its own respective resource allocation parameters accordingly. This identifier would be particularly relevant for a “unicast transmission [that] is sent to a specific wireless device.” EX1006, ¶¶5, 9-10, 44. Wu confirms this understanding and explicitly describes the use of identifiers to differentiate between multiple wireless devices as I explained in Section X.B.2.

249. Specifically, Wu describes a “**sixteen bit UE identifier**” that “**identifies which receiver is to receive** the current [] content.” EX1008, ¶98; see also *id.*, ¶¶32-34, 92, 94. Wu’s base station assigns and uses the UE identifier when identifying to receivers “which OFDM slots and/or which CDMA slots are for a given receiver.” *Id.*, ¶¶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. Using the identifier and slot information, the receiver determines whether to recover respective data from the transmitted OFDM signal. *Id.*, ¶¶25, 50. Specifically, “the receiver is further adapted to receive a control channel identifying for a given slot whether or not the receiver is scheduled during the slot.” *Id.*, ¶¶50, 100. “[T]he receiver demodulates a given OFDM slot only if scheduled during the slot.” *Id.*, ¶¶25, 50. In this manner, Wu describes using an identifier assigned to a particular UE to identify specific slots and recover information intended for that UE.

250. In view of Vijayan475’s suggestion of using an identifier, a POSITA would have found it obvious and would have been motivated to implement the UE identifier described in Wu with Vijayan475’s system for the reasons that I explained in Sections X.A and X.B.2. This identifier would allow a wireless device to differentiate its own allocation parameters from other allocation parameters

intended for other wireless devices. EX1006, ¶¶5, 25-26; EX1008, Abstract, ¶¶32-34, 87, 94, 98. Additionally, a POSITA would have found it obvious to transmit such identifier information with Vijayan475's overhead signaling. EX1006, ¶¶9-12, 38, 55, 62, 64; EX1008, ¶¶33-34, 87, 92, 94, 98. The overhead signaling includes the resource allocation parameters (Start Offset, Slot Info, and Stream Length parameters) for the wireless device used to determine the starting time-frequency coordinate and the N-value. EX1006, ¶¶9-12, 38, 40, 42-43, 45-49, 55-56, 62, 64.

251. Using the identifier, Vijayan475's wireless device would identify its own Start Offset, Slot Info, and Stream Length parameters in the overhead signaling to determine a starting time-frequency coordinate and N-value. EX1006, ¶¶40, 42, 45-49, 51-52, 54-56. The wireless device would then recover the information corresponding to its allocated transmission slots or MLC segment in the manner described above. *Id.*; Section X.B.3. In this manner, a POSITA would have been motivated to combine Vijayan475 and Wu, would have known how to combine them, and would have had a reasonable expectation of success in forming the combination. Thus, the combination of Vijayan475 and Wu discloses "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."

C. Vijayan475 in view of Wu renders obvious claim 7.

252. The limitations of independent claim 7 are substantially similar to those recited in claim 1. As I further outline below, Vijayan475 in view of Wu discloses all of the limitations of claim 7 for the reasons that I have explained for claim 1. *See* Section X.B.

253. At the outset, I note that claim 1 recites a method describing the functionality and interaction between both a base station and a mobile device. EX1001, 12:47-54. Specifically, claim 1 describes a “method for a wireless network comprising at least a base station and a mobile station.” *Id.* Claim 7 refers to substantially the same functionality but claims the functionality from the perspective of the “**mobile device**.” *Id.*, 13:15-21. Thus, the combination of Vijayan475 and Wu still discloses this same functionality for the reasons that I have provided above for claim 1 and as I discuss further below.

U.S. Pat. No. 10,447,450	Obviousness in view of Vijayan475 and Wu
[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:	<i>See</i> Claim Element [1-pre] ; Section X.B.1.
[7A] receive an identifier from a base station in a cell in which the mobile device	<i>See</i> Claim Elements [1A] , [1C] , and [1D] ; Sections

is operating; and	X.B.2, X.B.4, X.B.5.
[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	See Claim Elements [1B] and [1C] ; Sections X.B.3, X.B.4.
[7C] recover the information from the received signal using the starting time-frequency coordinate and N in conjunction with the received identifier.	See Claim Element [1D] ; Section X.B.5.

254. I note that there are only minor differences between claim 7 and claim 1, none of which change the outcome that the combination of Vijayan⁴⁷⁵ and Wu discloses each and every claim feature for the reasons that I presented for claim 1. To address some of the minor differences, I note that the preamble of claim 7 introduces the concept of a “wireless packet system.” While Vijayan⁴⁷⁵ discloses the preamble of claim 7 for the reasons that I explained with respect to the preamble of claim 1, Vijayan⁴⁷⁵ also 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. 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. In this manner, Vijayan475 also describes using packets for wireless communications as well.

255. Additionally, claim [7A] also recites the mobile device operating within a cell serviced by base station. Vijayan475 also describes this same configuration with base station cells in Figure 1. *Id.*, ¶¶26-28. This configuration also applies when the “wireless device” described in Vijayan475 is a “cellular phone.” *Id.*, ¶26.

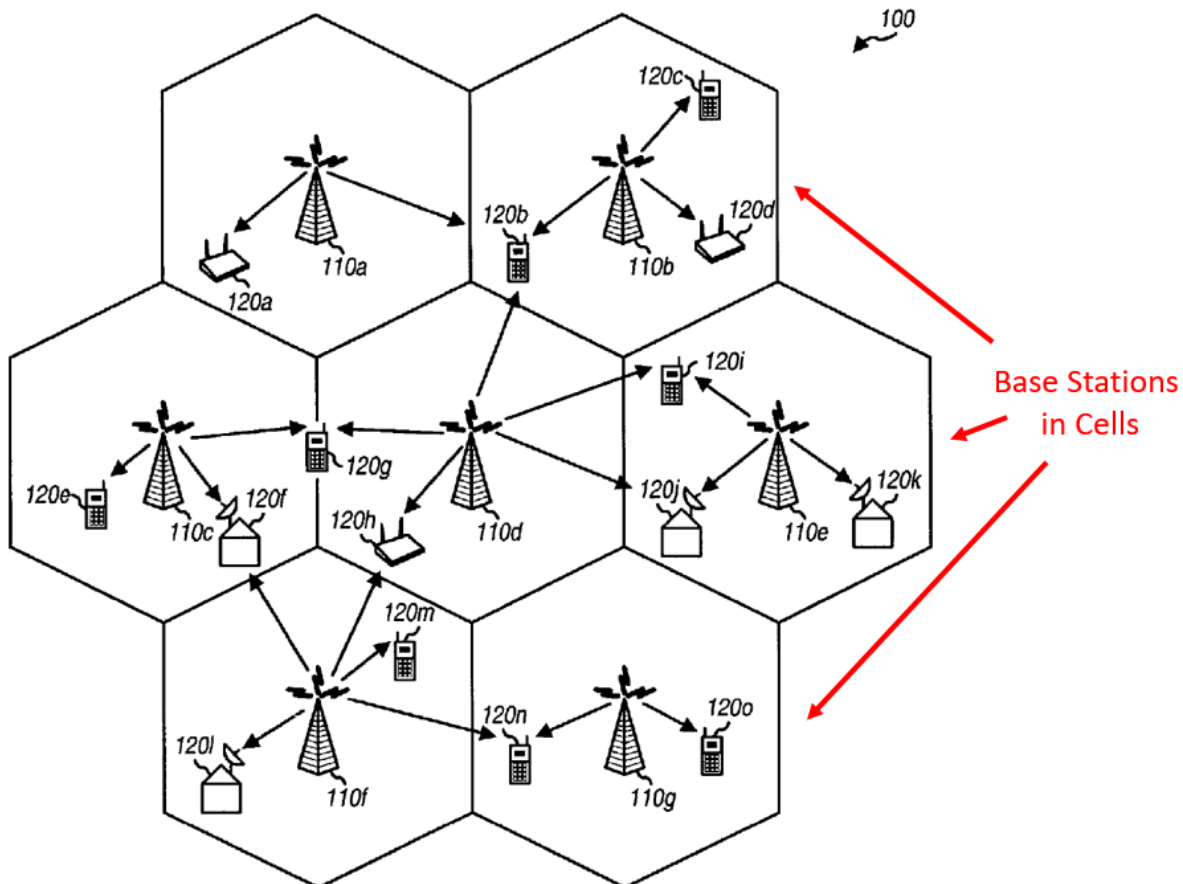


FIG. 1

EX1006, FIG. 1 (annotated).

256. Thus, the combination of Vijayan475 and Wu renders obvious claim 7 for substantially the same reasons that I provided for claim 1.

D. Vijayan475 in view of Wu renders obvious claim 13.

257. The limitations of independent claim 13 are substantially similar to those recited in claim 1. As I further outline below, Vijayan475 in view of Wu discloses all of the limitations of claim 13 for the reasons that I have explained for claim 1. See Section X.B.

258. At the outset, I note that claim 1 recites a method describing the functionality and interaction between both a base station and a mobile device. EX1001, 12:47-54. Specifically, claim 1 describes a “method for a wireless network comprising at least a base station and a mobile station.” *Id.* Claim 13 refers to substantially the same functionality but claims the functionality from the perspective of the “**base station.**” *Id.*, 14:7-13. Thus, the combination of Vijayan475 and Wu still discloses this same functionality for the reasons that I have provided above for claim 1 and as I discuss further below.

U.S. Pat. No. 10,447,450	Obviousness in view of Vijayan475 and Wu
[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	See Claim Element [1-pre] ; Section X.B.1.

frequency subcarriers, the base station configured to:	
[13A] provide an identifier to a mobile device in the cell;	See Claim Elements [1A] , [1C] , and [1D] ; Sections X.B.2, X.B.4, X.B.5.
[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	See Claim Element [1B] and [1C] ; Sections X.B.3, X.B.4.
[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.	See Claim Elements [1B] , [1C] and [1D] ; Sections X.B.3, X.B.4, X.B.5.

259. I note that there are only minor differences between claim 13 and claim 1, none of which change the outcome that the combination of Vijayan⁴⁷⁵ and Wu discloses each and every claim feature for the reasons that I presented for claim 1. To address some of the minor differences, I note that like claim 7, the preamble of claim 13 recites a “wireless packet system.” While Vijayan⁴⁷⁵ discloses the preamble of claim 13 for the reasons that I explained with respect to the preamble of claim 1, Vijayan⁴⁷⁵ also describes communications using “packets” as I explained with reference to claim 7. EX1006, ¶¶28, 32-35, 45, 50-54; Section X.C.

260. Additionally, claim element [13A] also recites the mobile device operating within a cell serviced by a base station. As I explained with reference to claim 7, Vijayan475 also describes this same configuration with wireless devices receiving data from base station cells as depicted in Figure 1. EX1006, FIG. 1, ¶¶26-28; Section X.C.

E. Vijayan475 in view of Wu renders obvious claims 2, 8, and 14.

261. Claim 2, 8, and 14 respectively recites:

- 2. The method of claim 1, wherein the starting time-frequency coordinate indicates a starting OFDM symbol of the segment of time-frequency resource.
- 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.
- 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.

262. Vijayan475 discloses a “starting time-frequency coordinate” indicating a starting OFDM symbol. As I explained with reference to the preamble of claim 1, Vijayan475 discloses the transmission of OFDM symbols. See Section X.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

starting slot index (“Start Slot”) at a “designated symbol period index (Start Offset).” *Id.* This starting symbol period index—which may be indicated using a Start Offset parameter—therefore specifies a starting OFDM symbol period for a time-frequency resource segment. *Id.* And as I 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 period for a time-frequency resource segment.

263. Vijayan475 depicts examples of this configuration in Figure 4. *Id.*, ¶¶36, 39-40, 45-49.

MLC x has a starting coordinate of (Symbol Period Index = 3, Slot Index = 4)
Symbol Period Index = 3 specifies the starting OFDM symbol of the segment ²¹⁶

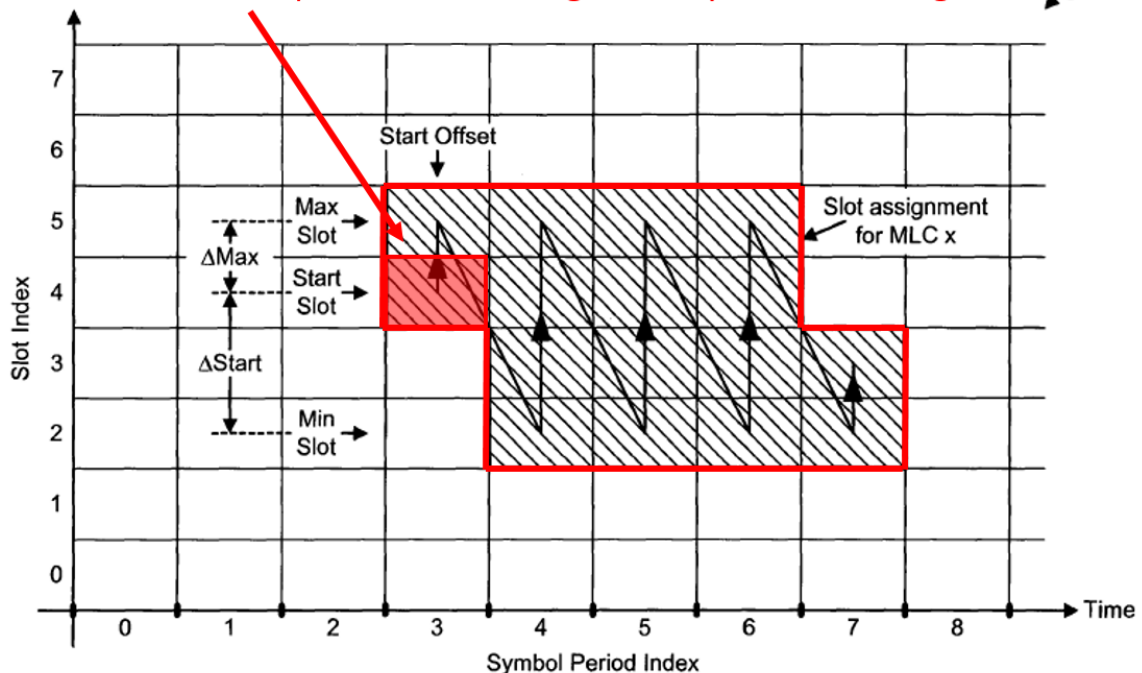


FIG. 4

EX1006, FIG. 4 (annotated).

264. As I previously explained, Vijayan475 discloses a starting time-frequency coordinate derived using the “Start Offset” and “Slot Info” parameters. EX1006, ¶¶40, 42, 45-49, 56. When viewed in the context of Figure 4, Vijayan475’s starting time-frequency coordinate also specifies the particular starting OFDM symbol for the segment. *Id.* Thus, Vijayan475’s indication of the starting symbol period index of a segment also identifies a starting OFDM symbol of the segment.

F. Vijayan475 in view of Wu renders obvious claims 3, 9, and 15.

265. Claim 3, 9, and 15 respectively recites:

- 3. The method of claim 1, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.
- 9. The mobile device of claim 7, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.
- 15. The base station of claim 13, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.

266. Vijayan475 discloses a “starting time-frequency coordinate” indicating a starting subcarrier of the segment of time-frequency resource. As I previously explained, Vijayan475 discloses a starting time-frequency coordinate

corresponding to a Start Slot. EX1006, ¶¶40, 42, 46-49; Section X.B.3. The Start Slot—with its corresponding “slot index”—identifies a starting set of “subbands” or “subcarriers” for a segment of time-frequency slots. EX1006, ¶36 (“M slots are formed in each symbol period and are mapped to ***M disjoint or non-overlapping sets of subbands***, where $M \geq 1$.”); *see also id.*, ¶25. In this manner, when Vijayan475 specifies a “Start Slot”—or uses Start Offset and Slot Info parameters to specify a “Start Slot”—Vijayan475 identifies a starting time-frequency coordinate that indicates a starting subcarrier of a time-frequency resource segment. *Id.*, ¶25 (“***With OFDM, each subband is associated with a respective subcarrier*** that may be modulated with data.”). In this manner, Vijayan475’s use of a Start Slot and starting Slot Index to identify the start of the segment indicates a starting subcarrier for the segment. That is, the starting subcarrier is the first subcarrier in the Start Slot.

267. To illustrate this teaching, Vijayan475 provides Figure 4 where the segment corresponding to MLC x has a starting Slot Index of 4. *Id.*, FIG. 4, ¶40. As I have annotated below, 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.

MLC x has a starting coordinate of (Symbol Period Index = 3, Slot Index = 4)
The starting subcarrier is the first subband in Slot Index 4

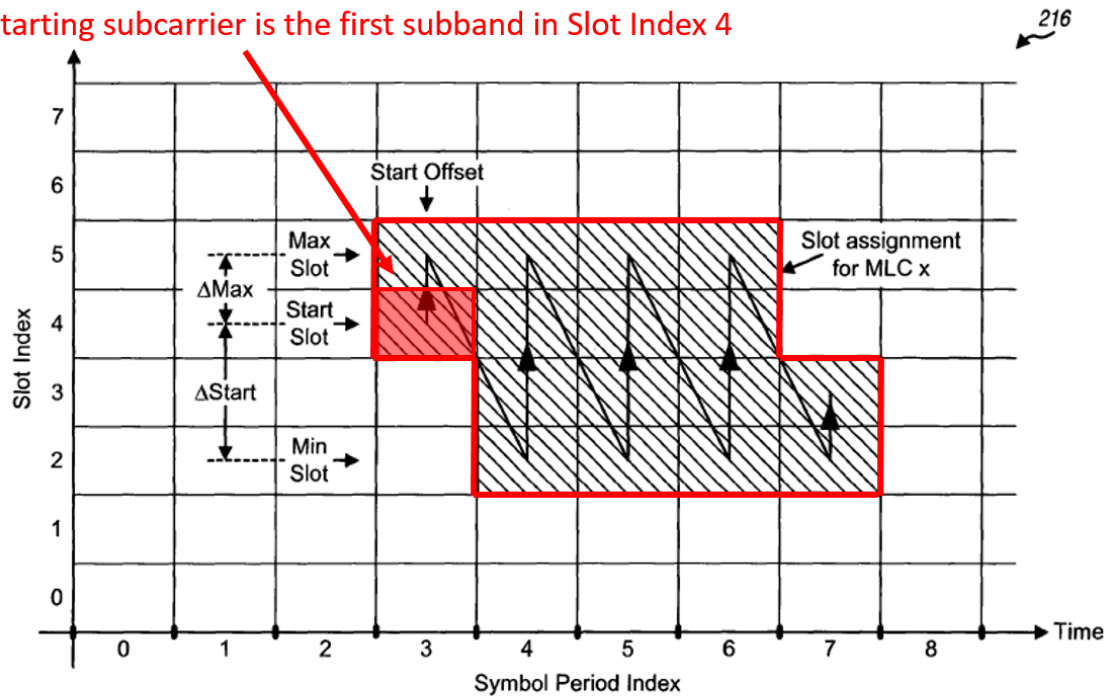


FIG. 4

EX1006, FIG. 4 (annotated).

268. Thus, Vijayan475 discloses the starting time-frequency coordinate indicating a starting subcarrier of the segment of time-frequency resource.

G. Vijayan475 in view of Wu renders obvious claims 4, 10, and 16.

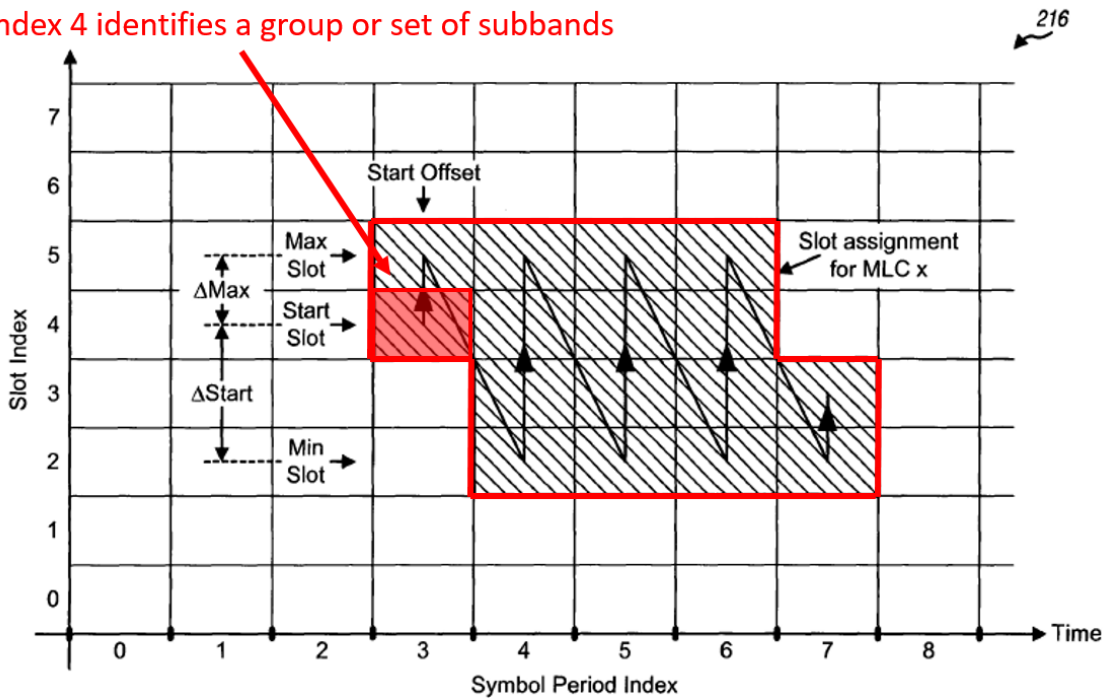
269. Claim 4, 10, and 16 respectively recites:

- 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.
- 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.

- 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.

270. Vijayan475 discloses a “starting time-frequency coordinate” indicating a starting group of subcarriers of the segment of time-frequency resource. As I previously explained, Vijayan475 discloses a starting time-frequency coordinate corresponding to a Start Slot for a segment. EX1006, ¶¶40, 42, 46-49; Section X.B.3. In each slot of the segment (including the Start Slot), Vijayan475 discloses the use of a group of 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. In this manner, the Start Slot identified by the starting time-frequency coordinate identifies a starting group of subcarriers as well. *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. *Id.*

MLC x has a starting coordinate of (Symbol Period Index = 3, Slot Index = 4)
Slot Index 4 identifies a group or set of subbands



EX1006, FIG. 4 (annotated).

271. For example, when examining the segment corresponding to MLC x, the Start Slot indicates Slot Index 4, which includes a set of subbands. *Id.*, FIG. 4, ¶¶36, 40. Thus, the starting time-frequency coordinate described in Vijayan475 also indicates a starting group of subcarriers for a segment. *Id.*, FIG. 4, ¶¶25, 36, 40, 42, 46-49.

H. Vijayan475 in view of Wu renders obvious claims 5, 11, and 17.

272. Claim 5, 11, and 17 respectively recites:

- 5. The method of claim 1, wherein modular coding is applied to the time-frequency resource units in the segment of time-frequency resource.

- 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.
- 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.

273. As I previously explained in Section IX.H, the '450 patent appears to use 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.

274. Specifically, Vijayan475 explains that the “number of slots allocated to the MLC may be determined based on the stream lengths and the transmission parameters (e.g., the code rate and **modulation scheme**) used for the MLC.” *Id.*, ¶45. Vijayan475 explains that “different coding and modulation schemes” may be used to improve the reception of data bits. *Id.*, ¶63. The base station may use a “control channel” to inform the wireless device of the particular “code rate and modulation scheme used for the MLC.” *Id.*, ¶66. The base station may identify a “mode” to identify the modulation scheme for transmitted data that has used a “modulation symbol” format to convey data symbols. *Id.*, ¶¶67-68. A “modulation symbol is a complex value for a point in a signal constellation used for a

modulation scheme (e.g., M-PSK, M-QAM, and so on).” *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.

XI. GROUND 3: Claims 6, 12, and 18 are unpatentable under 35 U.S.C. § 103 as obvious over Vijayan⁰⁸⁹, Laroia, and Choi.

275. Claim 6, 12, and 18 respectively recites:

- 6. The method of claim 5, wherein a repetition coding is further applied to the time-frequency resource units.
- 12. The mobile device of claim 11, wherein a repetition coding is further applied to the time-frequency resource units.
- 18. The base station of claim 17, wherein a repetition coding is further applied to the time-frequency resource units.

276. At the outset, I note that claims 6, 12, and 18 appear to include a typographical error. The claims recite “time-frequence resource units,” but this appears to instead refer to “time-frequency resource units” based on the other claims. I provide my analysis based on this understanding.

277. I note that the specification of the ’450 patent does not provide any specific or special definition for “repetition coding.” The ’450 patent states that “[t]hose skilled in the art will appreciate that coding and **signal repetition** can be combined to provide lower coding rates. For example, rate-1/8 coding can be

realized by a concatenation of rate-1/2 coding and **4-time repetition.**” EX1001, 6:58-62.

278. In view of this description, a POSITA would have recognized “repetition coding” to refer to a simple and well-known technique where information bits are repeated. EX1021, ¶4 (“In the case of transmitted blocks including multiple bits, e.g., 2 or 3 bits, **repetition coding may be used, e.g., the data bit may be repeated.**”); EX1022, ¶86 (“To implement a **simple encoding and decoding scheme for receiver and transmitter, a repetition coding is used** for signal space expansion instead of the more sophisticated, but also more complex coding and decoding schemes.”) ¶88 (“the input data stream is input to the repetition coder 2203 which **repeats the bits of the input data stream** and outputs the input data stream and a second data stream comprising **copies of the data bits of the data bit stream.**”); see also EX1016, 500-502 (describing a “Repetition_Coding_Indication” value indicating the “repetition code used for the DL-MAP. Repetition code may be 0 (no additional repetition), 1 (one additional repetition), 2 (three additional repetitions) or 3 (five additional repetitions).”) This repetition may provide redundancy or error correction. EX1021, ¶¶41, 86; EX1022, ¶¶88, 137 (using a “very simple repetition coding scheme as the **fundamental FEC (forward error correction) part**”).

279. Indeed, the '450 patent acknowledges that it is referring to well-known repetition coding that would have been known to “[t]hose skilled in the art.” EX1001, 6:58-62. Choi describes such an example and demonstrates that it would have been obvious to apply repetition coding to time-frequency resource units.

280. Choi describes a process for “transmitting data over a wireless channel.” EX1009, Abstract. Choi describes “enhancing the transmission of the data by further **repetition encoding** the data.” *Id.* This repetition coding may improve “error correction” and provide a “more robust data transmission scheme at reduced data rates.” *Id.*, ¶2. Choi explains this repetition coding can be applied to OFDM symbols as well. *Id.*, ¶¶16-18. When applying the repetition code, Choi explains:

The **repetition code can be implemented either in the time domain or in the frequency domain. For time domain repetition, the OFDM symbols in the time domain** (after the IFFT operation) **are repeated a desired number of times**, depending on the data rate. This scheme has an advantage in efficiency since just one guard interval is required for r-repeated OFDM symbols in the time domain.

Id., ¶16.

The **OFDM symbols can also be repeated in the frequency domain** (before the IFFT). The disadvantage of this scheme is

that one guard interval has to be inserted between every OFDM symbol in the time-domain since the OFDM symbols with frequency-domain repetition are not periodic. However, ***repetition in the frequency domain can achieve better multipath performance if the repetition pattern is configured in the frequency-domain to achieve frequency diversity.***

Id., ¶18.

281. Choi also explains that if desired, encoded data may be repeated in both the time and frequency domains: “Preferably, the values are repeated in the frequency domain, but the values may also be repeated in the time domain.” *Id.*, ¶13. When applying “repetition coding” to the time and frequency domains, Choi explains that ***“the described techniques may be combined*** or used separately according to specific system requirements.” *Id.*, ¶51. Thus, Choi discloses applying repetition coding in both time and frequency domains.

282. A POSITA would have been motivated to combine Choi with Vijayan089 and Laroia to provide “error correction” and a “more robust data transmission scheme at reduced data rates” as well. *Id.*, ¶2. For example, Vijayan089 acknowledges that repeating portions of signals is a well-known technique and also explicitly uses redundancy checks to provide error correction: “The coding scheme may comprise error detection coding (e.g., a cyclic redundancy check (CRC)), forward error correction coding, and so on, or a

combination thereof.” EX1005, ¶39; *see also id.*, ¶¶83, 101, 114, 118. A POSITA would have recognized that Choi’s repetition coding would have furthered this goal and would have helped to alleviate errors in OFDM systems. EX1009, ¶¶16-18, 22-24, 45. Therefore, a POSITA would have been motivated to combine Choi with Vijayan089 and Laroia.

283. A POSITA would have also known how to combine Choi with Vijayan089 and Laroia and would have had a reasonable expectation of success in implementing the combination. Similar to Vijayan089 and Laroia, Choi also describes wireless communications using OFDM. EX1009, ¶¶16-18, 22-24, 45; Sections IX.A, IX.B.1.c, IX.B.2. Additionally, Choi describes applying repetition coding in the time domain and/or the frequency domain. *Id.*, ¶¶13, 16, 18, 51. In view of Choi’s disclosure, a POSITA would have found it obvious to apply the repetition coding in the time domain, the frequency domain, or both. *Id.* In forming the combination with Vijayan089 and Laroia, a POSITA would have therefore found it obvious and would have been motivated to apply Choi’s repetition coding to the time-frequency units disclosed in Vijayan089. EX1005, ¶39; *see also id.*, ¶¶83, 101, 114, 118.

284. Thus, the combination of Vijayan089, Laroia, and Choi renders obvious applying repetition coding to time-frequency resource units.

XII. GROUND 4: Claims 6, 12, and 18 are unpatentable under 35 U.S.C. § 103 as obvious over Vijayan475, Wu, and Choi.

285. Claim 6, 12, and 18 respectively recites:

- 6. The method of claim 5, wherein a repetition coding is further applied to the time-frequency resource units.
- 12. The mobile device of claim 11, wherein a repetition coding is further applied to the time-frequency resource units.
- 18. The base station of claim 17, wherein a repetition coding is further applied to the time-frequency resource units.

286. As I explained with reference to Ground 3, claims 6, 12, and 18 appear to include a typographical error. *See* Section XI. The claims recite “time-frequency resource units,” but this appears to instead refer to “time-frequency resource units” based on the other claims. I provide my analysis based on this understanding. *Id.*

287. Choi discloses the “repetition coding” recited in claims 6, 12, and 18 for the reasons that I previously explained. *See* Section XI; EX1009, ¶¶13, 16-18, 51. Choi also discloses applying this repetition coding in the time and/or frequency domains when communicating OFDM symbol data. EX1009, ¶¶13, 16-18, 51. In this manner, when combined with Vijayan475 and Wu, the combination renders claim 6, 12, and 18 obvious. *Id.*, ¶¶2, 39, 83, 101, 114, 118.

288. Similar to Ground 3, a POSITA would have been motivated to combine Choi with Vijayan475 and Wu. A POSITA would have been motivated to

combine Choi with Vijayan⁴⁷⁵ and Wu to provide “error correction” and a “more robust data transmission scheme at reduced data rates” as well. *Id.*, ¶¶2, 39, 83, 101, 114, 118. For example, Vijayan⁴⁷⁵ acknowledges that repeating portions of signals is a well-known technique and also explicitly uses redundancy to improve the reception of signals:

The location information for each MLC may be sent once to allow the wireless devices to receive the MLC. The location information for all MLCs may be sent in the composite overhead information at the start of each super-frame. ***The location information for each active MLC may also be sent redundantly along with the payload for the MLC to improve efficiency in receiving the MLC.***

EX1006, ¶64.

289. In this manner, Vijayan⁴⁷⁵ discloses the use of redundancy to improve reception efficiency. EX1006, ¶64. A POSITA would have recognized that Choi’s repetition coding would have furthered this goal and would have helped to alleviate errors in OFDM systems. EX1009, ¶¶16-18, 22-24, 45. Therefore, a POSITA would have been motivated to combine Choi with Vijayan⁴⁷⁵ and Wu.

290. A POSITA would have also known how to combine Choi with Vijayan⁴⁷⁵ and Wu and would have had a reasonable expectation of success in implementing the combination. Similar to Vijayan⁴⁷⁵ and Wu, Choi also describes

wireless communications using OFDM. EX1009, ¶¶16-18, 22-24, 45; Sections X.A, X.B.1.c, X.B.2. Additionally, Choi describes applying repetition coding in the time domain and/or the frequency domain. *Id.*, ¶¶13, 16, 18, 51. In view of Choi's disclosure, a POSITA would have found it obvious to apply the repetition coding in the time domain, the frequency domain, or both. *Id.* In forming the combination with Vijayan⁴⁷⁵ and Wu, a POSITA would have therefore found it obvious and would have been motivated to apply Choi's repetition coding to the time-frequency slots disclosed in Vijayan⁴⁷⁵. EX1006, ¶¶36-42, 45-49, 57.

291. Thus, the combination of Vijayan⁴⁷⁵, Wu, and Choi renders obvious applying repetition coding to time-frequency resource units.

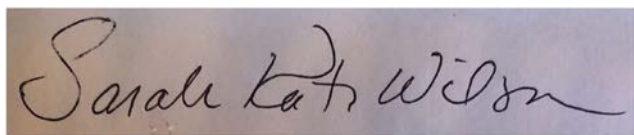
Declaration of Sarah Kate Wilson
U.S. Patent No. 10,447,450

In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed this 27th day of September, 2022.

Respectfully submitted,

A rectangular box containing a handwritten signature in dark ink. The signature is cursive and appears to read "Sarah Kate Wilson".

Sarah Kate Wilson, Ph.D.