

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.

IPR2022-01567
Patent 10,447,450 B2

Before HYUN J. JUNG, CHARLES J. BOUDREAU, and
MATTHEW S. MEYERS, *Administrative Patent Judges*.

BOUDREAU, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

Volkswagen Group of America, Inc. (“Petitioner”) filed a Petition requesting *inter partes* review of claims 1–18 of U.S. Patent No. 10,447,450 (Ex. 1001, “the ’450 patent”). Paper 2 (“Pet.”). Neo Wireless LLC (“Patent Owner”) filed a Preliminary Response. Paper 7 (“Prelim. Resp.”).

We have authority to determine whether to institute an *inter partes* review. 35 U.S.C. § 314(b) (2018); 37 C.F.R. § 42.4(a) (2020). We may not institute an *inter partes* review “unless . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. § 314(a).

Upon consideration of the arguments and evidence presented, we determine that Petitioner has demonstrated a reasonable likelihood of prevailing with respect to at least one of the challenged claims.

Accordingly, we institute *inter partes* review of claims 1–18 of the ’450 patent on all asserted grounds. *See* 37 C.F.R. § 42.108(a) (“When instituting . . . review, the Board will authorize the review to proceed on all of the challenged claims and on all grounds of unpatentability asserted for each claim.”).

II. BACKGROUND

A. *Real Parties in Interest*

Petitioner and Patent Owner identify themselves as the real parties in interest, and Petitioner identifies itself as a subsidiary of Volkswagen AG. Pet. 3; Paper 5, 1 (Patent Owner’s Mandatory Notices).

B. *Related Matters*

The parties advise us that the ’450 patent is or has been involved in at least 23 ongoing or terminated district court proceedings, including, among others, *Neo Wireless LLC v. Volkswagen Group of America, Inc.*, No. 1:22-

cv-00076 (E.D. Tenn.), filed March 29, 2022, and terminated June 14, 2022; *In re Neo Wireless, LLC Patent Litigation*, 2:22-md-03034 (E.D. Mich.), filed June 23, 2022; and *Neo Wireless LLC v. Volkswagen Group of America, Inc.*, No. 2:22-cv-11404 (E.D. Mich.), filed June 28, 2022.

Pet. 3–4; Paper 5, 1–3. The ’450 patent also was the subject of a petition for *inter partes* review in *Dell Inc. v. Neo Wireless, LLC*, IPR2021-01486 (petition filed September 16, 2021, Paper 3; institution denied April 14, 2022, Paper 12). We additionally note that Ford Motor Company and American Honda Motor Co., Inc. (“Honda”) also have filed petitions for review of the ’450 patent. IPR2023-00763, Paper 1; IPR2023-00793, Paper 3. Honda’s petition is substantially identical to the instant Petition and was accompanied by a motion for joinder as a petitioner in this proceeding. IPR2023-00793, Paper 2.

C. The ’450 Patent

The ’450 patent, titled “Method and System for Multi-carrier Packet Communication with Reduced Overhead,” issued October 15, 2019, from an application filed August 14, 2017, and claims priority through a series of continuation applications from a provisional application filed September 28, 2005. Ex. 1001, codes (22), (45), (54), (60), (63).

According to the ’450 patent, bandwidth efficiency is one of the most important system performance factors for wireless communication systems. Ex. 1001, 1:33–34. In order to support the high degree of flexibility needed to accommodate different applications having different sized application payloads and different quality of service (“QoS”) requirements in packet-based data communication, however, wireless communication systems generally must provide a high degree of flexibility. *Id.* at 1:34–40. In wireless systems based on the IEEE 802.16 standard, for example, multiple

packet streams are established for each mobile station to support different applications, and each packet stream is mapped into a wireless connection. *Id.* at 1:42–47. Special scheduling messages, DL-MAP and UL-MAP, are utilized to broadcast scheduling decisions to the mobile stations. *Id.* at 1:47–50. According to the '450 patent, the MAP scheduling method defined by the IEEE 802.16 standard involves significant control overhead, amounting altogether to 52 bits, representing as much as 32.5% of overall data communication for application such as voice-over-IP (“VoIP”) and resulting in a relatively low spectral efficiency. *Id.* at 1:51–2:13.

With the goal of improving spectral efficiency, the '450 patent describes a system and method for minimizing the control overhead in a multi-carrier wireless communication network by using a “time-frequency resource.” Ex. 1001, 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.* at code (57), 2:47–50. By grouping applications of a similar type together within a zone, a reduction can be achieved in the number of bits necessary for mapping a packet stream to a portion of the time-frequency resource. *Id.* at 2:50–54.

Figure 3 of the '450 patent is reproduced below.

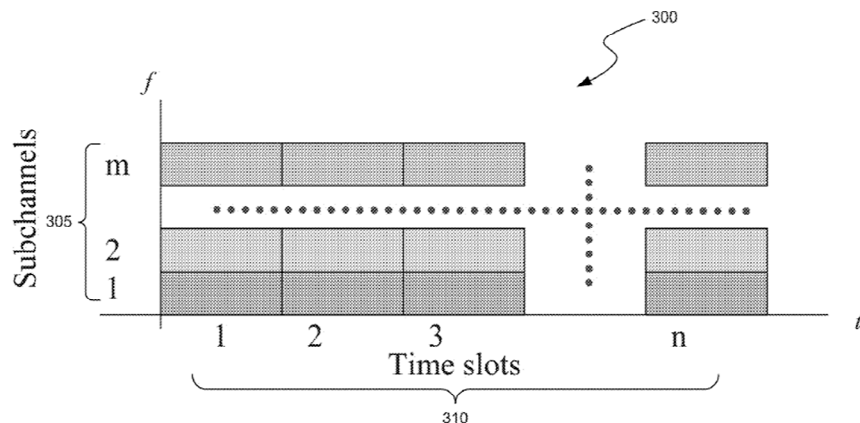


FIG. 3

Figure 3, above, is a block diagram depicting a division of communication capacity in a physical media resource (e.g., radio or cable) into frequency and time domains. Ex. 1001, 2:25–26, 4:16–18. With reference to Figure 3, the frequency is divided into two or more subchannels 305, represented as subchannels 1, 2, . . . m; and time is divided into two or more time slots 310, represented as time slots 1, 2, . . . n. *Id.* at 4:18–22. The '450 patent explains that “[t]he canonical division of the resource by both time and frequency provides a high degree of flexibility and fine granularity for resource sharing between multiple applications or multiple users of the resource.” *Id.* at 4:22–26.

Figure 6 of the '450 patent is reproduced below.

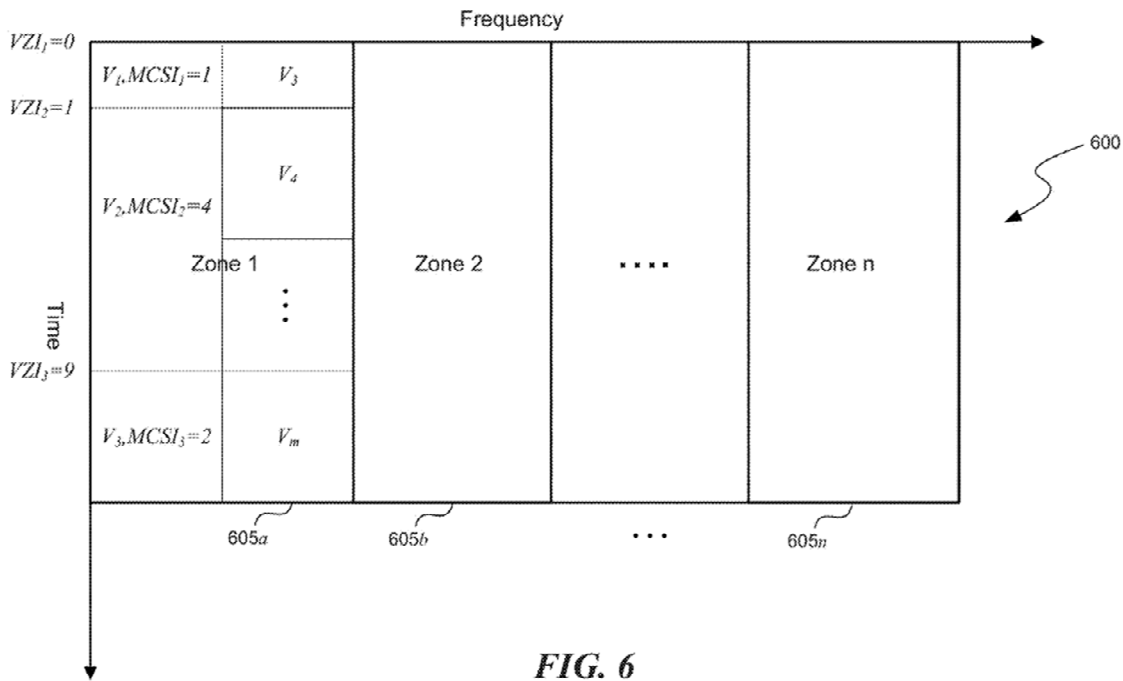


FIG. 6

Figure 6, above, is a block diagram of a frequency-time resource utilized by a wireless communication network. Ex. 1001, 2:32–33, 5:32–34. The '450 patent explains that Figure 6 depicts an alternative way of managing multiple packet streams in order to overcome the inefficiencies associated

with the mapping of packet streams in typical wireless systems based on the IEEE 802.16 standard. *Id.* at 5:34–43. In Figure 6, time-frequency resource 600 is divided into zones 605*a*, 605*b*, . . . 605*n*, each of which is associated with a particular type of application (e.g., VoIP, video applications). *Id.* at 5:43–49. By grouping like applications together, the '450 patent explains, the amount of control overhead in MAC headers is reduced. *Id.* at 5:49–51. More particularly, according to the '450 patent, when applications of a similar type 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.* at 5:54–57. In some embodiments, the identification of the time-frequency segment associated with a particular packet stream can be indicated by the starting time-frequency coordinate and the ending time-frequency coordinate relative to the starting point of the zone. *Id.* at 5:57–61. If the time-frequency resource is divided into two or more zones, the amount of control information necessary to map to a location relative to the starting point of the zone may be significantly less than the amount of information necessary to map to an arbitrary starting and ending coordinate in the entire time-frequency resource. *Id.* at 5:64–6:2.

The '450 patent further explains that within each zone 605*a*, 605*b*, . . . 605*n*, the time-frequency resource may be further divided in accordance with certain rules to accommodate multiple packet streams $V_1, V_2, \dots V_m$. Ex. 1001, 6:3–6. For example, as depicted in Figure 6, zone 605*a* is divided into multiple columns, and the packet streams are arranged from top down in each column and from left to right across the columns. *Id.* at 6:6–9. The width of each column can be a certain number of subcarriers, and each packet stream $V_1, V_2, \dots V_m$ may be associated with an application. *Id.*

at 6:9–11. For example, V_1 is the resource segment to be used for the first voice packet stream, V_2 is the resource segment to be used for the second voice packet stream, etc. *Id.* at 6:12–14. Further, according to the '450 patent, when the zones are further subdivided into time-frequency segments in accordance with certain rules, 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.* at 6:22–29.

The '450 patent further describes use of a “basic resource unit,” which is the resource utilized by the highest available modulation coding scheme (“MCS”) associated with a particular packet stream, such that the resources used by other MCSs can be represented as integer multiples of the basic unit. Ex. 1001, 6:45–52. Once the MCS is selected for each packet stream contained in a particular zone, the offset to a segment representing a particular packet stream may be easily calculated, and the index for any selected packet stream is defined as the sum of all basic resource units associated with each packet stream preceding the selected packet stream, with an optional adjustment depending on the location where the division of the time-frequency resource is started. *Id.* at 7:7–18. The '450 patent explains that using basic resource units as the granularity of a location offset to the packet stream thus reduces the number of bits required to represent its location with the zone. *Id.* at 7:28–30.

D. Illustrative Claim

Among the challenged claims, claims 1, 7, and 13 are independent.

Claim 1, reproduced below, is illustrative of the challenged claims.

1. 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:

assigning an identifier to the mobile station;

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

receiving by the mobile station the transmitted signal; and

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.

Ex. 1001, 12:47–67.

E. Evidence

Petitioner relies on the following prior art references in the asserted grounds of unpatentability:

Name	Reference	Exhibit
Vijayan089	Vijayan et al., US 2005/0058089 A1, published March 17, 2005	1005
Wu	Wu et al., US 2005/0063345 A1, published March 24, 2005	1008
Vijayan475	Vijayan et al., US 2005/0141475 A1, published June 30, 2005	1006
Choi	Choi et al., US 2005/0243774 A1, published November 3, 2005	1009
Laroia	Laroia et al., US 2005/0277429 A1, published December 15, 2005	1007

Pet. 6. Petitioner asserts that “all references relied upon qualify as prior art with respect to September 28, 2005,” the filing date of the provisional application from which the ’450 patent claims priority. *Id.* at 5. According to Petitioner, Vijayan089, Wu, Vijayan475, Choi, and Laroia all are prior art under at least pre-AIA 35 U.S.C. § 102(e); and Vijayan089, Vijayan475, and Wu additionally are prior art under pre-AIA 35 U.S.C. § 102(a).¹ *Id.*

Petitioner also relies on a Declaration of Sarah Kate Wilson, Ph.D. (Ex. 1003). Patent Owner relies on a Declaration of William P. Alberth, Jr. (Ex. 2001).

¹ Because the application from which the ’450 patent issued was one in a series of continuation applications of which the earliest was filed before March 16, 2013, the pre-AIA (“America Invents Act”) versions of §§ 102 and 103 apply. Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284, 285–88 (2011); *see* Ex. 1001, code (63).

F. Asserted Grounds

Petitioner asserts that claims 1–18 are unpatentable under 35 U.S.C. § 103(a) on the following grounds:

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1–5, 7–11, 13–17	103(a)	Vijayan089, Laroia
1–5, 7–11, 13–17	103(a)	Vijayan475, Wu
6, 12, 18	103(a)	Vijayan089, Laroia, Choi
6, 12, 18	103(a)	Vijayan475, Wu, Choi

III. ANALYSIS

A. Legal Standards

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (2012) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden of persuasion never shifts to the patent owner. *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

A patent claim is unpatentable for obviousness if the differences between the claimed subject matter 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 to which said subject matter pertains.” Pre-AIA 35 U.S.C. § 103(a).²

The ultimate determination of obviousness is a question of law, but that determination is based on underlying factual findings.

² *See supra* note 1.

The underlying factual findings include (1) “the scope and content of the prior art,” (2) “differences between the prior art and the claims at issue,” (3) “the level of ordinary skill in the pertinent art,” and (4) the presence of secondary considerations of nonobviousness such “as commercial success, long felt but unsolved needs, failure of others,” and unexpected results.

In re Nuvasive, Inc., 842 F.3d 1376, 1381 (Fed. Cir. 2016) (citation omitted) (quoting *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966)).

“To satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements. The petitioner must instead articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness.” *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016). Furthermore, in assessing the prior art, the Board must consider whether a person of ordinary skill would have been motivated to combine the prior art to achieve the claimed invention.

Nuvasive, 842 F.3d at 1381.

As the Supreme Court has held, “because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known,” “it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418–19 (2007).

B. Level of Ordinary Skill in the Art

Dr. Wilson opines in her Declaration that

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.

Ex. 1003 ¶ 52; *see also* Pet. 18 (citing Ex. 1003 ¶¶ 52–53). Patent Owner does not provide its own assessment regarding the level of skill in the art, or otherwise dispute Dr. Wilson's testimony. *See generally* Prelim. Resp.; *see also* Ex. 2001 ¶¶ 21–23 (Mr. Alberth acknowledging Dr. Wilson's assessment and testifying that he “accept[s] Dr. Wilson's proposed qualifications of a POSITA” for purposes of his Declaration).

Based on our review of the record at this stage, we find Dr. Wilson's assessment to be consistent with the level of skill reflected in the prior art references of record. *See Daiichi Sankyo Co. v. Apotex, Inc.*, 501 F.3d 1254, 1256 (Fed. Cir. 2007) (listing the type of problems encountered in the art, prior art solutions to those problems, and the sophistication of the technology as factors that may be considered in determining the level of ordinary skill in the art). Nonetheless, we further find that the qualifier “at least” before the number of years of academic or industry experience introduces unnecessary ambiguity into the assessment as it lacks any upper bound. Accordingly, we adopt Dr. Wilson's assessment, minus the qualifier “at least,” for purposes of determining whether there is a reasonable likelihood that Petitioner would prevail with respect to at least one of the claims challenged in the Petition.

C. Claim Construction

We interpret claim terms

using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.

37 C.F.R. § 42.100(b) (2021).

Petitioner argues that “[t]he ’450 patent does not explicitly define any claim terms, and the claim terms recited in the challenged claims are sufficiently clear on their face.” Pet. 18. Thus, Petitioner asserts, no terms require explicit construction. *Id.* Nonetheless, Petitioner contends that Patent Owner argued in a previous litigation that the term “configured to” (which we find to be recited in claims 7 and 13) should be construed such that “[a]n apparatus/element is ‘configured to’ perform a function if it includes hardware and/or software enabling the apparatus/element to perform the function.” *Id.* at 18–19 (citing Ex. 1020, 4). Citing the testimony of Dr. Wilson, Petitioner argues that a person of ordinary skill in the art “would have understood this term to have its plain and ordinary meaning, but to the extent that this construction is adopted, the grounds of unpatentability presented [elsewhere in the Petition] still render this claim element obvious.” *Id.* at 19 (citing Ex. 1003 ¶¶ 54–57).

Patent Owner responds that, while Petitioner proposes no construction beyond plain meaning in this proceeding, Petitioner is among nine defendants that submitted terms for construction in related district court litigation and participated in meet-and-confer negotiations with respect to those terms. Prelim. Resp. 4–5 (citing Ex. 2003, 1, 5–6 (Joint Claim

Construction Statement from *In re Neo Wireless, LLC Patent Litigation*)). Patent Owner acknowledges that Petitioner added “footnotes suggesting that it ‘do[es] not take a position on the constructions’” when the parties submitted the constructions to the court but contends that Petitioner later “stipulated in the District Court that it waives its rights to challenge those constructions, in that Court or in this proceeding, including on appeal.” *Id.* at 5 (citing Ex. 2004, 1 n.1 (App’x A: Agreed Claim Terms from *In re Neo Wireless, LLC Patent Litigation*); Ex. 2005 1 n.1 (App’x B: Disputed Claim Terms from *In re Neo Wireless, LLC Patent Litigation*); Ex. 2006 (Notice of Stipulation Regarding Claim Construction from *In re Neo Wireless, LLC Patent Litigation*)). Against that backdrop, Patent Owner argues that “[a]ll the parties agree, and Petitioner agrees not to challenge, that ‘time-frequency coordinate,’ which applies to all claims, should be construed as ‘one dimensional time-frequency coordinate’”; that “[t]he parties agree that, with respect to independent claim 7 and its dependent claims, the preamble is limiting and should be given its plain and ordinary meaning”; and that “the parties agree, with respect to dependent claim 11, that ‘wherein modular coding is applied to the time-frequency resource units in the segment of time-frequency resource’ should be construed as ‘wherein a modular coding scheme is applied to the time-frequency resource units in the segment of time-frequency resource.’” *Id.* at 6 (citing Ex. 2004, 2, 5).

Further, Patent Owner argues, Patent Owner and the defendants in the district court litigation disagree as to the construction of the term “time-frequency resource unit,” which appears in each of the challenged independent claims, with Patent Owner asserting that the term should be given its “[p]lain and ordinary meaning” and that “[n]o construction [is] necessary,” while the litigation defendants propose to construe that term as

“a combination of time and frequency units designed according to the application requirements of the application that is being grouped.” Prelim. Resp. 6 (citing Ex. 2005, 3).

Having considered the parties’ arguments, we agree with Petitioner that no terms or phrases in the claims require express construction at this stage of the proceeding. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))). First, regardless of whether we adopt Patent Owner’s construction of “time-frequency coordinate” as “one dimensional time-frequency coordinate,” we find, as discussed in more detail below, that at least Vijayan089 teaches such a one-dimensional time-frequency coordinate. *See, e.g., infra* § III.E.3.c. Second, we also conclude that we need not expressly construe the term “time-frequency resource unit.” *See* Prelim. Resp. 6. Notwithstanding Patent Owner’s contention that Petitioner’s district court co-defendants proposed a construction for that term in co-pending litigation, Patent Owner itself points out that “Petitioner has made no attempt to apply Defendants’ proposed litigation construction . . . for any of its grounds” in this proceeding. *Id.* at 6–7 (citing Pet. 44–48, 74–80). Accordingly, we preliminarily find that the parties appear to agree that plain and ordinary meaning of “time-frequency resource unit” should apply in this proceeding.

Nonetheless, we identify below a potential dispute with regard to the construction of the claim limitation “each unit containing a set of frequency subcarriers in a group of OFDM symbols” that is underdeveloped on the present record. *See infra* §§ III.E.3.c, III.F.3.c. The parties are advised to

address the construction of that limitation in their briefing in the course of trial.

D. Discretionary Denial Under 35 U.S.C. § 314(a)

Patent Owner contends the Board should exercise its discretion to deny institution under 35 U.S.C. § 314(a), contending that the instant challenge should be denied as an improper serial petition in view of the Board’s denial of institution in IPR2021-01486. Prelim. Resp. 45–53. Citing statements in the Petition that summarize the Board’s reasons for denying institution of *inter partes* review in IPR2021-01486 and explain why the instantly presented references and arguments differ from those presented in that earlier proceeding, Patent Owner contends that the Petition raises “particularly significant” “road-mapping concerns.” *Id.* at 46–48 (citing Pet. 17, 97–98; *Code200, UAB v. Bright Data Ltd.*, IPR2022-00861, Paper 18, 5 (Aug. 23, 2022) (precedential); *General Plastic Co. v. Canon Kabushiki Kaisha*, IPR2016-01357, Paper 19, 11, 16–17 (Sept. 6, 2017) (precedential); *Synaptics, Inc. v. Amkor Tech, Inc.*, IPR2017-00085, Paper 12, 10 (Apr. 18, 2017)).

1. Serial Petitioning

In *General Plastic*, the Board articulated a non-exhaustive list of factors to consider in evaluating whether to exercise discretion under § 314(a) to deny a petition that challenges a patent that was previously challenged before the Board. These factors are:

1. whether the same petitioner previously filed a petition directed to the same claims of the same patent;
2. whether at the time of filing of the first petition the petitioner knew of the prior art asserted in the second petition or should have known of it;

3. whether at the time of filing of the second petition the petitioner already received the patent owner's preliminary response to the first petition or received the Board's decision on whether to institute review in the first petition;
4. the length of time that elapsed between the time the petitioner learned of the prior art asserted in the second petition and the filing of the second petition;
5. whether the petitioner provides adequate explanation for the time elapsed between the filings of multiple petitions directed to the same claims of the same patent;
6. the finite resources of the Board; and
7. the requirement under 35 U.S.C. § 316(a)(11) to issue a final determination not later than 1 year after the date on which the Director notices institution of review.

Gen. Plastic, Paper 19 at 9–10. These factors are “a non-exhaustive list” and “additional factors may arise in other cases for consideration, where appropriate.” *Id.* at 16, 18.

a. Whether the same petitioner previously filed a petition directed to the same claims of the same patent

As Patent Owner points out, all claims of the '450 patent were challenged previously in IPR2021-01486, filed by Dell. Prelim. Resp. 1. The Board denied institution in that proceeding on April 14, 2022. IPR2021-01486 (Paper 12). While recognizing that Board decisions denying “follow-on” petitions have generally “concentrated upon the discretion to deny serial petitions by a single petitioner,” Patent Owner argues that “these concerns also apply when the petitioners are not the same,” citing *Valve Corp. v. Electronic Scripting Products, Inc.*, IPR2019-00062, Paper 11, 2, 15 (Apr. 2, 2019) (precedential) and *Ericsson Inc. v. Uniloc 2017, LLC*, IPR2019-01550, Paper 8, 12 (Mar. 17, 2020). Prelim. Resp. 48–50.

We have considered Patent Owner’s arguments but determine that the first *General Plastic* factor weighs against exercising our discretion to deny institution. In *General Plastic*, the petitioner filed a set of five follow-on petitions after its own earlier petitions for *inter partes* review of the same two patents were denied on the merits. *Gen. Plastic*, Paper 19 at 2–3. Petitioner here, as Patent Owner admits, has not previously filed any petition directed to the ’450 patent. Moreover, although *General Plastic* has not been limited to instances where multiple petitions are filed by the same petitioner (*see, e.g., Valve*, Paper 11 at 9 (stating that “when different petitioners challenge the same patent, we consider any relationship between those petitioners when weighing the *General Plastic* factors”))), we find no evidence of record in the present case that Petitioner shares any relationship with Dell. Unlike in *Valve*, in which the Board found a “substantial relationship” to exist between different petitioners where the earlier and later petitioners not only were co-defendants in district court litigation but the earlier petitioner’s accused products in the litigation incorporated technology licensed from the later petitioner, we find no evidence in the record before us of any similar relationship between Petitioner and Dell. We are not persuaded that Petitioner’s and Dell’s both being defendants in district court litigation involving the ’450 patent rises to the type of “significant relationship” described in *Valve*. *Cf. Valve*, Paper 11 at 10. This case also differs from *Ericsson*, where the Board found that a petitioner had “implicitly created” a relationship with earlier petitioners “by using the prior petitioners’ work as a menu and picking and choosing from their work product.” *Ericsson*, Paper 8 at 12. Notwithstanding Patent Owner’s citation of *Ericsson* (Prelim. Resp. 49), Petitioner here does not rely on prior art “pick[ed] and cho[sen]” from any earlier petitions.

b. Whether, at the time of filing of the first petition, the petitioner knew of the prior art asserted in the second petition or should have known of it

Patent Owner does not contend that Petitioner knew or should have known of the prior art asserted in the Petition at the time Dell filed the petition in IPR2021-01486. Indeed, it appears from the record that the '450 patent had not yet been asserted against Petitioner as of the time Dell filed its petition in September 2021. *See* Paper 5, 3; Pet. 3 (identifying March 29, 2022, as filing date of first district court proceeding against Petitioner involving the '450 patent). Unlike in *Ericsson*, where the petitioner picked and chose from among references previously cited in earlier petitions challenging claims of the same patent, the prior art asserted here by Petitioner was not cited in any prior petition for review of the '450 patent. *See Ericsson*, Paper 8 at 12–13. And again, we find no evidence in the record of any significant relationship between Petitioner and Dell. Thus, whether Petitioner knew of, or should have known of, the prior art relied upon in this Petition at the time Dell filed its petition is of no import under this factor. For this reason, we determine that the second *General Plastic* factor does not weigh in favor of exercising our discretion to deny institution.

c. Whether at the time of filing of the second petition the petitioner already received the patent owner's preliminary response to the first petition or received the Board's decision on whether to institute review in the first petition

It is undisputed that Petitioner had received both Patent Owner's preliminary response and the Board's decision denying institution in IPR2021-01486 at the time of filing the Petition. *See* Pet. 17–18 (summarizing the proceedings in IPR2021-01486). Nonetheless, as noted

above, the present Petition is the first petition filed by Petitioner with respect to the '450 patent, and we find the impact of this factor to be mitigated to some extent by Patent Owner's staggered assertions of the '450 patent in district court proceedings over more than a year. *See id.* at 3–4 (listing related matters and filing dates thereof); Paper 5 (listing related matters). At the time Patent Owner first asserted the '450 patent against Petitioner in the Eastern District of Tennessee in March 2022, more than a year after asserting the '450 patent against Dell in the Western District of Texas in January 2021, Patent Owner had already filed its preliminary response in IPR2021-01486, and the Board's decision denying institution in IPR2021-01486 issued only about two weeks later. Accordingly, we weigh this factor at most slightly in favor of exercising our discretion to deny institution.

d. The length of time that elapsed between the time the petitioner learned of the prior art asserted in the second petition and the filing of the second petition; Whether the petitioner provides adequate explanation for the time elapsed between the filings of multiple petitions directed to the same claims of the same patent

We do not find any evidence in the record with regard to when Petitioner learned of the asserted prior art, and accordingly, we have no basis to conclude that Petitioner delayed in filing the Petition. Moreover, the instant Petition is the first petition that Petitioner has filed directed to the '450 patent, and again, Patent Owner's arguments do not show any relationship between Petitioner and Dell, rendering the "time elapsed between the filings of multiple petitions" factor inapplicable to our analysis. Accordingly, we determine these factors do not weigh in favor of exercising our discretion to deny institution.

- e. The finite resources of the Board; The requirement under 35 U.S.C. § 316(a)(11) to issue a final determination not later than 1 year after the date on which the Director notices institution of review*

Having considered Patent Owner’s arguments, we determine that the sixth and seventh *General Plastic* factors do not weigh in favor of exercising our discretion to deny institution. “[T]he intent of the [sixth] factor . . . is to conserve *Board* resources from repeat or multiple staggered petitions challenging the same claims of the same patent before the Board.” *Samsung Elecs. Co. v. Immersion Corp.*, IPR2018-01499, Paper 11, 17 (PTAB Mar. 6, 2019). Unlike in *Ericsson*, this proceeding is not part of a series of repeat or multiple staggered proceedings, but rather is the only challenge to the ’450 patent that Petitioner has filed, and no other challenges to the ’450 patent have been instituted.

f. Weighing the factors

For the reasons stated above, we determine that only *General Plastic* factor 3 weighs to any extent in favor of exercising our discretion under 35 U.S.C. § 314(a) to deny institution. On balance, particularly in view of the lack of evidence of any relationship between Petitioner and prior petitioner Dell, we decline Patent Owner’s request to deny the Petition under 35 U.S.C. § 314(a) for reason of serial petitions.

2. Other Arguments

Patent Owner further contends that, “[e]ven aside from the hindsight ‘road-mapping’ on which the Petition is based, . . . the ‘different’ alleged prior art raised in this petition is even less persuasive, for obviousness purposes, than the alleged prior art raised in the grounds already denied trial as meritless at the threshold” in IPR2021-01486. Prelim. Resp. 50. For example, Patent Owner alleges, citing to arguments earlier in the

Preliminary Response, “Vijayan089 and Vijayan475 are worse than the obviousness combination in [the prior petition] in that their alleged ‘time-frequency resource units’ do not contain ‘a group of OFDM symbols.’” *Id.* at 50–51 (citing *id.* at 29–45 (Prelim. Resp. § IV)).

As we explain in our discussion below of the merits of Petitioner’s challenges, we are sufficiently persuaded at this stage of the proceeding that Petitioner has established a reasonable likelihood of prevailing in its asserted challenges, notwithstanding Patent Owner’s arguments to the contrary. *See infra* §§ III.E–G. Accordingly, we are not persuaded by Patent Owner’s argument that the challenge raised by the present Petition is less persuasive than that presented in IPR2021-01486.

Finally, referring again to IPR2021-01486, Patent Owner argues that “the denial of the prior challenge is entitled to weight” and that “failure of the prior challenge is evidence of nonobviousness.” Prelim. Resp. 51–58 (title case and bold face omitted). More particularly, according to Patent Owner, “[a] denial of institution on the merits is entitled to significant weight in a later IPR against the same patent,” as “[u]nlike a decision to institute, which is decided on a low threshold and is preliminary, a decision to **deny** institution is decided on the opposite threshold (**lack** of reasonable likelihood), and is final.” *Id.* at 53. Patent Owner further contends that failed obviousness challenges are “objective indicia of nonobviousness.” *Id.* at 54. We disagree. We draw no inference from a prior denial of *inter partes* review where the prior petition was based on different prior art references. Although a decision on institution of *inter partes* review—whether granting or denying institution—is not appealable, it is not a final judgment on the merits giving rise to preclusive effect. *See In re MaxPower Semiconductor, Inc.*, 13 F.4th 1348, 1351–52 (Fed. Cir. 2021) (jurisdiction

under 28 U.S.C. § 1295(a)(4)(A) was unavailable because a decision on institution of *inter partes* review is not a final judgment). Further, although various “objective indicia of nonobviousness,” or “secondary considerations,” are, when in evidence, an essential part of our obviousness analysis, Patent Owner cites, and we are aware of, no precedent for a prior denial of a petition for *inter partes* review being recognized as objective evidence of non-obviousness. *See Graham*, 383 U.S. at 17–18 (identifying commercial success, long-felt but unsolved needs, and the failure of others as examples of secondary considerations); *see also* Andrew Blair-Stanek, Increased Market Power as a New Secondary Consideration in Patent Law, 58 Am. U. L. Rev. 707, 712–13 (2009) (“Courts to date have developed nine secondary considerations: (1) long-felt need; (2) failure of others; (3) commercial success; (4) commercial acquiescence via licensing; (5) professional approval; (6) copying by and praise from infringers; (7) progress through the PTO; (8) near-simultaneous invention; and (9) unexpected results.”); *WBIP, LLC v. Kohler Co.*, 829 F.3d 1317, 1335 (Fed. Cir. 2016) (“Evidence of industry skepticism weighs in favor of non-obviousness.”).

E. Obviousness of Claims 1–5, 7–11, and 13–17 over Vijayan089 and Laroia

Petitioner alleges claims 1–5, 7–11, and 13–17 would have been obvious over Vijayan089 and Laroia, relying in part on Dr. Wilson’s Declaration. Pet. 30–60 (citing Ex. 1003 ¶¶ 106–189). Patent Owner responds, relying in part on Mr. Alberth’s Declaration. Prelim. Resp. 1–2, 8–18, 29–41 (citing Ex. 2001 ¶¶ 30, 33, 38, 57–59, 68–72).

We begin our analysis with an overview of Vijayan089 and Laroia, and we then address the parties' contentions with respect to the challenged claims.

1. Vijayan089

Vijayan089, titled "Multiplexing and Transmission of Multiple Data Streams in a Wireless Multi-carrier Communication System," describes transmission of multiple data streams in "super-frames," each having a predetermined time duration and divided into multiple frames. Ex. 1005, codes (54), (57). According to Vijayan089, data blocks for the data streams are encoded to generate corresponding code blocks that are each partitioned into multiple subblocks, and the multiple subblocks for each code block are transmitted in the multiple frames of the same super-frame, one subblock per frame. *Id.* at code (57), ¶ 10. Each data stream is allocated a number of transmission slots in each super-frame and assigned specific transmission units to achieve efficient packing, reduce transmission time, provide adequate time-diversity, and minimize signaling. *Id.* at code (57), ¶ 11. Vijayan089 discloses that a wireless device can select and receive individual data streams and that, because overhead signaling for various parameters of the data streams may be transmitted prior to each super-frame and may also be embedded within the data payload of each data stream, the wireless device can determine the time-frequency location of each desired data stream in the upcoming super-frame and minimize power consumption by powering on only when the desired data stream is transmitted. *Id.*

Figure 1 of Vijayan089 is reproduced below.

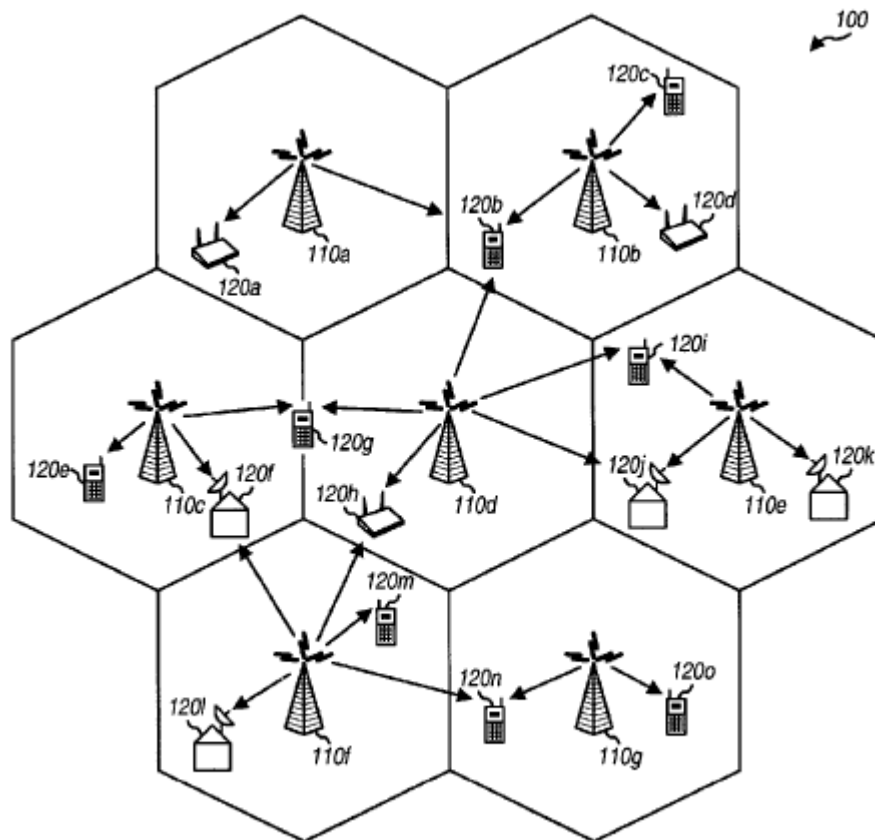


FIG. 1

Figure 1, above, is an illustration of a wireless multi-carrier system of Vijayan089. Ex. 1005 ¶ 14. With reference to Figure 1, system 100 includes base stations 110 (also called, e.g., access points or transmitters) distributed throughout the system, along with fixed or mobile wireless devices 120 (also called, e.g., user terminals, mobile stations, user equipment) located throughout the coverage area of the system. *Id.* ¶ 36. Each base station 110 may broadcast multiple data streams simultaneously to wireless devices 120 within its coverage area. *Id.* ¶ 37. Each data stream is sent on a separate physical layer channel (PLC) (also called, e.g., a data channel or traffic channel). *Id.*

Figure 2 of Vijayan089 is reproduced below.

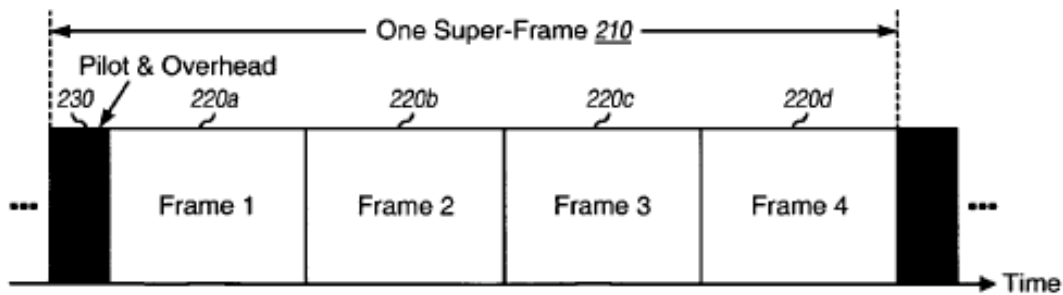


FIG. 2

Figure 2, above, shows an exemplary super-frame structure that may be used for broadcast system 100. Ex. 1005 ¶¶ 15, 38. Each super-frame 210 has a predetermined time duration, which, according to Vijayan089, may be selected based on various factors, and each super-frame is divided into multiple equal-sized frames 220. *Id.* ¶ 38. In the embodiment shown in Figure 2, each super-frame is divided into four frames. *Id.* Further, each super-frame 210 is preceded by pilot and overhead section 230, which in one embodiment includes one or more pilot OFDM symbols used by the wireless devices for, for example, frame synchronization, frequency acquisition, timing acquisition, or channel estimation; and one or more overhead OFDM symbols used to carry overhead signaling information for all PLCs of the associated (e.g., immediately following) super-frame. *Id.* ¶ 44. According to Vijayan089, the wireless devices may initially use the overhead OFDM symbols to determine the time-frequency location of each desired data stream and may subsequently power on only during the time that the desired data stream is transmitted using the embedded overhead signaling. *Id.* Vijayan089 explains that these signaling techniques may provide significant savings in power consumption. *Id.* Vijayan089 further discloses that, although Figure 2 depicts a specific super-frame structure, pilot and

overhead information may alternatively be sent in other manners, such as on dedicated subbands using frequency division multiplexing (FDM). *Id.* ¶ 45.

Figure 4 of Vijayan089 is reproduced below.

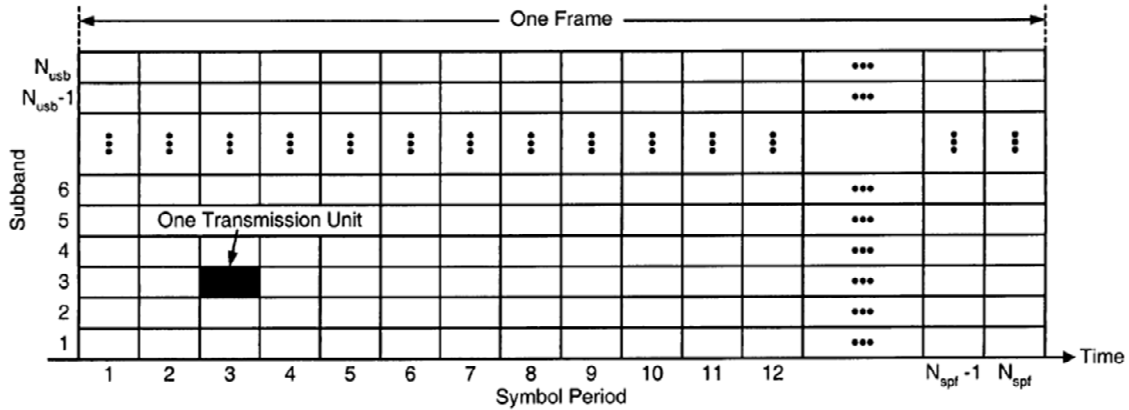


FIG. 4

Figure 4, above, depicts the structure of a single frame on a time-frequency plane, where the horizontal axis represents time, given in units of OFDM symbol periods, and the vertical axis represents frequency. Ex. 1005 ¶¶ 17, 46. According to Vijayan089:

Each OFDM symbol period is the time duration to transmit one OFDM symbol The specific number of symbol periods per frame (N_{spt}) is determined by the frame duration and the symbol period duration, which in turn is determined by various parameters such as the overall system bandwidth, the total number of subbands (N_{tsb}), and the cyclic prefix length Each frame also covers the N_{tsb} total subbands, which are given indices of 1 through N_{tsb} .

With OFDM, one modulation symbol may be sent on each subband in each symbol period, i.e., each transmission unit. . . . In each OFDM symbol period, N_{dsb} data symbols may be sent on the N_{dsb} data subbands, N_{psb} pilot symbols may be sent on the N_{psb} pilot subbands, and N_{gsb} guard symbols are sent on the N_{gsb} guard subbands. As used herein, a “data symbol” is a modulation symbol for data, a “pilot symbol” is a modulation symbol for pilot, and a “guard symbol” is a signal value of zero. The pilot symbols are known a priori by the wireless devices. The N_{dsb}

data symbols in each OFDM symbol may be for one or multiple PLCs.

Id. ¶¶ 46–47. Further, according to Vijayan089, the allocated resources from each active PLC may be given in units of “transmission slots,” where each slot corresponds to a group of data subbands or modulation symbols in a symbol period, such that each active PLC is allocated at least one slot in a super-frame and is also assigned specific slots therein. *Id.* ¶¶ 59, 60.

Vijayan089 explains that although allocation and assignment may be viewed separately for clarity, they “are typically performed jointly since allocation may be affected by assignment, and vice versa.” *Id.* ¶ 60. A resource allocation/assignment scheme attempts to achieve a balance between conflicting goals and may allow for flexibility in the setting of priority. *Id.* ¶ 66. More particularly, each active PLC in a super-frame is allocated a certain number of slots based on the payload of the PLC, such that different PLCs may be allocated different numbers of slots, and the specific slots to assign to each active PLC may be determined in various manners. *Id.* ¶ 67.

Three such manners are depicted in Figures 7A, 7B, and 7C of Vijayan089. *Id.* ¶¶ 67–79. Figure 7B is reproduced below.

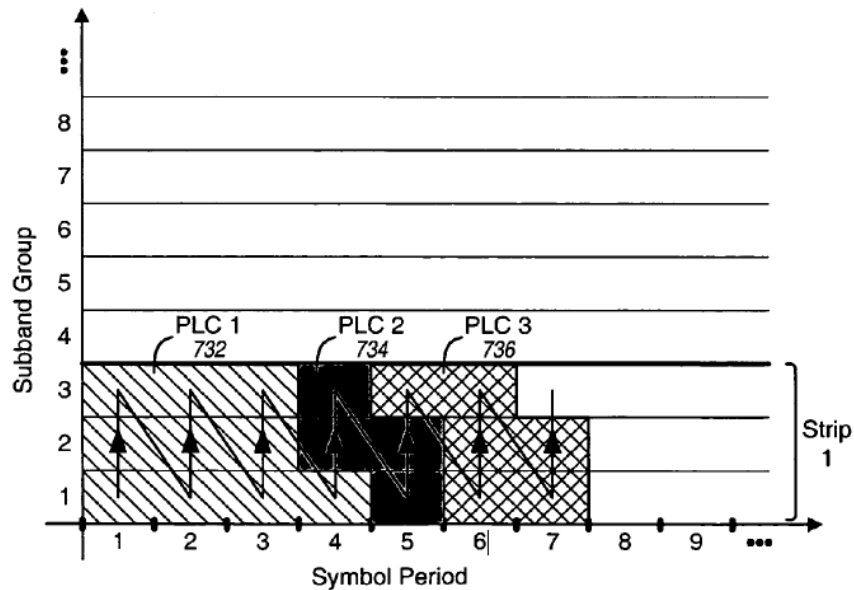


FIG. 7B

Figure 7B, above, shows assignment of slots to PLCs in “sinusoidal” or “zigzag” segments. Ex. 1005 ¶¶ 23, 72. With reference to Figure 7B, Vijayan089 explains that a frame may be divided into N_{st} strips, each covering at least one subband group and further spanning a contiguous number of symbol periods. *Id.* ¶ 72. Each active PLC is mapped to and assigned slots in one of the strips in a specific order, e.g., using a vertical zigzag pattern in which slots are selected from low to high subband group indices. *Id.* ¶¶ 72–73. In the example shown in Figure 7B, strip 1 includes subband groups 1 through 3. *Id.* ¶ 73. PLC 1 is assigned a segment 732 containing ten slots from subband group 1 in symbol period 1 through subband group 1 in symbol period 4; PLC 2 is assigned a segment 734 containing four slots from subband group 2 in symbol period 4 through subband group 2 in symbol period 5; and PLC 3 is assigned a segment 736 containing six slots from sub band group 3 in symbol period 5 through

subband group 2 in symbol period 7. *Id.* The remaining slots in strip 1 may be assigned to other active PLCs mapped to this strip. *Id.*

Vijayan089 explains that the slot assignment scheme depicted in Figure 7B “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.” Ex. 1005 ¶ 74. Vijayan089 further explains that “[e]ach active PLC is assigned a segment within the strip,” where “[t]he 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.* Also, “[a]n additional parameter is used to indicate the specific strip to which the PLC is mapped.” *Id.* In general, according to Vijayan089, “the segment assigned to each active PLC may include any number of slots,” but “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.* According to Vijayan089, the slot assignment scheme of Figure 7B “facilitate[s] efficient packing of PLCs in each frame” and “also reduce[s] the amount of overhead signaling needed to indicate the specific slots assigned to each active PLC.” *Id.* ¶ 76.

2. *Laroia*

Laroia, titled “Efficient Paging in a Wireless Communication System,” describes methods and apparatus for two-stage paging wireless communications systems, allowing for reduced wireless terminal power consumption requirements associated with paging. Ex. 1007, codes (54), (57), ¶ 21. In the described methods, wireless terminals are assigned to paging groups, and first paging signals are communicated from a base station to the terminals, causing the terminals to wake up and ascertain whether their paging group should expect a second paging signal or else go

back to sleep. *Id.* at code (57), ¶¶ 22, 26. Laroia explains that the disclosed paging methods may be used in an OFDM wireless communications system. *Id.* ¶ 34.

Figure 2 of Laroia is reproduced below.

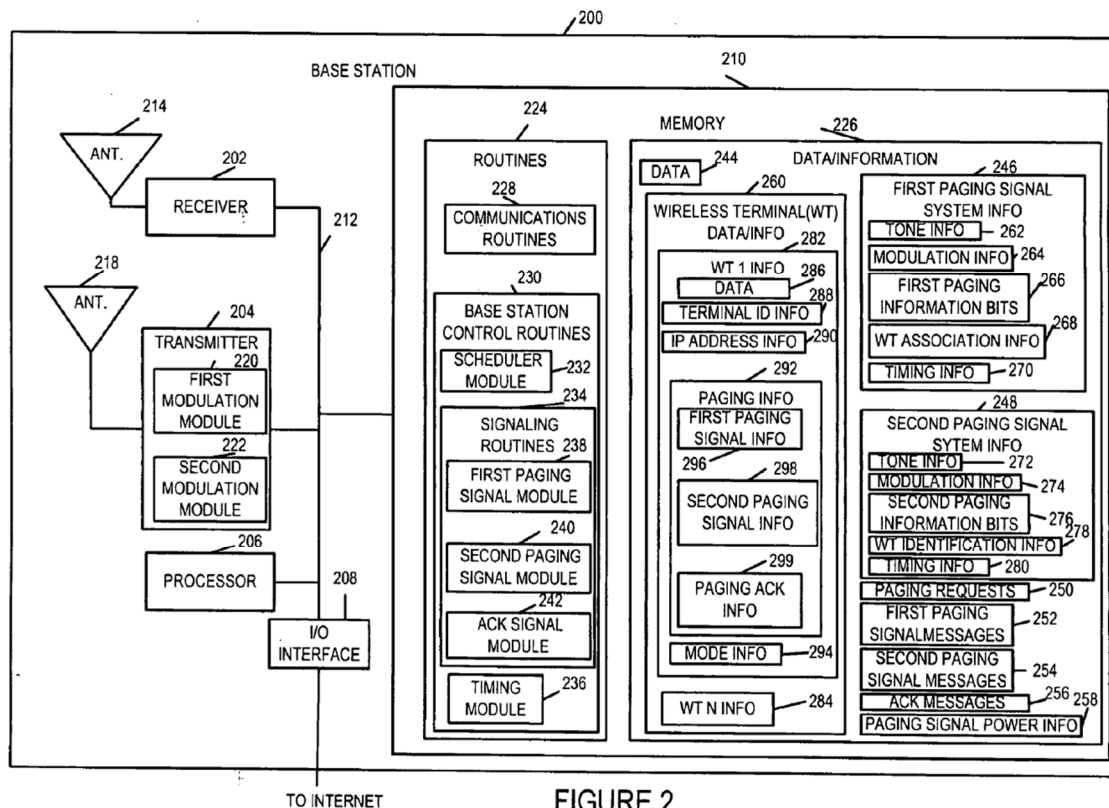


FIGURE 2

Figure 2 illustrates an exemplary base station implemented in accordance with Laroia's invention. Ex. 1007 ¶¶ 9, 35. With reference to Figure 2, base station 200 includes receiver 202, transmitter 204, processor 206, I/O interface 208, and memory 210, coupled together via bus 212 over which the various elements may interchange data and information. *Id.* ¶ 35. Memory 210 includes routines 224 and data/information 226, where data/information 226 is used by processor 206 to control base station 200, perform routine base station operations, and implement the paging methods of the invention. *Id.* ¶ 36. Data/information 226 includes, *inter alia*, first paging signal system information 246, second paging signal system

information 248, and wireless terminal (WT) data/information 260. *Id.* ¶ 37. WT data/information 260 includes, *inter alia*, “terminal identification (ID) information” 288, which may be a base station assigned ID for wireless terminal WT1. *Id.* ¶ 38. Second paging signal information system information 248 includes, *inter alia*, “WT identification information” 278, which in turn may include information allowing a wireless terminal receiving second paging information to identify that it is the specific intended recipient for a second paging signal message. *Id.* ¶ 40.

3. Independent Claim 1

a. Petitioner’s Contentions

Petitioner contends that claim 1 is unpatentable over Vijayan089 and Laroia. Pet. 30–51. With reference to the asserted combination, Petitioner argues that “Vijayan089 expressly discloses using time-frequency ‘transmission units’ or ‘transmission slots’ to allocate resources and using a starting time-frequency coordinate and an N-value of transmission slots,” while “Laroia expressly assigns an identifier to a wireless terminal so that it can discern its own messages intended for reception.” *Id.* at 30. Petitioner further contends that a person of ordinary skill in the art “would have found it obvious and would have been motivated to combine Vijayan089 and Laroia to also provide [Laroia’s] capability in Vijayan089’s system.” *Id.* (citing Ex. 1003 ¶¶ 107–116, 134–137).

i. Preamble

With respect specifically to the preamble of claim 1,³ Petitioner contends that Vijayan089 describes the same operating method and wireless

³ We need not decide for purposes of this Decision whether the preambles of any of the challenged claims are limiting.

network recited in claim 1. Pet. 33 (citing Ex. 1003 ¶¶ 117–129). First, Petitioner alleges, Vijayan089 discloses “a wireless network comprising at least a base station and a mobile station,” pointing to Vijayan089’s “wireless multi-carrier broadcast system 100” that includes “base stations 110” and “wireless devices 120,” noting that “Vijayan089 also states that the ‘wireless device’ may refer to a ‘mobile station.’” *Id.* at 33–35 (citing Ex. 1003 ¶¶ 118–120; Ex. 1005 ¶¶ 36–37, Figs. 1, 11, 12). Second, Petitioner contends, Vijayan089 discloses “employing a frame structure of multiple frames for transmission,” citing Vijayan089’s “super-frame 210” that can be “divided into multiple . . . frames” that includes time and frequency components and use time-frequency “transmission units” for transmission of data. *Id.* at 35–36 (citing Ex. 1003 ¶¶ 121–124; Ex. 1005 ¶¶ 11, 38–49, 58–67, Figs 2, 4). Finally, Petitioner contends that 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,” pointing to Figure 4 and corresponding text of Vijayan089, illustrating and describing frequency subbands (i.e., “frequency subcarriers,” in the parlance of claim 1) and time intervals measured “in units of OFDM symbol periods,” where “ N_{dsb} data symbols may be sent on the N_{dsb} data subbands” within “each OFDM symbol period.” *Id.* at 36–38 (quoting Ex. 1005 ¶¶ 46, 47) (citing Ex. 1003 ¶¶ 125–129; Ex. 1005, ¶¶ 5, 37, 46–47, 59–67, 70–77, Fig. 4).

ii. “assigning an identifier to the mobile station”

Petitioner argues that Vijayan089 renders obvious the step of “assigning an identifier to the mobile station,” as recited in claim 1. Pet. 38–39. More particularly, Petitioner points out that “Vijayan089

allocates transmission units via a ‘unicast transmission [that] is sent to a specific wireless device’” and “also allows a wireless device ‘to recover each data stream independently, without having to process the other data streams being transmitted simultaneously.’” *Id.* at 38 (quoting Ex. 1005 ¶¶ 6, 9) (citing Ex. 1005 ¶¶ 6, 7, 9, 11, 44, 35, 106). According to Petitioner, “[t]o provide unicast transmissions and independent data stream recovery, a POSITA would have found it obvious for Vijayan089 to have assigned an identifier to each wireless device,” because “[o]therwise, it would be more difficult for each wireless device to discern its own respective data stream for recovery.” *Id.* at 38–39 (citing Ex. 1003 ¶ 130–133).

In the alternative, Petitioner contends that Laroia explicitly discloses the recited “assigning” step, citing Laroia’s disclosures of “terminal identification (ID) information” as being “a base station assigned ID for [wireless terminal] WT 1” and of “‘WT identification information’ allow[ing] a wireless terminal to identify that it ‘is the specific intended recipient’ for a particular message.” Pet. 39 (emphasis omitted) (quoting Ex. 1007 ¶¶ 38, 40) (citing Ex. 1003 ¶¶ 134–137; Ex. 1007 ¶¶ 38–40, 49, 53, 58, 63–65, Figs. 2, 3, 5).

Citing Dr. Wilson’s testimony, Petitioner argues that a person of ordinary skill in the art would have been motivated to combine Vijayan089 and Laroia to implement Laroia’s assignment of a wireless device identifier with Vijayan089’s OFDM communication system for several reasons. Pet. 30–32 (citing Ex. 1003 ¶¶ 108–116). First, Petitioner contends, related to its argument discussed above that Vijayan089 itself renders the “assigning” step obvious, a person of ordinary skill in the art would have used an identifier to specifically identify a wireless device, in order to implement Vijayan089’s disclosure of “unicast communications.” *Id.*

at 30–31 (citing Ex. 1003 ¶¶ 108–110; Ex. 1005 ¶¶ 6, 7, 35). While conceding that “Vijayan089 does not explicitly discuss types of identifiers or how to implement such identifiers,” Petitioner argues that a person of ordinary skill in the art “would have therefore sought references that taught techniques for implementing wireless device identifiers,” and that “Laroia is such a reference.” *Id.* at 31 (citing Ex. 1003 ¶¶ 108–110; Ex. 1007 ¶¶ 38, 40, 53, 63).

Petitioner further contends, “[i]mplementing a wireless device identifier within Vijayan089’s system would also further Vijayan089’s goal of ‘minimiz[ing] power consumption’ and having a wireless device that powers on ‘only when the desired data stream is transmitted’”—a goal that Petitioner contends is described by both Vijayan089 and Laroia. Pet. 31 (citing Ex. 1005 ¶¶ 7–9, 11, 44, 61; Ex. 1007 ¶¶ 3, 6, 63, 64, code (57)). Moreover, Petitioner contends, “[c]ombining Vijayan089 and Laroia would have amounted to combining well-known prior art elements to yield predictable results,” as “[a]ssigning a wireless device identifier was a well-known technique in the prior art used to allow a mobile device to discern its own intended messages,” and “[i]n view of this ubiquitous usage, a POSITA would have had a reasonable expectation of success in combining Vijayan089 and Laroia to facilitate wireless transmissions.” *Id.* at 31–32 (citing Ex. 1003 ¶¶ 113–114; Ex. 1005, ¶¶ 5, 36, 37, 107–111, Figs. 1, 11, 12; Ex. 1007 ¶¶ 32–35, 38–42, Figs. 1–3). Finally, Petitioner contends, “[t]his combination would have been predictable and would have operated to perform its intended purposes in view of [the references’] common OFDM configuration.” *Id.* at 32 (citing Ex. 1003 ¶¶ 113–116). According to Petitioner, “[i]n the combined system, the base station would have used the identifier to specify the resource allocation parameters for a particular

wireless device,” which “would have then used the identifier to discern its assigned transmission slots . . . and recover its respective data.” *Id.* (citing Ex. 1003 ¶¶ 113–116; Ex. 1005 ¶¶ 11, 44, 74, 76, 106, 110).

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

Petitioner argues that Vijayan089 discloses transmitting a signal “from the base station to the mobile station over a segment of time-frequency resource,” as recited in claim 1, citing disclosure in Vijayan089 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.” Pet. 41 (emphasis omitted) (quoting Ex. 1005 ¶ 74) (citing Ex. 1003 ¶¶ 138–154; Ex. 1005 ¶¶ 11, 59, 72–76, Fig. 4). Petitioner contends that Vijayan089 describes the same base station and mobile station configuration described in claim 1, with Vijayan089’s base station transmitting OFDM “data streams to be individually recovered” by a wireless device over “transmission units” or “transmission slots” having time and frequency components that disclose the claimed “time-frequency resource.” *Id.* at 41–42 (citing 1003 ¶ 139; Ex. 1005 ¶¶ 9, 11, 59, 72–76, 108–110, Fig. 4). Petitioner points in particular to Vijayan089’s depiction of a transmission unit in Figure 4 and depictions of transmission slots grouped into PLC segments (i.e., “segment[s] of time-frequency resource,” in the parlance of claim 1) in Figures 7A and 7B, along with corresponding description. *Id.* at 42–44 (citing Ex. 1003 ¶¶ 139–143; Ex. 1005 ¶¶ 9, 11, 37, 46, 59, 60, 68–76, Figs. 4, 7A, 7B).

- iv. *“the segment having a starting time-frequency coordinate and the segment comprising N time-frequency resource units within a time interval . . . where $N=2, 4, \text{ or } 8$ ”*

Quoting Vijayan089’s disclosure 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” and that a PLC segment “may include any number of slots,” where “less overhead signaling is required to identify the assigned segments if the segment sizes are construed to be in multiple (e.g., 2 or 4) slots,” Petitioner contends that “[t]he ‘start of the segment’ parameter (e.g., the starting subband and symbol period) discloses the claimed ‘starting time-frequency coordinate’” and that “Vijayan089 discloses . . . the ‘length of the segment’ being 2, 4, or 8 slots.” Pet. 45 (emphasis omitted) (quoting Ex. 1005 ¶¶ 74) (citing Ex. 1003 ¶¶ 144–145). Further quoting Vijayan089’s disclosure of “map[ping] all of the slots in a . . . 2-D slot assignment using one dimension,” Petitioner contends that “[t]his single dimension of a number of slots discloses the claimed number of ‘time-frequency resource units.’” *Id.* (emphasis omitted) (quoting Ex. 1005 ¶ 74) (citing Ex. 1003 ¶¶ 146–148). Petitioner points to segment 734 corresponding to “PLC 2” in Figure 7B of Vijayan089 as illustrative, arguing that “[s]egment 734 includes a starting time-frequency coordinate of: Symbol Period = 4, Subband Group = 2” and “also has four (i.e., $N = 4$) time-frequency resource units depicted as four transmission slots (colored in black).” *Id.* at 46–47 (citing Ex. 1003 ¶¶ 149–151; Ex. 1005, ¶¶ 9, 11, 59, 67–76, Fig. 7B).

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

Petitioner maps Vijayan089’s “transmission slot” to the recited “unit” and maps the “subband group[s]” in each transmission slot to the recited “set of frequency subcarriers.” Pet. 47 (citing Ex. 1003 ¶¶ 152–154; Ex. 1005 ¶¶ 56, 59 (disclosing that each transmission slot “corresponds to one group of (e.g., 500) data subbands”), 87, Fig. 7B). Petitioner contends “[e]ach group of subbands transmits OFDM symbols,” quoting Vijayan089’s disclosure that “[w]ith OFDM, one modulation symbol may be sent on each subband in each symbol period.” *Id.* at 48 (quoting Ex. 1005 ¶ 47) (citing Ex. 1003 ¶¶ 152–154; Ex. 1005 ¶¶ 5, 59).

vi. *“receiving by the mobile station the transmitted signal”*

Petitioner contends that “Vijayan089 discloses a wireless device (*i.e.*, the claimed ‘mobile station’) receiving transmitted information signals from a base station.” Pet. 48–49 (citing Ex. 1005 ¶¶ 109–111, Fig. 12). In particular, Petitioner cites Vijayan089’s disclosure of “wireless device 120x” including, *inter alia*, “antenna 1212,” “receiver unit 1214,” and “OFDM demodulator 1220,” where “antenna 1212 receives the modulated signal transmitted by base station 110x and provides a received signal to . . . receiver unit (RCVR) 1214,” “[r]eceiver unit 1214 conditions, digitizes, and processes the received signal,” and “OFDM demodulator 1220 . . . identifies the ‘received data symbols and received overhead symbols.’” *Id.* at 49 (quoting Ex. 1005 ¶ 109). Thus, Petitioner argues, “these components receive the signal transmitted from the base station corresponding to the PLC segments with corresponding slot assignments.” *Id.* (citing Ex. 1003 ¶¶ 155–157; Ex. 1005 ¶¶ 9, 11, 59, 67, 72–76, 108–10).

- vii. *“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”*

Petitioner contends that Vijayan089’s wireless device using receiver unit 1214 and OFDM demodulator 1220 recovers data from the received OFDM signal based on the starting time-frequency coordinate and N time-frequency resource units. Pet. 50 (citing Ex. 1003 ¶¶ 158–161; Ex. 1005 ¶¶ 65, 109–11, Fig. 12). Further, Petitioner argues, “controller 1260” of Vijayan089’s wireless device 120x “also uses ‘overhead signaling’ identifying the ‘resource allocating and assignment for each selected PLC’ to recover the OFDM data in ‘one or more specific data streams/PLCs,’” and Vijayan089 discloses that the overhead signaling includes “two parameters: the start of the segment . . . and the length of the segment.” *Id.* (emphasis omitted) (quoting Ex. 1005 ¶¶ 74, 110) (citing Ex. 1005 ¶¶ 9, 11, 44, 59, 72–74). With those parameters, Petitioner asserts, “the wireless device can ‘determine the time-frequency location of each desired data stream,’” and “[t]he wireless device therefore recovers a ‘given data stream of interest’ using a starting time-frequency coordinate (the ‘start of the segment’ parameter) and N time-frequency resource units (the ‘length of the segment’—including 2 or 4 transmission slots).” *Id.* (emphasis omitted) (quoting Ex. 1005 ¶ 11) (citing Ex. 1003 ¶¶ 158–161; Ex. 1005 ¶¶ 11, 44, 106).

Additionally, as in connection with the “assigning” step discussed above, Petitioner contends that “Vijayan089 suggests using an identifier corresponding to the wireless device when recovering the data during unicast transmissions” and that “Laroia confirms this understanding and explicitly uses identifiers to differentiate between multiple wireless

terminals.” Pet. 50–51; *see supra* § III.E.3.a.ii. Citing Dr. Wilson’s testimony, Petitioner argues that a person of ordinary skill in the art “would have found it obvious and would have been motivated to implement the identifier described in Laroia with Vijayan089’s system.” *Id.* at 51 (citing Ex. 1003 ¶¶ 164–165). In Petitioner’s view, “th[e] identifier would allow a wireless device to differentiate its own allocation parameters from others” and “would be transmitted with Vijayan089’s overhead signaling, which includes the starting time-frequency coordinate and number of slots.” *Id.* (citing Ex. 1003 ¶¶ 164–165; Ex. 1005 ¶¶ 11, 44, 74, 76; Ex. 1007 ¶¶ 40, 53, 63). Using the identifier and allocation parameters, Petitioner asserts, “Vijayan089’s wireless device would recover signals from the slots corresponding to a PLC segment.” *Id.* (citing Ex. 1003 ¶¶ 164–165; Ex. 1005 ¶¶ 109–111, Fig. 12).

b. Patent Owner’s Contentions

i. “starting time-frequency coordinate”

In response to Petitioner’s contentions, Patent Owner argues, first, that the combination of Vijayan089 and Laroia fails to teach or render obvious the “starting time-frequency coordinate” recited in each of the challenged independent claims. Prelim. Resp. 8. Rather, Patent Owner contends, “Vijayan089 . . . uses both ‘a starting subband and symbol period,’ which Petitioner improperly attempts to combine into a single parameter.” *Id.*

According to Patent Owner, “[t]he ’450 patent describes several innovations that together allow for a reduction in overhead when allocating time-frequency resources,” and “[t]he use of a single ‘starting time-frequency resource’ is one of these innovations, required by all the claims and recited in each independent claim.” Prelim. Resp. 9 (citing Ex. 1001, cls. 1, 7, 13). Patent Owner contends that the ’450 patent distinguishes a

prior art allocation scheme in which both a “start symbol offset” and a “start logical subchannel offset” were needed to specify the start of the time/frequency region. *Id.* (citing Ex. 1001, 1:62–66). Quoting the testimony of Mr. Alberth, Patent Owner argues that “a ‘POSITA would have understood the claimed ‘starting time-frequency coordinate’ to be different from and exclude the collective labeling of a starting time coordinate and a separately described starting frequency coordinate.’” *Id.* at 10 (quoting Ex. 2001 ¶ 57). Additionally citing the claim construction briefing from the parallel district court litigation, Patent Owner further contends that “[i]t is . . . undisputed that the ‘starting time-frequency coordinate’ must have a single dimension covering both time and frequency,” and “[a]ny reference that uses both a starting time coordinate and a separate starting frequency coordinate does not have a one-dimensional coordinate in both time and frequency.” *Id.* (emphasis omitted) (citing Ex. 2001 ¶ 57; Ex. 2004, 5; Ex. 2006, 2).

In light of these considerations, Patent Owner argues that “[m]uch like in the [IPR2021]-01486 Petition, this Petition in effect draws a box around two separate, one-dimensional coordinates in Vijayan089 and asserts that they ‘collectively’ constitute a single ‘starting time-frequency coordinate.’” Prelim. Resp. 13. In particular, Patent Owner points to Petitioner’s contentions that Vijayan089’s “‘start of the segment’ parameter (e.g., the starting subband and symbol period) discloses the claimed ‘starting time-frequency coordinate’” and that Vijayan089’s “[s]egment 734 includes a starting time-frequency coordinate of: Symbol Period = 4, Subband Group = 2.” *Id.* at 13–15 (quoting Pet. 45–47). In Patent Owner’s view, notwithstanding Vijayan089’s “refer[ence] to the starting subband and symbol period collectively as the ‘start of segment’ parameter,” “[i]t is . . .

clear that the ‘start of the segment’ is composed of two individual sub-parameters,” and “[t]hus, Vijayan089 is like the . . . reference in the ’450 patent’s background, in that it has both a starting time coordinate and a separate starting frequency coordinate.” *Id.* at 13–14 (citing Ex. 1005 ¶¶ 73, 74; Ex. 2001 ¶ 58). In this regard, Patent Owner contends, “[t]he Petition’s arguments with respect to Vijayan089 are materially similar to the arguments that were previously rejected in the [IPR2021]-01486 Petition,” which “attempted to merge . . . ‘OFDMA Symbol offset’ and ‘subchannel offset’ collectively into the claimed ‘time frequency-coordinate.’” *Id.* at 16–17 (citing IPR2021-01486, Paper 3, 47, 60 (Petition); IPR2021-01486, Paper 10, 27 (Decision Denying Institution)). Finally, Patent Owner contends that “Vijayan089’s ‘start of segment,’ even if it were to be considered a single starting coordinate, is not a ‘starting *time-frequency coordinate*’ because it does not satisfy the undisputed requirement that a ‘time-frequency coordinate’ be ‘one dimensional.’” *Id.* at 18.

- ii. *“N time-frequency resource units . . . containing a set of frequency subcarriers in a group of OFDM symbols”*

Patent Owner additionally argues that “Vijayan089 does not teach or render obvious ‘time-frequency resource units . . . each unit . . . in a group of OFDM symbols,” contending that Vijayan089’s “transmission slots” that Petitioner maps to the recited “time-frequency resource units” cover only a single OFDM symbol, not a “group of OFDM symbols.” Prelim. Resp. 29, 33. According to Patent Owner, the Petition “ignor[es] [Vijayan089’s] explicit discussion of OFDM symbols and conflat[es] the claimed ‘OFDM symbols’ with modulation symbols.” *Id.* at 29.

In Patent Owner’s view, “[o]ne of the key features of the [recited] time-frequency resource unit is that it has multiple symbols,” allowing for a reduction in “the amount of control overhead but at the cost of flexibility.” Prelim. Resp. 30–32 (citing Ex. 1001, 6:49–50, Table 1; Ex. 2001 ¶¶ 30, 68). Patent Owner contends that the Petition correctly identifies Vijayan089’s “symbol periods” as the recited “OFDM symbols” when asserting that Viyanan089 has “time intervals . . . comprising a plurality of [OFDM] symbols,” but that, “[w]hen attempting to establish that ‘each unit containing a set of frequency subcarriers in a group of OFDM symbols,’ . . . Petitioner changes its tune” and “switches to arguments based on modulation symbols” rather than “symbol periods as the alleged ‘OFDM symbols.’” *Id.* at 33–34 (citing Pet. 37, 42, 48). According to Patent Owner, “[t]he reason for this switch is quite simple: each of Vijayan089’s transmission slots covers only one symbol period, and thus the transmission slot is not ‘in a group of OFDM symbols’ as required by the claims.” *Id.* at 34.

Further, Patent Owner contends, “Vijayan089 OFDM symbol period and modulation period are very different concepts, that are not interchangeable.” Prelim. Resp. 34. In particular, Patent Owner argues, “Vijayan089’s symbol period is simply a measure of time, as indicated by the fact that it is described as the unit in time axis,” whereas “[b]y contrast the ‘modulation symbol’ is a unit or resource for transmitting different types of signals,” and “[t]here can be multiple modulation symbols in a single symbol period” *Id.* at 34–36 (quoting Ex. 2001 ¶¶ 69, 70).

“Using the correct read of the ‘OFDM symbol’ onto Vijayan089,” Patent Owner asserts, “its transmission slots do not satisfy the limitation of ‘containing a set of frequency subcarriers in a group of OFDM symbols.’” Prelim. Resp. 37 (emphasis omitted). Patent Owner contends that this is

“most clearly evident from examining Figure 7B of Vijayan089 as annotated by Petitioner.” *Id.* at 37–38 (citing Pet. 46). With reference to that figure, Patent Owner contends:

Mr. Alberth explains how this figure and its annotations show “time-frequency resource units” containing a set of frequency subcarriers in a *single* “OFDM symbol” rather than the “*group* of OFDM symbols” required by the claims:

Figure 7B of Dr. Wilson’s annotation to this figure correctly states that “PLC 2 ... includes four time-frequency resource units (N=4). Ex. 1003 [Wilson Decl.] ¶¶ 144; *see also* Pet., 46 (Ex. 1005 [Vijayan089] Fig. 7B with Petitioner’s annotations). The “time-frequency resource units” clearly refers to the four blackened boxes resembling a tetris symbol S rotated clockwise onto its side labeled 734. Each of the four black boxes is a transmission slot. Ex. 1005 [Vijayan089] ¶ 59 (“The allocated resources for each active PLC may be given in units of ‘transmission slots’ (or simply, ‘slots’).”). From this figure it can easily be seen that each slot has a duration of only one symbol period. *See* Ex. 1005 [Vijayan089] Fig. 7B. Since the slot is the alleged “time-frequency transmission unit,” and each symbol period is the duration of a single claimed “OFDM symbol,” this shows that the “time-frequency transmission unit” does not contain subcarriers in “a group of OFDM symbols” as required by the claim. Rather, the slot only lasts one symbol period so the alleged “time-frequency transmission unit” at most contains a set of frequency subcarriers in a single OFDM symbol.

Prelim. Resp. 38–39 (quoting Ex. 2001 ¶ 71).

Finally, Patent Owner contends that, “[e]ven if, contrary to the evidence presented above, the modulation symbol could be considered the claimed ‘OFDM symbol’ and the ‘group of OFDM symbols’ limitation could be met, this read is inconsistent with Petitioner’s earlier position that

the claimed ‘OFDM symbol’ should be read on Vijayan089’s symbol period,” and “Petitioner’s attempt to ‘switch horse mid-race’ should be rejected.” Prelim. Resp. 40–41 (citing *Facebook, Inc. v. Uniloc USA, Inc.*, IPR2017-01524, Paper 7, 19 (Dec. 4, 2017); *Coherus Biosciences, Inc. v. Hoffman-La Roche Inc.*, IPR2017-02066, Paper 11, 14 (Mar. 9, 2018); *Denso Corp. v. Collision Avoidance Techs. Inc.*, IPR2017-01715, Paper 7, 55-57 (Jan. 23, 2018)).

c. Discussion

On the preliminary record before us, we are persuaded that Petitioner has articulated reasoning with rational underpinning to support combining the teachings of Vijayan089 and Laroia and has shown a reasonable likelihood that it will prevail in showing that claim 1 is unpatentable over the combination.

Despite Patent Owner’s arguments that Vijayan089 fails to teach a “starting time-frequency coordinate” (Prelim. Resp. 1, 8–10, 13–18), Vijayan089 expressly discloses a slot assignment scheme that “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” (Ex. 1005 ¶ 74; *see also id.* at claim 52 (reciting “wherein transmission units in each 2-D strip are mapped to a one-dimensional (1-D) strip, and wherein each data stream mapped to the 2-D strip is assigned a segment of contiguous transmission units in the corresponding 1-D strip”)). That disclosure is cited in the Petition (*see* Pet. 25) and by Dr. Wilson (Ex. 1003 ¶ 88) but is not addressed by Patent Owner. We understand from that disclosure that Vijayan089 thus teaches a one-dimensional time-frequency coordinate.

As Patent Owner recognizes, Vijayan089 further discloses that “[t]he 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” (Ex. 1005 ¶ 74). In view of the preceding disclosure in the same paragraph of Vijayan089 that the slots may be mapped “onto a one-dimensional (1-D) strip,” we do not understand the identification of the start of the segment “by the starting subband and symbol period” as requiring “**both** a starting time coordinate **and** a separate starting frequency coordinate,” as Patent Owner contends. *See* Prelim. Resp. 14.

Indeed, dependent claims 2 and 3 of the ’450 patent, discussed in Section III.E.5 below, separately contemplate that the starting time-frequency coordinate of claim 1 may indicate either “a starting OFDM symbol of the segment of time-frequency resource” (claim 2) or “a starting subcarrier of the segment of time-frequency resource (claim 3). *See* Ex. 1001, 13:1–6. If, as Patent Owner appears to suggest, the starting time-frequency coordinate cannot “be given by the starting subband and symbol period,” it is unclear how the further limitations set forth in claims 2 and 3 are to be reconciled with such a prohibition. The parties are advised to address these considerations more fully in their trial briefing.

Notwithstanding Patent Owner’s arguments that Vijayan089 does not teach or suggest the limitation of “each unit containing a set of frequency subcarriers in a group of OFDM symbols” (Prelim. Resp. 29–41), we also find Petitioner’s contentions with respect to that limitation sufficient on the preliminary record.

Whereas Patent Owner appears to read the limitation not only to require each time-frequency resource unit to contain a set of frequency

subcarriers in a group of OFDM symbols but also to require that each time-frequency resource unit must individually span multiple OFDM symbols, we find that to present an issue of claim construction that is underdeveloped on the preliminary record before us. The parties are accordingly advised to address the construction of that limitation in their briefing in the course of trial.

4. Independent Claims 7 and 13

Independent claim 7 is directed to a mobile device in a wireless packet system using a frame structure essentially as recited in the preamble of claim 1, where the mobile device is configured to receive an identifier and a signal, essentially as recited in the assigning and transmitting steps of claim 1, and to recover the information from the signal, again essentially as recited in claim 1. Ex. 1001, 13:15–33. Independent claim 13 is directed to a base station in a wireless packet system similarly using the frame structure as recited in the preamble of claim 1, where the base station is configured to provide an identifier to a mobile device in the cell, allocate a segment of time-frequency resource as recited in claim 1 to the mobile device, and transmit signal containing information to the mobile device in a manner that allows the mobile device to recover the information, essentially as in the “recovering” step of claim 1. *Id.* at 14:7–26.

Petitioner refers back to its arguments for claim 1 for all limitations of claims 7 and 13. Pet. 51–54. With respect to the recitations in claims 7 and 13 of the mobile device and base station, respectively, operating in a “wireless packet system,” Petitioner further contends that Vijayan089 describes communications using “packets,” citing disclosure in Vijayan089 that a “data stream for a PLC is partitioned into data packets” and Vijayan089’s mapping “the number or slots needed to transmit one packet”

based on the mode or modulation scheme used for transmission. *Id.* at 52 (citing Ex. 1003 ¶¶ 168–170; Ex. 1005, code (57), ¶¶ 83, 85–87, 114), 54 (citing Ex. 1003 ¶¶ 173–174; Ex. 1005, code (57), ¶¶ 83, 85–87, 114). Petitioner additionally contends that “Vijayan089 depicts base station cells in Figure 1 and a wireless device as a ‘cellular phone,’” thus teaching that the mobile device operates within a cell serviced by a base station, as further recited in claims 7 and 13. *Id.* (citing Ex. 1005 ¶¶ 36–37, Fig. 1). Further, according to Petitioner, Laroia also describes the same cell-based configuration, as depicted in Figure 1 thereof. *Id.* at 53 (citing Ex. 1007, ¶¶ 32–34, Fig. 1).

Patent Owner relies on the same arguments for claims 7 and 13 as for claim 1. *See* Prelim. Resp. 8–18, 29–41. For the reasons discussed in Section III.E.3 above with respect to claim 1, and based on Petitioner’s further arguments addressing the packet and cell-based limitations of claims 7 and 13, we conclude that Petitioner shows a reasonable likelihood of prevailing with respect to both claims.

5. Dependent Claims 2–5, 8–11, and 14–17

Claims 2, 8, and 14 depend from claims 1, 7, and 13, respectively, and each further recites “wherein the starting time-frequency coordinate indicates a starting OFDM symbol of the segment of time-frequency resource.” Ex. 1001, 13:1–3, 34–36, 14:27–29. Claims 3, 9, and 15 depend from claims 1, 7, and 13, respectively, and each further recites “wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.” *Id.* at 13:4–6, 13:37–39, 14:30–32. Claims 4, 10, and 16 depend from claims 1, 7, and 13, respectively, and each further recites “wherein the starting time-frequency coordinate indicates a starting group of subcarriers of the segment of time-frequency resource.” *Id.*

at 13:7–9, 13:40–42, 14:33–35. Claims 5, 11, and 17 depend from claims 1, 7, and 13, respectively, and each further recites “wherein modular coding is applied to the time-frequency resource units in the segment of time-frequency resource.” *Id.* at 13:10–12, 14:1–3, 14:36–38.

For the dependent claims listed above, Petitioner argues with citations to Vijayan089 and Dr. Wilson’s testimony that Vijayan089 teaches each of their additional limitations. Pet. 54–60. Patent Owner does not provide any arguments specifically for any of the challenged dependent claims, but relies only on the arguments presented for the independent claims. *See* Prelim. Resp. 8–18, 29–41.

Based on the arguments presented and the evidence cited in the Petition, Petitioner shows a reasonable likelihood of prevailing on each of claims 2–5, 7–11, and 13–17 in its challenge based on Vijayan089 and Laroia.

6. Conclusion

Petitioner has shown a reasonable likelihood that it will prevail in showing that claims 1–5, 7–11, and 13–17 would have been obvious over Vijayan089 and Laroia.

F. Obviousness of Claims 1–5, 7–11, and 13–17 over Vijayan475 and Wu

Petitioner alleges claims 1–5, 7–11, and 13–17 would have been obvious over Vijayan475 and Wu, relying in part on Dr. Wilson’s Declaration. Pet. 60–91 (citing Ex. 1003 ¶¶ 190–274). Patent Owner responds, relying in part on Mr. Alberth’s Declaration. Prelim. Resp. 1–2, 8–12, 18–32, 41–45 (citing Ex. 2001 ¶¶ 30, 38, 52, 57, 60–65, 68, 72).

We begin our analysis with an overview of Vijayan475 and Wu, and we then address the parties’ contentions with respect to the challenged claims.

1. *Vijayan475*

Vijayan475, titled “Transmission of Overhead Information for Reception of Multiple Data Streams,” relates to “techniques for transmitting overhead information for reception of multiple data streams in a communication system.” Ex. 1006, code (54), ¶ 3. *Vijayan475* describes a super-frame structure for communications and is generally directed to OFDM communications. *Id.* ¶¶ 10–12, 25, 63–71.

Figure 1 of *Vijayan475* is reproduced below.

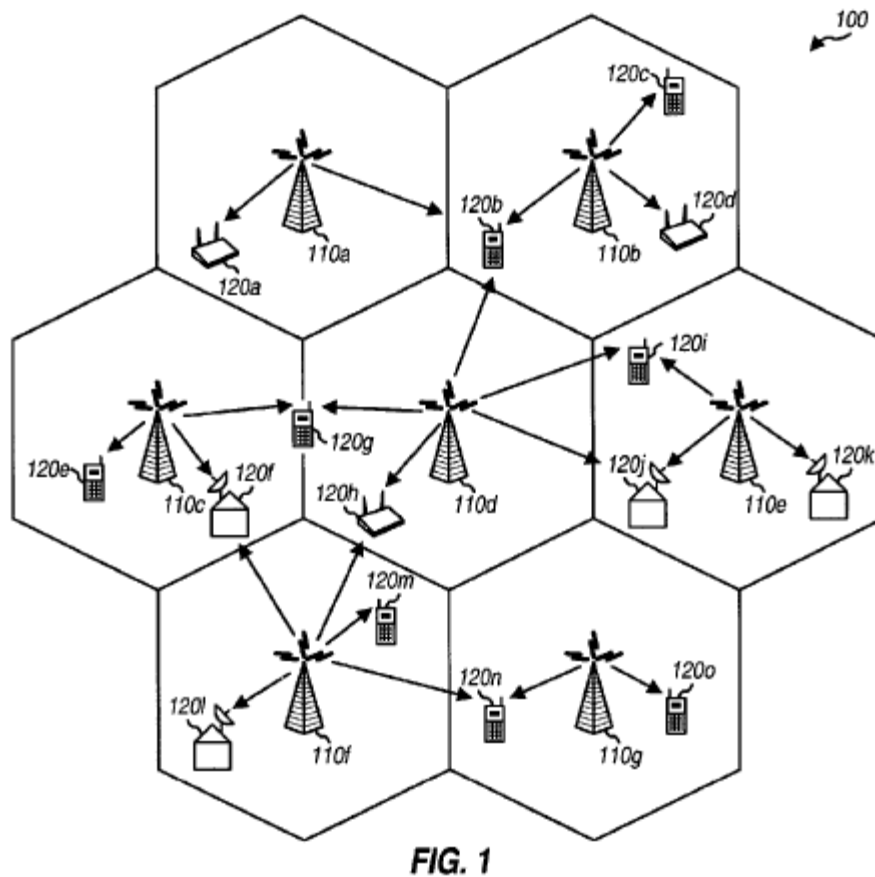


Figure 1, above, is an illustration of a wireless multi-carrier system of *Vijayan475*. Ex. 1006 ¶ 15. With reference to Figure 1, system 100 includes base stations 110 (also called, e.g., access points or transmitters) distributed throughout the system, along with fixed or mobile wireless

devices 120 (also called, e.g., user terminals, mobile stations, user equipment) located throughout the coverage area of the system. *Id.* ¶ 26. Each base station 110 may broadcast multiple data streams simultaneously to wireless devices 120 within its coverage area. *Id.* ¶ 27. The data streams are sent on data channels or multiplexed logic channels (MLCs). *Id.* In a specific embodiment that is described in detail, each MLC may carry up to three data streams (e.g., one for signaling and up to two for packet/traffic data), but Vijayan475 states that, in general, each MLC may carry any number of data streams. *Id.* ¶ 28.

Figure 2 of Vijayan475 is reproduced below.

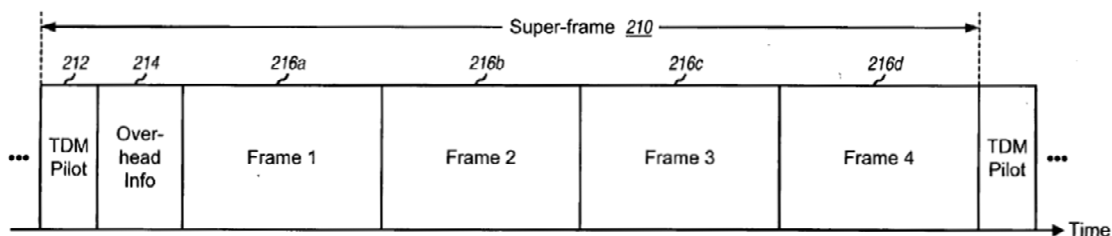


FIG. 2

Figure 2, above, shows an exemplary super-frame structure that may be used for system 100. Ex. 1006 ¶¶ 16, 29–32. With reference to Figure 2, data transmission occurs in units of super-frames 210 (also referred to as frames or time slots), each spanning a predetermined time duration that may be selected based on various factors. *Id.* ¶ 29. In Figure 2, each super-frame includes field 212 for a time division multiplexed (TDM) pilot, field 214 for overhead information, and four equal-sized frames 216a–216d. *Id.* ¶ 30. Data streams are multiplexed and sent in frames 216a–216d. *Id.*

Vijayan475 discloses that data may be transmitted in various manners in system 100. Ex. 1006 ¶ 36. In one embodiment, M slots are formed in each symbol period, where $M \geq 1$, and mapped to sets of subbands. *Id.* “For a given super-frame structure, a fixed number of slots is available for

transmission in each super-frame.” *Id.* ¶ 37. “Each MLC may be ‘allocated’ a fixed or variable number of slots in each super-frame, depending on the MLCs payload, the availability of slots in the super-frame, and possibly other factors.” *Id.* ¶ 38. “Each ‘active’ MLC, which is an MLC to be transmitted in a given super-frame, is allocated at least one slot,” and “[e]ach active MLC is also ‘assigned’ 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.*

Figure 4 of Vijayan475 is reproduced below.

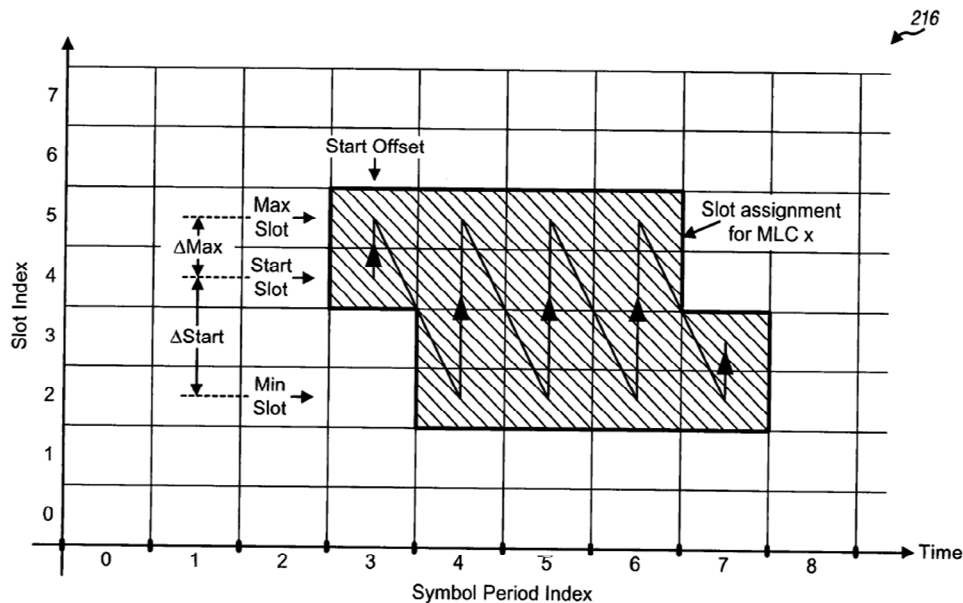


FIG. 4

Figure 4, above, shows an exemplary slot assignment scheme that assigns slots to MLCs using a “sinusoidal” or “zigzag” pattern. Ex. 1006 ¶¶ 18, 39. In the illustrated assignment scheme, “a frame is divided into one or more ‘strips’, and each strip spans at least one slot index and further spans a

contiguous number of (e.g., all) symbol periods in the frame.” *Id.* ¶ 39. Each active MLC is mapped to one strip and is assigned slots in that strip. *Id.* For example, the slots in each strip may be assigned to the MLCs in a specific order using a vertical zigzag pattern that “selects slots from the lowest slot index for the strip to the highest slot index for the strip, one symbol period at a time, starting with the first symbol period for the strip.” *Id.* Figure 4 also shows the assignment of slots to a given MLC x for one frame 216. *Id.* ¶ 40. In particular, Vijayan475 explains,

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.

Id. Vijayan475 further explains that “slot information may be encoded to reduce the number of bits needed to convey th[e] information.” *Id.* ¶ 46.

2. Wu

Wu, titled “System and Method for Embedding OFDM in CDMA Systems,” relates to single and multi-carrier CDMA systems and methods and to methods of providing increased capacity to such systems and methods. Ex. 1008, code (54), ¶ 2. Wu describes, *inter alia*, a system comprising a transmitter in combination with a plurality of receivers, at least one of which is OFDM-capable. *Id.* ¶ 26. According to Wu, the transmitter may be adapted to transmit, for example, a downlink signal that may include an OFDM packet channel divided into OFDM slots and a control channel that identifies to receivers which OFDM slots are for a given receiver to

use and “identifiers for each receiver scheduled during the slot and an indication of which sub-carriers are for which receiver.” *Id.* ¶¶ 7, 20, 21, 33, 34. The user equipment (UE) receiver then demodulates the “OFDM slot only if scheduled during the slot.” *Id.* ¶¶ 25, 50. To implement the disclosed features, Wu in certain embodiments describes transmitting a “supplementary high speed shared control channel” (HS-SCCH) that is used to transmit information that allow receivers to determine where their content has been transmitted in the downlink structure. *Id.* ¶ 94. Among other information, the supplementary HS-SCCH may include a UE identifier (“sixteen bit UE identifier 165”) that “identifies which receiver is to receive the current [high speed data packet access] HSDPA content.” *Id.* ¶¶ 94, 98, Fig. 4.

3. Independent Claim 1

a. Petitioner’s Contentions

Petitioner contends that claim 1 is unpatentable over Vijayan⁴⁷⁵ and Wu. Pet. 63–83. With reference to the asserted combination, Petitioner argues that “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,” while “Wu discloses a user equipment (UE) identifier to specifically designate a wireless device to receive allocated transmissions.” *Id.* at 60–61 (citing Ex. 1003 ¶¶ 190–191, Ex. 1006 ¶¶ 36–42; Ex. 1008 ¶¶ 33, 34, 92, 94, 98). Petitioner further contends that a person of ordinary skill in the art “would have found it obvious and would have been motivated to combine Vijayan⁴⁷⁵ and Wu to also provide [Wu’s] capability” in Vijayan⁴⁷⁵’s system. *Id.* at 61 (citing Ex. 1003 ¶¶ 192–199).

i. Preamble

With respect specifically to the preamble of claim 1, Petitioner contends that Vijayan475 describes the same operating method and wireless network recited in claim 1. Pet. 63 (citing Ex. 1003 ¶¶ 200–214). First, Petitioner alleges, Vijayan475 discloses “a wireless network comprising at least a base station and a mobile station,” pointing to Vijayan475’s “wireless multi-carrier broadcast system 100” that includes “base stations 110” and “wireless devices 120.” *Id.* at 64 (citing Ex. 1003 ¶¶ 201–203; Ex. 1006 ¶¶ 26–27). Petitioner cites Figures 8 and 9 of Vijayan475 as depicting a base station and wireless device, respectively, further noting that “Vijayan089 also states that the ‘wireless device’ may refer to a ‘mobile station’” and that “Vijayan475’s base stations and mobile stations communicate wirelessly to disclose the claimed ‘wireless network’ as depicted in Figure 1.” *Id.* at 46–66 (citing Ex. 1003 ¶¶ 201–203; Ex. 1006 ¶¶ 26, 67–75, Figs. 8, 9).

Second, Petitioner contends, Vijayan475 discloses “employing a frame structure of multiple frames for transmission,” citing Vijayan475’s “super-frame 210” that “includes multiple frames for transmission of OFDM signals,” such as the exemplary frame depicted in Figure 4. Pet. 66–67 (citing Ex. 1003 ¶¶ 204–208; Ex. 1006, code (57), ¶¶ 10, 12, 29–32, 37–42, 45, 56–59, Fig. 4). Petitioner contends Vijayan475 “also describes using time-frequency ‘slots’ within the super-frame structure to transmit data” and “describes allocating a ‘fixed or variable number of slots in each super-frame’ for a multiplexed logical channel (MLC) segment.” *Id.* at 67 (citing Ex. 1006 ¶¶ 36–41, 45–49, 57).

Finally, Petitioner contends that 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,” pointing to Figure 4 and corresponding text of Vijayan475, illustrating and describing “the assignment of slots to a given MLC x for one frame 216.” Pet. 67–68 (citing Ex. 1003 ¶¶ 209–214; Ex. 1006, ¶¶ 39–42, Fig. 4). Petitioner argues Vijayan475 “discloses each time interval comprising a plurality of OFDM symbols” and “describes OFDM communications provided on the subbands within each slot.” *Id.* at 69 (citing Ex. 1003 ¶¶ 211–213; Ex. 1006 ¶¶ 25, 69–71). Further, Petitioner contends, “[e]ach slot within the time interval has a duration of one OFDM ‘symbol period’ as seen in Figure 4,” where “the time interval spanning Symbol Period Indices 3-7 includes five OFDM symbols.” *Id.* (citing Ex. 1003 ¶¶ 211–213; Ex. 1006 ¶¶ 36, 39–42, Fig. 4). Thus, Petitioner asserts, “each time interval comprises a plurality of OFDM symbols.” *Id.* Further, Petitioner argues, “Vijayan475 also discloses ‘each OFDM symbol containing a plurality of frequency subcarriers’ as claimed,” as Vijayan475 states that “[m]ultiple carriers may be provided by orthogonal frequency division multiplexing (OFDM)” and that “OFDM effectively partitions the overall system bandwidth into multiple (N) orthogonal subbands” or “subcarriers.” *Id.* (emphasis omitted) (quoting Ex. 1006 ¶ 25) (citing Ex. 1006 ¶¶ 25, 26).

ii. “assigning an identifier to the mobile station”

Petitioner argues that Vijayan475 renders obvious the step of “assigning an identifier to the mobile station,” as recited in claim 1. Pet. 69–70 (citing Ex. 1003 ¶¶ 215–218; Ex. 1006 ¶¶ 5–9, 25, 26, 37–42, 44, 62). In support of this argument, Petitioner points out that “Vijayan475 allocates transmission units or ‘slots’ for a ‘unicast transmission [that] is sent to a specific wireless device.’” *Id.* (citing Ex. 1006 ¶¶ 5, 25). Petitioner

contends that a person of ordinary skill in the art “would have found it obvious to assign an identifier to the specific wireless device especially to provide unicast transmissions,” and to “allow the wireless device to discern its own intended data streams and ‘quickly find and extract’ or recover ‘individual data streams of interest.’” *Id.* at 70 (citing Ex. 1003 ¶ 215–218; Ex. 1006 ¶¶ 5–9, 25, 26, 37–42, 44, 62). Otherwise, Petitioner contends, “it would be more difficult for each wireless device to discern its own respective data stream for recovery.” *Id.* (citing Ex. 1003 ¶ 215–218).

In the alternative, Petitioner contends that Wu explicitly discloses the recited “assigning” step, citing Wu’s disclosure of a base station assigning a UE identifier to a mobile device via a control channel in an OFDM system. Pet. 70–72 (citing Ex. 1003 ¶¶ 219–222; Ex. 1008, code (57), ¶¶ 4, 20, 21, 25, 32–34, 50, 87, 92, 94, 98, 128–134, Fig. 2). Citing Dr. Wilson’s testimony, Petitioner argues that a person of ordinary skill in the art would have been motivated to combine Vijayan⁴⁷⁵ and Wu to implement Wu’s assignment of a UE identifier with Vijayan⁴⁷⁵’s OFDM communication system for several reasons. Pet. 61–63 (citing Ex. 1003 ¶¶ 192–199). First, Petitioner contends, related to its argument discussed above that Vijayan⁴⁷⁵ itself renders the “assigning” step obvious, a person of ordinary skill in the art would have used an identifier to specifically identify a wireless device, in order to implement Vijayan⁴⁷⁵’s disclosure of “unicast communications” or to communicate data to a specific wireless device. *Id.* at 61 (citing Ex. 1003 ¶¶ 192–199; Ex. 1006 ¶¶ 5, 25, 26). While conceding that “Vijayan⁴⁷⁵ does not explicitly discuss types of identifiers or how to implement such identifiers,” Petitioner argues that a person of ordinary skill in the art “would have therefore sought references that taught techniques for implementing

wireless device identifiers,” and that “Wu is such a reference.” *Id.* at 62 (citing Ex. 1003 ¶¶ 192–199; Ex. 1008 ¶¶ 32–34, 87, 92, 94, 98).

Petitioner further contends that a person of ordinary skill in the art would have been motivated to combine Wu’s UE identifier with Vijayan475 to allow its wireless devices to differentiate and identify its own slot allocation and respective messages for reception. Pet. 62 (citing Ex. 1006 ¶¶ 5, 25–26, 44; Ex. 1008 ¶¶ 33–34, 87, 92, 94, 98). Thus, Petitioner argues, “combining Wu with Vijayan475 would have improved the functionality of Vijayan475’s wireless devices by providing a simple process for discerning resource allocation slots.” *Id.* (citing Ex. 1003 ¶¶ 194–195). Moreover, Petitioner contends, “[c]ombining Vijayan475 and Wu would have amounted to combining well-known prior art elements to yield predictable results,” as “[a]ssigning a wireless device identifier was a well-known technique in the prior art used to allow a mobile device to discern its own intended resource allocation,” and “[i]n view of this ubiquitous usage, a POSITA would have had a reasonable expectation of success in combining Vijayan475 and Wu to facilitate wireless transmissions.” *Id.* at 62–63 (citing Ex. 1003 ¶¶ 196–199; Ex. 1006 ¶¶ 25–27, 36, 39–42, 67–75, Figs. 1, 8, 9; Ex. 1008 ¶¶ 101, 134, 137, Fig. 6). Finally, Petitioner contends, “[t]his combination would have been predictable and would have operated to perform its intended purposes in view of [the references’] common OFDM configuration and assignment of OFDM slots.” *Id.* at 63 (citing Ex. 1003 ¶¶ 196–199). According to Petitioner, “[t]he combined system would have used the UE identifier to specify the resource allocation parameters (e.g., Vijayan475’s slot allocation parameters and/or stream lengths) for a particular wireless device,” which Vijayan475 would have used to identify its assigned transmission slots to receive and recover the corresponding

data.” *Id.* (citing Ex. 1003 ¶¶ 195–199; Ex. 1006 ¶¶ 9–12, 38, 42–55, 62, 64).

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

Petitioner argues that Vijayan475 discloses transmitting a signal “from the base station to the mobile station over a segment of time-frequency resource,” as recited in claim 1, citing disclosure in Vijayan475 defining a “segment” using a “starting time-frequency coordinate” and N time-frequency resource units in the form of encoded starting “slot information” and “stream length” parameters. Pet. 72 (citing Ex. 1003 ¶¶ 223–241; Ex. 1006 ¶¶ 38–42, 45–55). Petitioner contends that Vijayan475 describes the same base station and mobile station configuration described in claim 1, with Vijayan475’s base station transmitting “multiple [OFDM] data streams on multiple data channels’ which may be recovered by wireless devices,” and Vijayan475’s wireless device then “receiv[ing] the modulated signal’ and identif[ying] the transmitted OFDM symbols.” *Id.* at 73 (citing Ex. 1003 ¶¶ 224–227; Ex. 1006, code (57), ¶¶ 9, 60, 69, 71–73). Petitioner further contends,

Vijayan475’s base station also transmits the OFDM symbol information “over a segment of time-frequency resources” as claimed. [Ex. 1006], FIG. 4, ¶¶36-42. Vijayan475 describes transmitting data over “slots,” which disclose the claimed “time-frequency resource.” *Id.* “M slots are formed in each symbol period and are mapped to M disjoint or non-overlapping sets of subbands, where $M \geq 1$.” *Id.*, ¶36. Therefore, each slot is a resource having a time component (symbol period) and frequency component (subband). EX1003, ¶225.

Id. Petitioner maps “MLC x” in Vijayan475’s Figure 4 to the recited “segment of time-frequency resource,” citing Vijayan475’s disclosure that

the term MLC refers to a “multiplexed logical channel” segment that is assigned one or more slots to carry “one or more data streams.” *Id.* at 73–74 (citing Ex. 1003 ¶ 225; Ex. 1006 ¶¶ 9, 27, 28, 40, 51, 52). Petitioner contends that “[t]his assignment of ‘slots’ in the time-frequency plane discloses the claimed ‘segment of time-frequency resource[.]’” *Id.* at 74 (citing Ex. 1003 ¶¶ 226, 227; Ex. 1006 ¶¶ 27, 28, 36–42, 45).

- iv. *“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”*

Citing Vijayan475’s definition of a segment using a “Start Offset” and “Slot Info” parameters corresponding to the “Start Slot” and “the number of slots allocated to the MLC,” Petitioner contends that “Vijayan475’s ‘Start Offset’ and ‘Slot Info’ parameters collectively identify a starting time-frequency coordinate,” while “Vijayan475’s Stream Lengths parameter identifying the number of slots in the segment . . . discloses the claimed N time-frequency resource units.” Pet. 75–77, 79 (citing Ex. 1003 ¶¶ 228–238; Ex. 1006 ¶¶ 36–42, 45 (Table 1), 45–49, 51, 52, 54–57, Fig. 4).

Petitioner further contends that “Vijayan475 also discloses a second way to convey [starting time-frequency coordinate] information to reduce overhead signaling,” citing disclosure in Vijayan475 that “slot information may be encoded to reduce the number of bits needed to convey this information,” using “ Δ Start” and “ Δ Max” parameters. Pet. 77 (quoting Ex. 1006 ¶ 46) (citing Ex. 1003 ¶¶ 231–234; Ex. 1006 ¶¶ 40, 42, 46–49). Petitioner argues that “Vijayan475 encodes these parameters as shown in Table 2,” and “the simple ‘Slot Info Code’ transmitted by a base station conveys the Min Slot, Δ Start, and Δ Max parameters to the wireless device”

for derivation of the starting time-frequency coordinate. *Id.* at 78 (citing Ex. 1003 ¶¶ 232–234; Ex. 1006 ¶¶ 45–49, 48 (Table 2), Fig. 4).

Lastly, Petitioner contends that “Vijayan475 also discloses or otherwise renders obvious a segment having N time-frequency resources units within a time interval where $N=2, 4, \text{ or } 8$.” Pet. 79 (citing Ex. 1003 ¶¶ 237, 238). For example, Petitioner argues, a person of ordinary skill in the art would have understood from Vijayan475’s disclosure of each MLC being assigned “M slots . . . where $M \geq 1$ ” that M could equal 2, 4, or 8 slots and that using 2, 4, or 8 slots for a segment would beneficially utilize less overhead signaling.” *Id.* (citing Ex. 1003 ¶¶ 237, 238; Ex. 1006 ¶¶ 36, 38). Moreover, Petitioner asserts, it would have been a simple design choice for a person of ordinary skill in the art to use any number of slots between one and sixteen (as assigned to MLC x in Figure 4 of Vijayan475) to convey an MLC segment. *Id.* at 79–80 (citing Ex. 1003 ¶¶ 237, 238; Ex. 1006, ¶¶ 36, 38, 40, Fig. 4).

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

Petitioner maps Vijayan475’s “slot” to the recited “unit,” as discussed above, and maps the “M disjoint or non-overlapping sets of subbands” in each symbol period to the recited “set of frequency subcarriers.” Pet. 80 (citing Ex. 1003 ¶¶ 239–241; Ex. 1006 ¶¶ 25, 36). Petitioner further contends, “Vijayan475 conveys data using OFDM symbols, which also use sets of subcarriers,” and “[w]hen transmitting OFDM symbols, multiple carriers or ‘multiple [] orthogonal subbands’ are used.” *Id.* (citing Ex. 1006 ¶¶ 25, 36, 69–71, Fig. 4). Thus, Petitioner argues, “Vijayan475 discloses each slot including a set of frequency subcarriers in a group of OFDM

symbols.” *Id.* (citing Ex. 1003 ¶¶ 239–241; Ex. 1006 ¶¶ 25, 36, 69–71, Fig. 4).

vi. *“receiving by the mobile station the transmitted signal”*

Petitioner contends that “Vijayan475 discloses a wireless device (*i.e.*, the claimed ‘mobile station’) receiving transmitted information signals from a base station.” Pet. 80–81 (citing Ex. 1006 ¶¶ 71–73, Fig. 9). In particular, Petitioner cites Vijayan475’s disclosure of “wireless device 120x” including, *inter alia*, “antenna 912,” “receiver unit 914,” and “OFDM demodulator 916,” where “antenna 912 receives the modulated signal transmitted by base station 110x and provides a received signal to . . . receiver unit (RCVR) 914,” “[r]eceiver unit 914 conditions, digitizes, and processes the received signal,” and “OFDM demodulator 916 . . . extract[s] the data and overhead symbols.” *Id.* at 81 (quoting Ex. 1006 ¶ 71). Thus, Petitioner argues, “these components receive the signal transmitted from the base station corresponding to the MLC segments with corresponding slot assignments.” *Id.* (citing Ex. 1003 ¶¶ 242–244; Ex. 1006 ¶¶ 36, 38–55).

vii. *“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”*

Petitioner contends that Vijayan475’s wireless device using receiver unit 914 and OFDM demodulator 916 recovers data from the received OFDM signal based on the starting time-frequency coordinate and N time-frequency resource units. Pet. 82 (citing Ex. 1003 ¶¶ 245–247; Ex. 1006 ¶¶ 71–73, Fig. 9). Further, Petitioner argues, “controller 940” and “RX data processor 930” of Vijayan475’s wireless device 120x “also recover the relevant information by identifying ‘one or more MLCs’ and the

corresponding ‘slot assignment for each selected MLC,’” and “RX data processor 930 then ‘processes each detected data symbol stream for each MLC of interest.’” *Id.* (citing Ex. 1006 ¶ 72). More particularly, according to Petitioner, “Vijayan475 recovers MLC segments using overhead signaling information” that “conveys a starting time-frequency coordinate and a number of slots (‘N-value’) using Start Offset, Slot Info, and Stream Length parameters.” *Id.* (citing Ex. 1006 ¶¶ 40, 42, 44–47, 56). With these parameters, Petitioner contends, “the wireless device determines the ‘time-frequency location of each MLC’ and recovers the corresponding information.” *Id.* (citing Ex. 1003 ¶¶ 245–248; Ex. 1006, code (57), ¶¶ 9, 10, 40, 42, 44–55, 60).

Still further, Petitioner argues that a person of ordinary skill in the art “would have also found it obvious and would have been motivated to implement the identifier described in Wu with Vijayan475’s system.” Pet. 82 (citing Ex. 1003 ¶¶ 248–251). As in connection with the “assigning” step discussed above, Petitioner contends that, in view of Vijayan475’s “unicast transmissions,” a person of ordinary skill in the art would have implemented Wu’s UE identifier to allow a wireless device to identify its own allocation parameters from those intended for other wireless devices. *Id.* at 83 (citing Ex. 1006 ¶¶ 5, 25, 26; Ex. 1008, code (57), ¶¶ 32–34, 87, 94, 98). Petitioner contends that “[t]his identifier would have been provided to the particular wireless device to allow recovery of the MLC segment and therefore would have also corresponded to the wireless device’s Start Offset, Slot Info, and Stream Length parameters.” *Id.* at 82–83 (citing Ex. 1003 ¶¶ 248–251; Ex. 1006 ¶¶ 5, 25, 26, 42, 45–55; Ex. 1008 ¶¶ 33, 34, 87, 92, 94, 98). Using the identifier and these parameters, Petitioner asserts, “the receiver would determine whether to recover data from a transmitted OFDM

signal based on ‘whether or not the receiver is scheduled during the slot.’”
Id. at 83 (citing Ex. 1003 ¶ 251; Ex. 1008 ¶¶ 25, 50, 100).

b. Patent Owner’s Contentions

i. “starting time-frequency coordinate”

In response to Petitioner’s contentions, Patent Owner argues, first, that the combination of Vijayan475 and Wu fails to teach or render obvious the “starting time-frequency coordinate” recited in each of the challenged independent claims. Prelim. Resp. 8. Rather, Patent Owner contends, “Vijayan475 specifies the start of its slot with two parameters – the start offset, which acts as a starting time coordinate, and the slot info, which specifies the starting frequency coordinate.” *Id.*

As detailed above in the discussion of Patent Owner’s contentions regarding the asserted Vijayan089-Laroia ground (*see supra* § III.E.3.b), Patent Owner contends that the ’450 patent distinguishes a prior art allocation scheme in which both a “start symbol offset” and a “start logical subchannel offset” were needed to specify the start of the time/frequency region; that “[i]t is . . . undisputed that the ‘starting time-frequency coordinate’ must have a single dimension covering both time and frequency”; and that “[a]ny reference that uses both a starting time coordinate and a separate starting frequency coordinate does not have a one-dimensional coordinate in both time and frequency.” Prelim. Resp. 9–10 (emphasis omitted) (citing Ex. 2001 ¶ 57; Ex. 2004, 5; Ex. 2006, 2).

Against this backdrop, Patent Owner argues that both Petitioner’s reading of Vijayan475’s “Start Offset” and “Slot Info” and its reading of Vijayan475’s “ Δ Start” and “ Δ Max” parameters along with the Min Slot parameter as identifying the recited “starting time-frequency coordinate” are flawed. Prelim. Resp. 18–19 (citing Pet. 76–77). In Patent Owner’s view,

“[e]ach of these reads attempts to artificially combine multiple parameters in different dimensions into the single claimed ‘starting time-frequency coordinate.’” *Id.* at 19. Patent Owner contends that “Vijayan475 does indeed identify multiple ways to assign its slots (the alleged ‘time-frequency resource’) to a given MLC,” including a “rectangular slot pattern” and a “zigzag pattern,” but that, as explained by Mr. Alberth, each uses separate parameters to convey where the MLC should start in the time domain (i.e., “slot symbol period” or “Start Offset”) and where the MLC should begin in the frequency domain (i.e., “slot index” or “Slot Info”). *Id.* at 19–24 (citing Ex. 1006 ¶¶ 40, 42, 45 (Table 1), Fig. 4; Ex. 2001 ¶¶ 60–62). In this regard, Patent Owner argues, Vijayan475 “is therefore not materially different from [the prior art IEEE] 802.16 [standard described] in the ’450 [patent]’s background, the 802.16-Kim combination rejected in the [IPR2021]-1486 IPR, and Vijayan089 above,” as “[a]ll of these systems use one parameter for a starting time coordinate and a different parameter for a starting frequency coordinate” and “do not disclose or render obvious the claimed single ‘starting time-frequency coordinate.’” *Id.* at 24.

Regarding Petitioner’s contention that Vijayan475 also discloses a second way to convey starting time-frequency coordinate information, using encoding “to reduce the number of bits needed to convey this information,” Patent Owner argues that such encoding “does not convert Vijayan475’s starting time coordinate and separate string frequency coordinate into the claimed ‘starting time-frequency coordinate,’” but rather “[i]t continues to use Start Offset as starting time coordinate” and uses different parameters in the frequency dimension.” Prelim. Resp. 24–26 (citing Ex. 1006 ¶¶ 45 (Table 1), 46–54, 56, 58, Fig. 5; Ex. 2001 ¶¶ 63–65). Further, according to Patent Owner, although Vijayan475’s encoding “reduces the number of bits

that needs to be transmitted to convey the zigzag shape from nine to seven,” “this is still more than the three bits that would have been needed to convey the starting frequency coordinate using 802.16.” *Id.* (citing Ex. 1006 ¶ 49; Ex. 2001 ¶ 63). Still further, Patent Owner contends, Vijayan475’s “Slot Info Code does not directly indicate the Start Slot, but it does allow Vijayan475’s wireless device to determine the starting location of the MLC is the frequency dimension,” and “[t]hus it ‘is itself a starting frequency coordinate.’” *Id.* at 27 (quoting Ex. 2001 ¶ 65). Thus, Patent Owner concludes, “Vijayan475 never uses the claimed ‘starting time-frequency coordinate’ with only one dimension but rather consistently uses **both** a starting time coordinate **and** a starting frequency coordinate.” *Id.*

ii. *“N time-frequency resource units . . . containing a set of frequency subcarriers in a group of OFDM symbols”*

Patent Owner additionally argues that “[t]he Petition’s argument for Vijayan475 is even weaker” than its argument for Vijayan089 “as it does not even attempt to show that the alleged ‘time-frequency resource unit’ is in multiple OFDM symbols,” and “[i]n fact, the alleged ‘time-frequency resource unit’ . . . covers only a **single** OFDM symbol.” Prelim. Resp. 29.

As detailed above in the discussion of Patent Owner’s contentions regarding the asserted Vijayan089-Laroia ground (*see supra* § III.E.3.b), Patent Owner contends that “[o]ne of the key features of the [recited] time-frequency resource unit is that it has multiple symbols,” allowing for a reduction in “the amount of control overhead but at the cost of flexibility.” Prelim. Resp. 30–32 (citing Ex. 1001, 6:49–50, Table 1; Ex. 2001 ¶¶ 30, 68). Patent Owner contends that, “[a]s with the Vijayan089, the Petition initially identified Vijayan475’s ‘symbol period’ as the alleged ‘OFDM symbol,’”

but “in the section attempting to show that the alleged ‘each unit containing a set of frequency subcarriers in a group of OFDM symbols’ the Petition makes no attempt to show that the slot spans multiple of the symbol periods.” *Id.* at 41–42 (citing Pet. 69, 80). According to Patent Owner, “[t]he Petition fails to explain how the fact that multiple slots of the MLC convey OFDM symbols has any bearing on whether each individual slot ‘contain[s] a set of frequency subcarriers in a group of OFDM symbols,’ as claimed.” *Id.* at 42. In Patent Owner’s view, “Vijayan475 is clear that, in the embodiment relied upon by the Petition, while each slot can cover multiple subcarriers, it is limited to one ‘symbol period.’” *Id.* at 43. Focusing on the 16 slots corresponding to MLC x in Vijayan475’s Figure 4, Patent Owner contends that “it is clear that every single one of these slots occupies **only one** symbol period.” *Id.* at 44–45 (citing Ex. 1006, Fig. 4; Ex. 2001 ¶ 72). Thus, Patent Owner concludes, “it is clear that the embodiment relied upon by Petitioner in Vijayan475 does not teach or render obvious a ‘time-frequency resource units . . . each unit . . . in **a group** of OFDM symbols’ as required by the claims.” *Id.* at 45.

c. Discussion

On the preliminary record before us, we are persuaded that Petitioner has articulated reasoning with rational underpinning to support combining the teachings of Vijayan475 and Wu and has shown a reasonable likelihood that it will prevail in showing that claim 1 is unpatentable over the combination.

Despite Patent Owner’s arguments that Vijayan475 fails to teach a “starting time-frequency coordinate” (Prelim. Resp. 1, 8–10, 18–28), we are sufficiently persuaded on the preliminary record before us that at least Vijayan475’s disclosure of encoding slot information to convey “ Δ Start,”

“ΔMax,” and “Min Slot” parameters as a single “slot info code” teaches the recited “starting time-frequency coordinate” (*see* Pet. 77–79 (citing Ex. 1003 ¶¶ 232–234; Ex. 1006 ¶¶ 40, 42, 46–49, 48 (Table 2), 56). The fact that Vijayan475’s wireless device *subsequently* may derive separate starting time and starting frequency coordinates from the slot info code does not negate the fact that the slot info code appears on the preliminary record to be a singular coordinate. *Cf.* Prelim. Resp. 25–27. Moreover, we are not persuaded otherwise by Patent Owner’s contention that Vijayan475’s slot info code would use “more . . . bits tha[n] would have been needed to convey the starting frequency coordinate” using the IEEE 802.16 prior art standard discussed in the Background section of the ’450 patent. *Id.* at 24–25 (citing Ex. 2001 ¶ 46). First, we understand the slot info code to convey not only “the starting frequency coordinate,” as in Patent Owner’s comparison, but also the “starting time-frequency coordinate.” Second, notwithstanding that a stated goal of the ’450 patent is to reduce overhead signaling, the claims do not recite any specific number of bits that may be employed for such signaling.

Regarding Patent Owner’s arguments that Vijayan475 does not teach or suggest the limitation of “each unit containing a set of frequency subcarriers in a group of OFDM symbols” (Prelim. Resp. 29–32, 41–45), we also find Petitioner’s contentions with respect to that limitation sufficient on the preliminary record, for essentially the same reasons as set forth in the discussion of the asserted ground based on Vijayan089 and Laroia (*see supra* § III.E.3.c). In particular, Patent Owner’s arguments appear to present an issue of claim construction that is underdeveloped on the preliminary record before us, and the parties are accordingly advised to address the

proper construction of the relevant limitation in their briefing in the course of trial.

4. Independent Claims 7 and 13

Petitioner refers back to its arguments for claim 1 for all limitations of claims 7 and 13. Pet. 83–86. With respect to the recitations in claims 7 and 13 of the mobile device and base station, respectively, operating in a “wireless packet system,” Petitioner further contends that Vijayan475 describes communications using “packets,” citing disclosure in Vijayan475 that 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” and Vijayan475’s disclosure of the use of MAC packets to transmit data and definition of Stream Length based on the length of a “stream layer packet.” *Id.* at 84 (citing Ex. 1006 ¶¶ 28, 32–35, 45, 50–54), 86 (same). Petitioner additionally contends that “Vijayan475 depicts base station cells in Figure 1 and a wireless device [as] a ‘cellular phone,’” thus teaching that the mobile device operates within a cell serviced by a base station, as further recited in claims 7 and 13. *Id.* (citing Ex. 1006 ¶¶ 26–28, Fig. 1).

Patent Owner relies on the same arguments for claims 7 and 13 as for claim 1. *See* Prelim. Resp. 8–12, 18–32, 41–45. For the reasons discussed in Section III.F.3 above with respect to claim 1, and based on Petitioner’s further arguments addressing the packet and cell-based limitations of claims 7 and 13, we conclude that Petitioner shows a reasonable likelihood of prevailing with respect to both claims.

5. Dependent Claims 2–5, 8–11, and 14–17

For dependent claims 2–5, 8–11, and 14–17, Petitioner argues with citations to Vijayan475 and Dr. Wilson’s testimony that Vijayan475 teaches each of the claims’ additional limitations. Pet. 86–91. Patent Owner does

not provide any arguments specifically for any of the challenged dependent claims, but relies only on the arguments presented for the independent claims. *See* Prelim. Resp. 8–12, 18–32, 41–45.

Based on the arguments presented and the evidence cited in the Petition, Petitioner shows a reasonable likelihood of prevailing on each of claims 2–5, 7–11, and 13–17 in its challenge based on Vijayan475 and Wu.

6. Conclusion

Petitioner has shown a reasonable likelihood that it will prevail in showing that claims 1–5, 7–11, and 13–17 would have been obvious over Vijayan475 and Wu.

G. Obviousness of Claims 6, 12, and 18 over Vijayan089, Laroia, and Choi or over Vijayan475, Wu, and Choi

Petitioner alleges claims 6, 12, and 18 would have been obvious, either over Vijayan089, Laroia, and Choi or over Vijayan475, Wu, and Choi, relying in part on Dr. Wilson’s Declaration. Pet. 91–94 (citing Ex. 1003 ¶¶ 275–291).

We begin our analysis with an overview of Choi, and we then address the parties’ contentions with respect to the challenged claims.

1. Choi

Choi, titled “Repetition Coding for a Wireless System,” relates generally to a data transmission scheme for a wireless communication system in which data transmission may be enhanced by “repetition encoding,” including in the context of systems using OFDM. Ex. 1009, codes (54), (57), ¶¶ 1, 13. Choi explains:

An OFDM symbol includes 48 values that are transmitted on different subchannels. To provide extended range, each value that is sent is repeated several times by the transmitter. In one embodiment, the bits are convolutionally encoded using the same

encoding scheme as the encoding scheme specified for the IEEE 802.11a/g standard. Each encoded value is repeated and transmitted. Preferably, the values are repeated in the frequency domain, but the values may also be repeated in the time domain. In some embodiments, the repetition coding is implemented before interleaving and a specially designed interleaver is used to handle repeated values. In addition, a pseudorandom code may be superimposed on the OFDM symbols to lower the peak to average ratio of the transmitted signal.

Id. ¶ 13. Choi further explains that “[f]or 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.” *Id.* ¶ 16. According to Choi, “[t]his scheme has an advantage in efficiency since just one guard interval is required for r-repeated OFDM symbols in the time domain.” *Id.* In contrast, Choi explains, repetition of OFDM symbols in the frequency domain requires insertion of a guard interval between every OFDM symbol in the time-domain, because OFDM symbols with frequency-domain repetition are not periodic. *Id.* ¶ 18. Nonetheless, Choi explains, “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.*

2. Dependent Claims 6, 12, and 18

Claims 6, 12, and 18 depend from claims 5, 11, and 17, respectively, and each recites “wherein a repetition coding is further applied to the time-frequency [sic] resource.” Ex. 1001, 13:13–14, 14:4–6, 14:39–41. Petitioner argues that “[t]he ’450 patent does not provide any special definition for ‘repetition coding,’ but states that ‘[t]hose skilled in the art will appreciate that coding and signal repetition can be combined to provide lower coding rates,” and Petitioner contends that a person of ordinary skill in

the art “would have therefore recognized ‘repetition coding’ as referring to a simple and well-known technique where information bits are repeated.” Pet. 91–92 (emphasis omitted) (quoting Ex. 1001, 6:58–62) (citing Ex. 1003 ¶¶ 275–279). Petitioner further contends that “Choi confirms that it would have been obvious to apply repetition coding to time-frequency resource units.” *Id.* at 92 (citing Ex. 1003 ¶¶ 280–281). In particular, Petitioner argues, “Choi describes ‘enhancing the transmission of the data by further repetition encoding the data’ to improve ‘error correction’ and provide a ‘more robust data transmission scheme at reduced data rates’” and “applies this repetition coding to OFDM symbols” “in both the time and/or frequency domains.” *Id.* (citing Ex. 1003 ¶¶ 280–281; Ex. 1009, code (57), ¶¶ 2, 13, 16–18, 51).

According to Petitioner, one of ordinary skill in the art would have been motivated to combine Choi with either Vijayan089 and Laroia or Vijayan475 and Wu to provide error correction and more robust data transmission, as taught by Choi. Pet. 92–93 (citing Ex. 1003 ¶¶ 182–284, 288–289; Ex. 1009, 2). Petitioner contends that Vijayan089 and Vijayan475 both acknowledge that repeating portions of signals was a well-known technique and both also explicitly use redundancy, either to provide “forward error correction coding,” in Vijayan089, or to improve the reception of signals, in Vijayan475. *Id.* (citing Ex. 1005 ¶¶ 39, 83, 101, 114, 118; Ex. 1006 ¶ 64). Petitioner contends that Choi’s repetition coding would have furthered these goals and would have alleviated errors in OFDM systems. *Id.* (citing Ex. 1003 ¶¶ 288–289; Ex. 1009 ¶¶ 16–18, 22–24, 45). A person of ordinary skill in the art would therefore have applied Choi’s repetition coding to Vijayan089’s time-frequency units or to Vijayan475’s time-frequency slots and would have also had a reasonable expectation of

success in doing so in view of their common OFDM usage. *Id.* at 92–94 (citing Ex. 1003 ¶¶ 282–284, 288–291; Ex. 1005 ¶ 39, 83, 101, 114, 118; Ex. 1006 ¶¶ 36–42, 45–49, 57; Ex. 1009 ¶¶ 16–18, 22–24, 45).

Patent Owner does not provide arguments specifically for claims 6, 12, and 18 but instead relies on its arguments for the independent claims from which they depend. *See* Prelim. Resp. 8–48.

Based on the arguments presented and the evidence cited in the Petition, we are persuaded that Petitioner has articulated reasoning with rational underpinning to support combining the teachings of Choi with either Vijayan089 and Laroia or Vijayan475 and Wu and has shown a reasonable likelihood that it will prevail in showing that each of claims 6, 12, and 18 in its challenges based on those combinations.

IV. CONCLUSION

For the foregoing reasons, Petitioner has demonstrated a reasonable likelihood that it will prevail in showing that claims 1–18 of the ’450 patent are unpatentable, and we institute an *inter partes* review of the ’450 patent on all asserted grounds. *See* 37 C.F.R. § 42.108(a).

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review is instituted on all challenged claims with respect to all grounds set forth in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(a), *inter partes* review of the ’450 patent is instituted commencing on the entry date of this Order, and pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4, notice is given of the institution of a trial.

IPR2022-01567
Patent 10,447,450 B2

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