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Paper 35
Entered: January 21, 2016

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ERICSSON INC. AND TELEFONAKTIEBOLAGET
LM ERICSSON,
Petitioner,

v.

INTELLECTUAL VENTURES II LLC,
Patent Owner.

Case IPR2014-01185
Patent 7,269,127 B2

Before JUSTIN BUSCH, PETER P. CHEN, and J. JOHN LEE,
Administrative Patent Judges.

CHEN, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

Ericsson Inc. and Telefonaktiebolaget LM Ericsson ("Petitioner") filed a Petition requesting an *inter partes* review of claims 1–10, 17, 20, 21, 23, and 24 of U.S. Patent No. 7,269,127 (Ex. 1001, "the '127 patent"). Paper 2 ("Pet."). Intellectual Ventures II LLC ("Patent Owner") filed a Preliminary Response. Paper 10 ("Prelim. Resp."). On January 28, 2015, we instituted an *inter partes* review of claims 1–10 and 17, but we did not institute an *inter partes* review of claims 20, 21, 23, and 24. Paper 11 ("Dec. to Inst.").

After institution of trial, Patent Owner filed a Patent Owner Response (Paper 19, "PO Resp."), to which Petitioner filed a Reply (Paper 22, "Pet. Reply"). Patent Owner filed a Motion for Observations on the Cross-Examination of Zygmunt Haas, Ph.D. (Paper 27), to which Petitioner responded (Paper 31). An oral hearing was held on October 21, 2015. The transcript of the consolidated hearing has been entered into the record. Paper 34 ("Tr.").

The Board has statutory authority under 35 U.S.C. § 6(c). In this Final Written Decision, issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73, we determine Petitioner has shown by a preponderance of the evidence that claims 1–10 and 17 of the '127 patent are unpatentable.

A. Related Proceedings

According to Petitioner, the '127 patent is involved in the following district court cases: *Intellectual Ventures I LLC, et al. v. AT&T Mobility*

LLC et al., 1-13-cv-01668 (D. Del.); *Intellectual Ventures I LLC, et al. v. Leap Wireless Int'l et al.*, 1-13-cv-01669 (D. Del.); *Intellectual Ventures I LLC, et al. v. Nextel Operations et al.*, 1-13-cv-01670 (D. Del.); *Intellectual Ventures I LLC, et al. v. T-Mobile USA Inc. et al.*, 1-13-cv-01671 (D. Del.); and *Intellectual Ventures I LLC, et al. v. U.S. Cellular Corp.*, 1-13-cv-01672 (D. Del.).

B. The '127 Patent

The '127 patent is titled, "Preamble Structures for Single-Input, Single-Output (SISO) and Multi-Input, Multi-Output (MIMO) Communication Systems." The subject matter of the challenged claims of the '127 patent relates generally to increased operating efficiency in wireless communication systems, and, in particular, to preamble structures in multi-input, multi-output (MIMO) wireless communication systems with two or more transmit and receive antennas, and single-input, single-output (SISO) wireless systems with one transmit and one receive antenna. Ex. 1001, 1:29–40, 3:21–24. In MIMO wireless communications systems, signals are pre-processed to avoid interference from other signals in common communications channels or paths. *Id*. at 1:54–57. Pre-processing techniques can include using frame structures, which are comprised of preamble structures and data structures. *Id*. at 1:58–63. An efficient preamble structure for use in wireless communications systems should provide for both synchronization of data symbols and estimation of parameters such as noise variance and other parameters. *Id*. at 2:56–62.

Figure 1 of the ’127 patent is reproduced below.

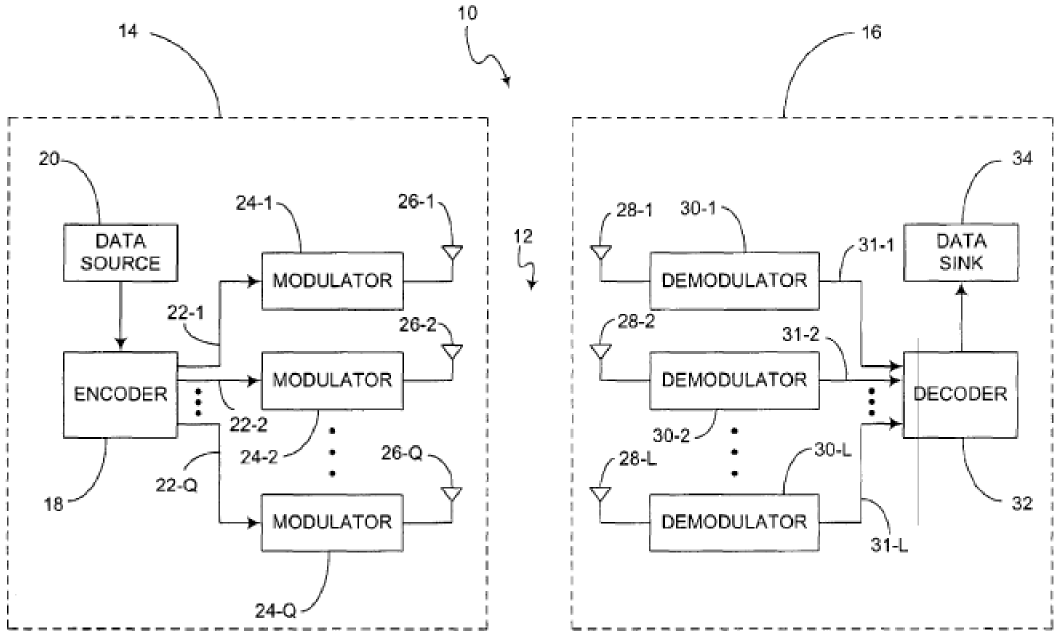

FIG. 1

Figure 1 is a block diagram of exemplary MIMO communication system 10. *Id*. at 4:3–4, 39–40. MIMO system 10 may be implemented as a wireless system for transmission from transmitter 14 across wireless channel 12 to receiver 16. *Id*. at 4:43–46, 5:8–10. Transmitter 14 includes encoder 18, which typically encodes data and/or other types of signals received, for example, from data source 20. *Id*. at 5:13–15.

A MIMO communication system may employ various signal modulation and demodulation techniques, including orthogonal frequency division multiplexing (OFDM). *Id*. at 4:58–62. Modulators 24-1 to 24-Q modulate signals for transmission using, for example, OFDM techniques. *Id*. at 5:31–35. In particular, modulators 24 include an inverse discrete

Fourier transform (IDFT) stage that receives a parallel format of training blocks and data blocks and converts them from the frequency domain to the time domain. *Id*. at 8:1-5. Within the modulator, the converted signals are input to an amplifier and then to transmit antennas 26-1 to 26-Q, which transmit the signals across channel 12. *Id*. at 8:31–34.

Data or information (e.g., voice, video, audio, text) can be transmitted as data symbols organized into data structures. *Id*. at 1:64–2:1. Training symbols are typically added as prefixes to data structures, to enable synchronization between transmitters and receivers of a communications system. *Id*. at 2:10–14. These training symbols can be referred to as preambles and are part of the preamble structures. *Id*. at 2:14–15. The preamble structure can contain an enhanced training symbol, which is divided into sections to perform synchronization and channel parameter estimation functions. *Id.* at 11:2–8.

Pilot symbols "have the same structure as preambles. However, instead of being placed as a prefix to the data structure, the pilot structures are periodically arranged within groups of data symbols." *Id*. at 2:17–22. Figure 2 of the '127 patent is reproduced below.

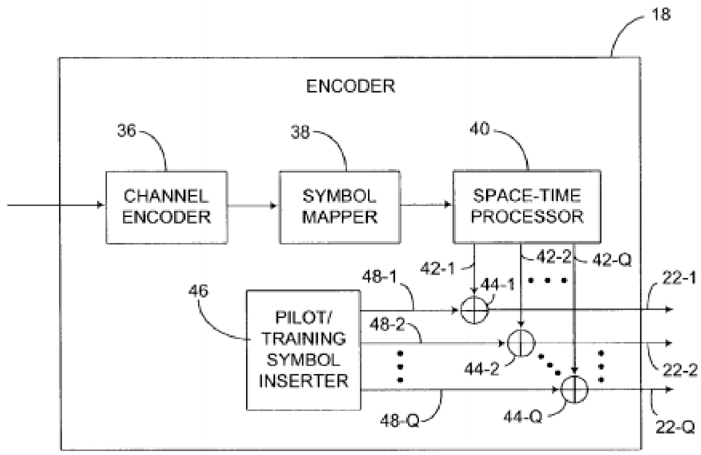

FIG. 2

Figure 2 is a block diagram of encoder 18. *Id*. at 4:5–6. Encoder 18 includes pilot training symbol inserter 46, which "provides pilot blocks and training blocks that are inserted into (or combined with) the data blocks" by adders 44-1 to 44-Q. *Id*. at 7:14–25. The pilot blocks, or pilot symbols, are "transmitted with data blocks to calibrate (i.e., synchronize) the receiver 16 to the transmitter 14 on a small scale." *Id*. at 7:40–42. The specification explains that:

> The term pilot blocks, as used in this description, refers to symbols provided by the pilot/training symbol inserter 46, which are inserted periodically into the data blocks. Typically, pilot symbols may be inserted at any point in the data blocks. The term training blocks refers to one or more continuous sections of symbols provided by the pilot/training symbol inserter 46.

Id. at 7:26–30. Figure 6 of the '127 patent is reproduced below.

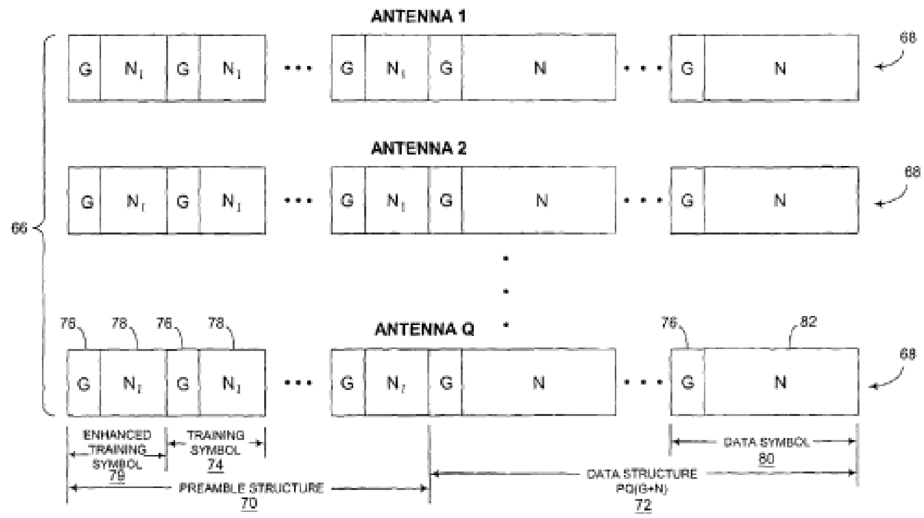

FIG. 6

Figure 6 is a diagram of frame structures 68 in signal structure 66. Ex. 1001, 10:50–55. Each of frame structures 68 includes preamble structure 70 and data structure 72. *Id*. at 10:57–59. Preamble structure 70 includes training symbol 74, and enhanced training symbol 79 located at the beginning of preamble structure 70. *Id*. at 10:62–11:5. Training block 78 of enhanced training symbol 79 is divided into several sections, for synchronization and for channel parameter estimation. *Id*. at 11:5–8. Data structure 72 includes one or more data symbols 80, which in turn include cyclic prefix 76 and data block 82. *Id*. at 11:27–30. The specification states:

> Although omitted from FIG. 6 for simplicity, pilot symbols may also be intermittently inserted into the data symbols 80 by the pilot/training symbol inserter 46, as discussed above.

Id. at 11:44–47.

Illustrative Claim

Claims 1–10 and 17 are the subject of the trial. Claim 1 is independent and is reproduced as follows.

> 1. A transmitter of a communication system, the transmitter comprising:
>
> an encoder having a pilot/training symbol inserter, the pilot/training symbol inserter configured to insert pilot symbols into data blocks and to combine training symbols with the data blocks;
>
> at least one modulator, each modulator having an inverse discrete Fourier transform (TDFT) [sic] stage and a cyclic prefix inserter, each modulator outputting a frame structure comprising a preamble structure and a data structure, the preamble structure comprising at least one training symbol and an enhanced training symbol; and
>
> at least one transmit antenna, each transmit antenna corresponding to a respective one or the at least one modulator, each transmit antenna transmitting the frame structure output from the corresponding modulator, wherein the enhanced training symbol is a single symbol.

Id. at 16:52–17:3.

C. Prior Art Supporting the Instituted Challenges

The following four prior art references were asserted in the instituted grounds.

Reference	**Title**	**Date**	**Ex. No.**
Schmidl	US 5,732,113	Mar. 24, 1998 (filed June 20, 1996)	Ex. 1002
Arslan	US 6,411,649	June 25, 2002 (filed Oct. 20, 1998)	Ex. 1003
Kim	US 7,012,881	Mar. 14, 2006 (filed Dec. 29, 2000)	Ex. 1004
Heiskala	US 6,298,035	Oct. 2, 2001 (filed Dec. 21, 1999)	Ex. 1006

D. The Instituted Challenges of Unpatentability

The following table summarizes the challenges to patentability on which we instituted *inter partes* review.

References	**Basis**	**Claim(s) Challenged**
Schmidl and Arslan	§ 103(a)	1–3, 5
Schmidl, Arslan, and Kim	§ 103(a)	4, 6–10
Schmidl, Arslan, Kim, and Heiskala	§ 103(a)	17

II. ANALYSIS

A. Claim Construction

In an *inter partes* review, claim terms in an unexpired patent are interpreted according to their broadest reasonable construction in light of the specification of the patent in which they appear. *See* 37 C.F.R. § 42.100(b); *In re Cuozzo Speed Techs., LLC*, 793 F.3d 1268, 1275–79 (Fed. Cir. 2015). The claim language should be read in light of the specification as it would be interpreted by one of ordinary skill in the art. *In re Am. Acad. of Sci. Tech. Ctr*., 367 F.3d 1359, 1364 (Fed. Cir. 2004). Claim terms generally are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *See In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Only those terms in controversy need to be construed, and only to the extent necessary to resolve the controversy. *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

In the Decision to Institute, we construed an "enhanced training symbol" as "a training symbol, comprising a plurality of sections including repeated sequences, and providing at least a synchronization function." Paper 11, 8–9. Neither party contests that construction in their post-institution filings.

We declined to construe "pilot symbol" in the Decision to Institute, stating that the broadest reasonable construction is apparent from the context of the claims and specification. *Id.* In its Response, Patent Owner proposed that "pilot symbol" should be construed to mean "a frequency domain symbol for refining the calibration of a receiver to a transmitter." PO Resp. 12–21. Petitioner "agrees with PO that a 'pilot symbol' as used in claim 1 is a frequency-domain symbol." Pet. Reply 3. We consider these statements in our analysis and Final Written Decision, but maintain our determination from the Decision to Institute that no express construction of this term is necessary.

Patent Owner also contends that claim 1's recited "pilot/training symbol inserter configured to insert pilot symbols into data blocks" should be construed to mean that pilot symbols are inserted into individual data blocks, but not in between, or among, data blocks. PO Resp. 16, 21–26; Tr. 41:21–42:2, 51:4–52:17. Petitioner contends that "pilot symbols can be inserted at any point into the data blocks," i.e., within a data block or between data blocks (Tr. 16:3–10, 68:21–69:11; *see* Pet. Reply 3–11).

Our interpretation of the disputed term begins with the language of the claim. *See Microsoft Corp. v. Proxyconn Inc.*, 789 F.3d 1292, 1299 (Fed. Cir. 2015). Claim 1 recites that pilot symbols are inserted "into data blocks." We construe claim 1's plain language using the plural form of "data blocks" to mean that pilot symbols may be inserted not only within a single data block, as Patent Owner contends, but also between one data block and another data block, as Petitioner contends.

Claims should also be read in light of the specification and teachings in the underlying patent. *Cuozzo*, 793 F.3d at 1280; *Microsoft*, 789 F.3d at

1298. Here, the specification also uses the plural form of data blocks in explaining that "[t]ypically, pilot symbols may be inserted at any point in the data blocks." Ex. 1001, 16:55–56, 7:28–29. There is no language in the specification disclaiming the insertion of pilot symbols between data blocks. We are persuaded that based on the claim's usage of the plural "data blocks," which is supported by the description in the specification, the broadest reasonable construction is "pilot/training symbol inserter configured to insert pilot symbols within, or between, one or more data blocks," and accordingly, does not exclude the insertion of pilot symbols between two data blocks that are in a group of data blocks.

Patent Owner further contends that, for dependent claim 17 (which depends from claim 8 which in turn depends from claim 1), the recited "transmitter comprising: an encoder . . ." should be construed to mean a single encoder. PO Resp. 28–29. Claim 1 uses the transitional term, "comprising" between the preamble ("A transmitter of a communication system") and the body of the claim. Ex. 1001, 16:52–53. Petitioner states that:

> It is well-settled that "'comprising' is a term of art used in claim language which means that the named elements are essential, but other elements may be added and still form a construct within the scope of the claim." Genentech, Inc. v. Chiron Corp., 112 F.3d 495, 501 (Fed. Cir. 1997). Thus, the claimed "encoder" is essential but other elements may be added, so the express language of claim 1 does not preclude implementation with two encoders.

Pet. Reply 20. We agree with Petitioner that "comprising" means including the elements set forth in the body of the claim, but not excluding other elements, and, therefore, the broadest reasonable construction of "an encoder" should not be limited to require only a single encoder. *Baldwin Graphic Sys., Inc. v. Siebert, Inc.*, 512 F.3d 1338, 1342 (Fed. Cir. 2008) (The Federal Circuit "has repeatedly emphasized that an indefinite article 'a' or 'an' in patent parlance carries the meaning of 'one or more' in open-ended claims containing the transitional phrase 'comprising.'") (citation omitted).

No other claim terms require express construction to resolve the issues raised in this *inter partes* review.

B. Level of Ordinary Skill in the Art

Petitioner has not proposed a level of ordinary skill in the art. Patent Owner proposed that one of ordinary skill in the art would possess a "Bachelor's degree in Electrical Engineering, Computer Science, or an equivalent field as well as at least 3–5 years of academic or industry experience in communications systems, with significant exposure to communication theory including modulation and digital signal processing." Ex. 2009 (Declaration of Dirk Hartogs, Ph.D.) ¶ 19. At the oral hearing, Petitioner stated there was no dispute between the parties as to the level of ordinary skill. Tr. 29:5–8.

We determine that an express definition of the level of ordinary skill is not required. The level of ordinary skill in the art can be reflected in the cited prior art references. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) ("[T]he absence of specific findings on the level of skill in the art does not give rise to reversible error where the prior art itself reflects an appropriate level and a need for testimony is not shown.") (internal quotations omitted); *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995). Therefore, we find the level of ordinary skill in the art to be reflected in the cited references.

C. Claims 1–3 and 5 – Asserted Obviousness over Schmidl and Arslan

Petitioner contends claims 1–3 and 5 are unpatentable under 35 U.S.C. § 103(a) as obvious over Schmidl and Arslan. Pet. 27–40. Claim 1 is independent, and claims 2, 3, and 5 depend from claim 1.

Schmidl (Exhibit 1002)

Schmidl is titled, "Timing and Frequency Synchronization of OFDM Signals," and, according to Petitioner, is the "primary reference" of its Petition, "directed at synchronization between wireless transmitters and receivers."[1] Pet. 10, 29. Schmidl discloses a method and apparatus for attaining rapid synchronization of a receiver to an OFDM signal. Ex. 1002, Title, Abstract, 8:30–35. Figure 1 of Schmidl is reproduced below.

[1] Schmidl is listed as a cited reference in the '127 patent but was not specifically addressed by the Examiner as a basis for substantive rejections during prosecution of the application for the '127 patent. Pet. 4; Ex. 1008.

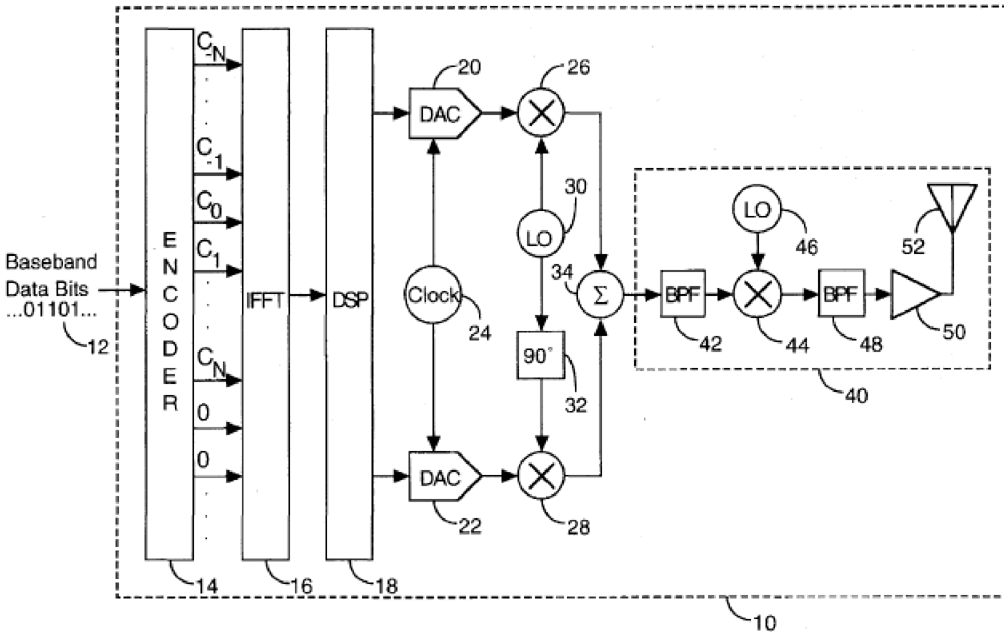

FIG. 1 (Prior Art)

Figure 1 illustrates "typical" prior art OFDM transmitter 10. Ex. 1002, 1:39–42. Transmitter 10 receives a stream of data bits 12 which are "immediately fed into" encoder 14. *Id*. at 1:42–44. Encoder 14 passes sequences of symbols onto inverse fast Fourier transformer 16, producing time-domain symbols that are modulated and form a composite OFDM signal that is passed to radio frequency transmitter 40 with antenna 52 for transmission to a receiver. *Id*. at 2:1–6, 2:38–40, 2:58–3:24.

Schmidl notes that, "timing and frequency synchronization of a receiver to an OFDM signal relies on the detection and analysis of a special OFDM training sequence that is included in the OFDM signal and preferably transmitted within a data frame." *Id*. at 11:60–64. Figure 6 of Schmidl is reproduced below.

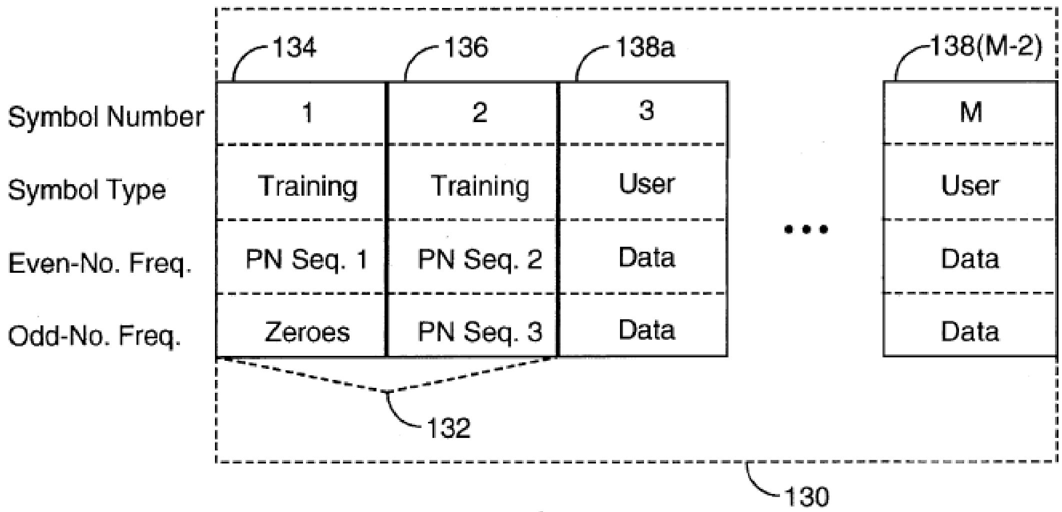

FIG. 6

Figure 6 illustrates the placement of an OFDM training sequence within a data frame. *Id*. at 10:14–15, 11:66–67. Data frame 130 includes OFDM training sequence 132 with first OFDM training symbol 134 and second OFDM training symbol 136. *Id*. at 12:1–4. Schmidl states:

> One of the key advantages of the present invention over the prior art is that it enables a receiver to accurately synchronize to the symbol/frame timing of an OFDM signal with the reception of just one symbol, first OFDM training symbol 134.

Ex. 1002, 14:27–31. Schmidl further discloses first OFDM training symbol 134 has two identical halves. Ex. 1002, 12:49–59.

Arslan (Ex. 1003)

Arslan is titled, "Adaptive Channel Tracking Using Pilot Sequences," and discloses synchronization of a channel estimator, or tracker, using a synchronization sequence, and retraining with known pilot symbols. Ex.

1003, Abstract. Periodic retraining based on pilot symbols that are inserted in a frame structure can reduce error propagation. *Id*. at Abstract, 3:1–12, 5:25–30. Figure 4 of Arslan is reproduced below.

FIG. 4

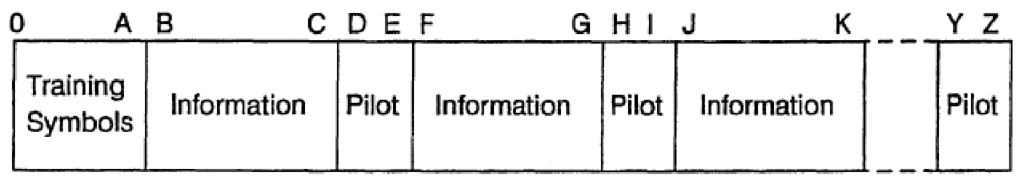

Figure 4 depicts a frame structure, with synchronizing portion 0 to A using training symbols, information portions B–C, F–G, and J–K, and pilot portions D–E, H–I, and Y–Z. Ex. 1003, 6:7–11. The "pilot portions are interspersed between information portions" to allow retraining of an adaptive channel estimator. *Id*. at 6:11–14. The synchronizing portion of the frame is a series of predefined symbols 0 to A, which are the same for each received frame. *Id*. at 6:13–15. The pilot portions contain predefined symbols which may be used to retrain the channel estimator. *Id*. at 6:19–21.

Analysis

Petitioner explains how the limitations of independent claim 1 are disclosed by Schmidl and Arslan. *See* Pet. 10–16, 27–35. For the recited encoder having a pilot/training symbol inserter configured to insert pilot symbols into data blocks and to combine training symbols with the data blocks, Petitioner contends Schmidl's OFDM transmitter comprises an encoder that "necessarily incorporates circuitry that inserts training symbols in the frequency domain such that a training symbol in the time domain is produced." Pet. Reply 14–15 (citing Ex. 1036 (Supplemental Declaration of Dr. Zygmunt Haas) ¶ 16); *see also* Pet. 28 (citing Ex. 1002, Figs. 1, 6, 1:42–49, 1:63–67, 11:67–12:4). Petitioner additionally contends that "Arslan is directed at utilizing pilot symbols inserted into the data symbols to maintain synchronization between wireless transmitters and receivers" and "discloses a frame structure having training symbols combined with information portions (data symbols) and pilot portions inserted into (between) information portions." Pet. 29–30 (citing Ex. 1003, Fig. 4, 3:1–6); *see also* Pet. Reply 17.

Petitioner further contends Schmidl discloses the recited at least one modulator (Ex. 1002, 2:7–13, 2:23–25), each modulator having an inverse discrete Fourier transform stage and a cyclic prefix inserter (*id*. at Fig. 1, 2:1–10, 2:40–43), and each modulator outputting a frame structure comprising a preamble structure and a data structure (*id.* at 11:59–12:27). For the recited preamble structure comprising at least one training symbol and an enhanced training symbol, Petitioner contends that Figure 6 of Schmidl discloses a first OFDM training symbol 134 corresponding to the recited "enhanced training symbol," and a second OFDM training symbol 136 corresponding to the recited "training symbol." Pet. 33; Ex. 1002, 12:1–4, 54–59.

Petitioner also contends Schmidl discloses the recited at least one transmit antenna (*id*. at 3:7–13), corresponding to one of the at least one modulators (*id*. at 3:13–23), and transmitting the frame structure output from the modulator (*id*. at Fig. 1), where the enhanced training symbol is a single symbol (*id*. at 12:49–59, 14:26–30). *See* Pet. 10–16, 27–35.

Patent Owner asserts, "[t]he combination of Schmidl and Arslan does not disclose a 'pilot/training symbol inserter configured to insert pilot symbols into data blocks' as required by independent claim 1." PO Resp. 11, 21–26. In particular, Patent Owner first argues that claim 1's "pilot symbols are frequency domain symbols inserted into a data block in the frequency domain," and that Arslan's pilot portions are time domain symbols, not frequency domain symbols. PO Resp. 13–17, 21–22. At his deposition, Patent Owner's declarant testified that the phrase, "insert pilot symbols into data blocks" excludes embodiments resulting in pilot symbols in the time domain. Pet. Reply 4 (citing Ex. 1034, 136:19–23).

In its Reply, Petitioner "agrees with [Patent Owner] that a 'pilot symbol' as used in claim 1 is a frequency-domain symbol," but adds that "the term 'pilot symbol' appears in claim 1 only as part of the term 'insert pilot symbols into data blocks,' and Petitioner disagrees with PO's interpretation of this claim term." Pet. Reply 3. Petitioner asserts OFDM pilot symbols can also occur in the time domain, because Figure 6 of the '127 patent depicts data structures in the time domain and the specification confirms that, "[a]lthough omitted from FIG. 6 for simplicity, pilot symbols may also be intermittently inserted into the data symbols 80 by the pilot/training symbol inserter, as discussed above." Ex. 1001, Fig. 6, 11:44–47. Patent Owner's expert testified that Figure 6 does depict symbols in the time domain. Pet. Reply 8 (citing Ex. 1034, 117:11–14).

We agree with Petitioner. The parties do not dispute that claim 1's insertion of pilot symbols occurs in the frequency domain. PO Resp. 15–16; Pet. Reply 3. After insertion, the symbols are then converted by the IDFT from the frequency domain to the time domain. Ex. 1001, 7:22–25, 8:1–6. Patent Owner's declarant testified that pilot symbols inserted "into" data blocks in the frequency domain do not appear in the time domain. Ex. 1034 (Deposition of Dirk Hartogs, Ph.D.), 124:4–11, 132:3–7. At the oral hearing, Patent Owner asserted likewise (Tr. 44:3–12, 44:20–45:3, 47:14–19), but also admitted that pilot symbols inserted "between" data blocks in the frequency domain can appear in the time domain. Tr. 49:4–13. As set forth above, we have construed claim 1's limitation of "insert pilot symbols into data blocks" to include insertion of such symbols between data blocks. *See* Section II.A.

In addition, the '127 patent specifies that pilot symbols can exist in the time domain. Ex. 1001, Fig. 6, 11:44–47. Patent Owner's declarant's testimony confirms that, "everything happening in Figure 6 is . . . in the time domain," Ex. 1034, 130:2–10. We agree with Petitioner's contention that the specification indicates the structure depicted in Figure 6 could include pilot symbols. *See* Ex. 1001, Fig. 6, 11:44–47. Accordingly, pursuant to the ’127 patent and our construction of “insert pilot symbols into data blocks,” we determine that as contended by Petitioner, pilot symbols may appear in both the frequency domain prior to being converted by the IDFT, and in the time domain after the transform.

Second, Patent Owner argues that Arslan’s time domain pilot portions are inserted only in between data blocks, and not within an individual data block, as allegedly required by claim 1. PO Resp. 22–26. In its Reply, Petitioner contends Patent Owner’s argument is based on an improper proposed construction of “insert pilot symbols into data blocks,” limiting insertion into a discrete, single data block. Pet. Reply 3, 11. Petitioner states Arslan’s frame structure contains “pilot symbols subsequently interspersed among data symbols.” Pet. Reply 15–16.

We agree with Petitioner because we have determined that Patent Owner’s proposed construction of “insert pilot symbols into data blocks” is too narrow, and that the broadest reasonable interpretation includes the insertion of pilot symbols within, or between, one or more data blocks. *See* Section II.A *supra*. Arslan teaches that pilot symbols are so “inserted in the sequence of a frame” and “interspersed between information portions.” Ex. 1003, Fig. 4, 7:40–41, 6:10–13. We are, thus, persuaded that Schmidl and Arslan teach or suggest the recited pilot/training symbol inserter configured to insert pilot symbols into (including between) data blocks.

Petitioner also describes why it would have been obvious to one of ordinary skill in the art to combine Schmidl with Arslan. Petitioner states that "both Schmidl and Arslan are directed at improving synchronization between a wireless transmitter and a wireless receiver, and disclose frame structures including information for the same." Pet. 16. In particular, Schmidl discloses an encoder that inserts training symbols in the frequency domain, to form training symbols in the time domain. Pet. Reply 13, 17 (citing Ex. 1036 ¶ 21); *see* Ex. 1002, 2:7–17. Arslan discloses a frame structure in the time domain containing pilot symbols interspersed among data symbols. Pet. Reply 16–17 (citing Ex. 1036 ¶¶ 20, 22). Petitioner further states:

> [I]t would have been obvious to use pilot symbols as separate time domain symbols for tracking time variations to calibrate or synchronize the receiver to the transmitter by using time-domain pilot symbols in Schmidl's system. . . [citing to Supplemental Declaration of Dr. Zygmunt Haas ¶ 22.] As discussed above, Schmidl discloses inserting symbols in the frequency domain for an OFDM system, for calibration and synchronization. *See id*. It would have been obvious to create those time-domain pilot symbols in the same manner as the time-domain training symbols are created in Schmidl's encoder – that is, by inserting blocks of known pilot symbols in the frequency domain that would result in time-domain pilot symbols. *See id*. It would be obvious to a POSA that the same circuitry in Schmidl's encoder 14 used to insert training symbols would be used to insert pilot symbols, resulting in the claimed "pilot/training symbol inserter configured to insert pilot symbols into data blocks." *See id*.

Pet. Reply 17–18; *see* Pet. 16, 29–30.

We are persuaded that there is a preponderance of evidence showing Schmidl and Arslan teach or suggest the limitations of claim 1, and that Petitioner has provided articulated reasoning supported by rational underpinnings for combining the references. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007). Based on the Petition, the Haas Declarations, and the record before us, we are persuaded that Petitioner has shown by a preponderance of the evidence that claim 1 is obvious over Schmidl and Arslan.

Claims 2, 3, and 5 all depend directly or indirectly from claim 1 (Pet. 35–40), and recite further features of the data structure, enhanced training symbol, and training block of the enhanced training symbol, respectively. Ex. 1001, 17:4–16, 17:22–25. Petitioner provides explanations of how Schmidl discloses the recited features of claims 2 and 3; and, with respect to claim 5, how "it naturally follows" that Schmidl's training interval, which has two identical halves each with a given number of samples, comprises twice the given number of samples. Pet. 35–40 (citing Ex. 1009, 64–65 (Declaration of Zygmunt J. Haas, Ph.D., element 5.1)); Ex. 1002, Figs. 4, 6, 1:42–47, 2:38–43, 12:49–13:9. Patent Owner does not attempt to refute any of Petitioner's specific contentions as to claims 2, 3, and 5.

Based on the Petition, the Haas Declarations, and the remainder of the entire record after trial, we conclude that Petitioner has proved by a preponderance of the evidence that dependent claims 2, 3, and 5 are obvious over Schmidl and Arslan.

D. Claims 4 and 6–10: Asserted Obviousness Over Schmidl, Arslan and Kim

Petitioner contends claims 4 and 6–10 are unpatentable under 35 U.S.C. § 103(a) as obvious over Schmidl, Arslan, and Kim. Pet. 40–46.

Kim (Exhibit 1004)

Kim is titled, "Timing and Frequency Offset Estimation Scheme for OFDM Systems by Using an Analytic Tone," and discloses the use of an analytic signal, or tone, to calculate timing offset and frequency offset estimations in OFDM systems. Pet. 16; Ex. 1004, 1:7–10, 5:49–52. Kim cites to an article by the Schmidl inventors. Ex. 1004, 1:53–60.

Figure 8 of Kim is reproduced below.

FIG. 8
PRIOR ART

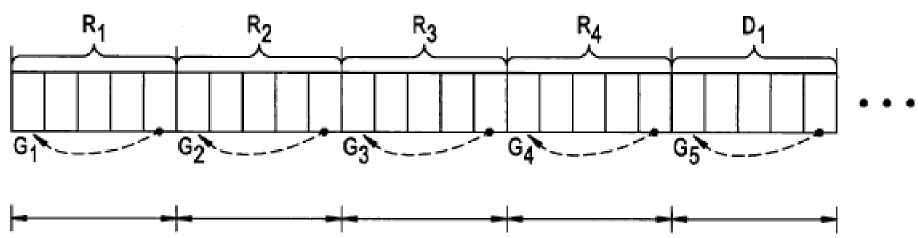

Figure 8 depicts a data structure and, in particular, a signal architecture for a wireless network in an OFDM system. Ex. 1004, 2:22–24, 5:31–32. Guard intervals G1 through G5 are provided at the beginning of each of data symbol D1 and training symbols R1 through R4, each of which also contains four sections. *Id*. at 2:24–26. In each of the symbols, the guard interval is N/4, where N=64, such that the length of the guard interval is 16. *Id*. at 2:32–34.

Analysis

Claims 4 and 6–10 all depend, directly or indirectly, from claim 1, and recite further features of the data block, the training block of the enhanced training symbol, and the cyclic prefix of the enhanced training symbol, including the number of samples in (i) data blocks, (ii) training blocks of training symbols, (iii) training blocks of enhanced training symbols, (iv) cyclic prefixes, and (v) sections of training symbols. Ex. 1001, 17:17–21, 26–41. Petitioner contends that Kim discloses that each data block includes 64 samples. Pet. 40–41, 43–44. Petitioner provides explanations of how Schmidl and Kim disclose the recited features of claims 4 and 6–10. Pet. 40–46; Ex. 1002, Figs. 4, 6, 4:55–63; Ex. 1004, Fig. 8, 2:22–36. With respect to claim 4, Petitioner also contends:

> [I]t would have been obvious for one of ordinary skill in the art to apply the known techniques of dividing the training symbols into a number of sections with each section including a number of samples, as taught by Kim, to the known training symbols of Schmidl to yield predictable results.

Pet. 40–41. With respect to claim 9, Petitioner states that because Kim discloses a training block having 16 samples divided equally among four equal sections, it "naturally follows" that each section contains an equal number of samples. Pet. 44–45 (citing Ex. 1009, 79–81 (element 9.1)).

Patent Owner does not attempt to refute any of Petitioner's specific contentions as to claims 4 and 6–10, and instead argues only that "Kim does not mention the use of pilot symbols and therefore cannot overcome the deficiencies of Schmidl and Arslan." PO Resp. 28. We are persuaded that there is a preponderance of evidence showing Schmidl, Arslan, and Kim teach or suggest the limitations of dependent claims 4 and 6–10, and that Petitioner has provided articulated reasoning supported by rational underpinnings for combining the references. Based on the Petition, the Haas Declarations, and the record before us, we conclude that Petitioner has proved by a preponderance of the evidence that dependent claims 4 and 6–10 are obvious over Schmidl, Arslan, and Kim.

E. Claim 17: Asserted Obviousness over Schmidl, Arslan, Kim, and Heiskala

Petitioner contends claim 17 is unpatentable under 35 U.S.C. § 103(a) as obvious over Schmidl, Arslan, Kim, and Heiskala. Pet. 46–48.

Heiskala (Ex. 1006)

Heiskala is titled, "Estimation of Two Propagation Channels in OFDM," and discloses an OFDM system with two transmitters to transmit training symbols over separate channels. Ex. 1006, Abstract, 1:5–9, 6:5–7, Fig. 4. Schmidl is a cited reference in Heiskala; Figure 1 of Heiskala, which is "a block diagram of a typical OFDM transmitter according to the prior art" (*id*. at 2:49–50), appears to be a copy of Figure 1 of Schmidl.

Analysis

Claim 17 depends indirectly from claim 1, and further recites two modulators and "transmit antennas," and first and second training blocks corresponding to the transmit antennas. Ex. 1001, 18:4–10. Petitioner contends that Heiskala discloses using two OFDM transmitters, each including a modulator and an antenna. Pet. 46–48. Petitioner further contends that:

> both Schmidl and Heiskala are directed at OFDM transmitters for transmitting training symbols, and, furthermore, Heiskala examines Schmidl's transmitter and proposes improvements to the same. . . . [citing to Haas Decl., ¶¶ 60–61]. Accordingly, it would have been obvious for one of ordinary skill in the art to apply the known technique of using two transmitters to transmit training symbols, as taught by Heiskala, to the known OFDM system of Schmidl, to yield predictable results of transmitting training symbols using two OFDM transmitters, each having a modulator and an antenna.

Pet. 47. Patent Owner argues claim 17 "requires a single encoder" coupled to two modulators and two antennas "as demonstrated by the plain language of the claim as well as the specification. In contrast, Petitioners' proposed combination results in a system with two encoders . . . ." PO Resp. 28–29; *see id.* at 30–34.

In its Reply, Petitioner contends the claim is not limited to a single encoder, and that PO improperly reads Figure 1 of the '127 patent, which depicts one encoder, into the limitations of the claim. Pet. Reply 19–22. We agree with Petitioner, as the plain language of claim 17 is not limited to a single encoder. Rather, as discussed above, the preamble of independent claim 1, from which claim 17 ultimately depends, transitions to the body of the claim with the word "comprising." Thus, claim 1's recitation of "an encoder" does not exclude other elements, such as more than one encoder. *See* section II.A. *supra*.

At oral hearing, Patent Owner stated, "claim 17 requires two modulators coupled to a single encoder." Tr. 65:2–3. Claim 17, however, does not recite coupling of an encoder to modulators. Pet. Reply 20–21 (citing Ex. 1034, 60:10–16).

We are persuaded that there is a preponderance of evidence showing Schmidl, Arslan, Kim, and Heiskala teach or suggest the limitations of dependent claim 17, and that Petitioner has provided articulated reasoning supported by rational underpinnings for combining the references. Based on the record before us, we conclude that Petitioner has proved by a preponderance of the evidence that dependent claim 17 is obvious over Schmidl, Arslan, Kim, and Heiskala.

CONCLUSION

Petitioner has demonstrated by a preponderance of the evidence the unpatentability of claims 1, 2, 3, and 5 of the '127 patent as obvious over Schmidl and Arslan; claims 4 and 6–10 as obvious over Schmidl, Arslan and Kim; and claim 17 as obvious over Schmidl, Arslan, Kim, and Heiskala.

III. ORDER

Accordingly, it is

ORDERED that, based on Petitioner's showing by a preponderance of the evidence, claims 1–10 and 17 of the '652 patent are unpatentable.

This is a Final Written Decision. Parties to the proceeding seeking judicial review of this decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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