

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD. and
SAMSUNG ELECTRONICS AMERICA, INC.,
Petitioner,

v.

EMPIRE TECHNOLOGY DEVELOPMENT LLC,
Patent Owner.

IPR2024-00897
Patent 8,565,331 B2

Before NABEEL U. KHAN, SHARON FENICK, and
ANDREAS BALTATZIS, *Administrative Patent Judges*.

KHAN, *Administrative Patent Judge*.

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

I. INTRODUCTION

A. *Background and Summary*

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (collectively, “Petitioner”) filed a Petition (Paper 3, “Pet.”) requesting an *inter partes* review of claims 1–8 of U.S. Patent No. 8,565,331 B2 (“the ’331 patent,” Ex. 1001). Empire Technology Development LLC (“Patent Owner”)¹ timely filed a Preliminary Response (Paper 12, “Prelim. Resp.”). With the Preliminary Response, Patent Owner filed a Statutory Disclaimer of claims 6–8 of the ’331 patent. Prelim. Resp. 22; Ex. 2010.

An *inter partes* review may not be instituted “unless . . . the information presented in the petition . . . shows that 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) (2018). Having considered the arguments and evidence presented by Petitioner and Patent Owner, we determine that Petitioner has not demonstrated a reasonable likelihood of prevailing with respect to at least one claim challenged in the Petition. Accordingly, we do not institute *inter partes* review of any claims of the ’331 patent.

B. *Related Proceedings*

The parties identify the following pending matter as involving the ’331 patent: *Empire Technology Development LLC v. Samsung Electronics*

¹ In its Mandatory Notices, Patent Owner states that the ’331 patent “is assigned to the Board of Regents of the University of Texas System, and [Empire Technology Development LLC] is the exclusive licensee with all substantial rights to the ’331 Patent, which includes the right to enforce for past, current, and future infringement, and the right to defend.” Paper 8, 1 (citing Ex. 2001 ¶¶ 3.3(b), 5.3, 6.1; Ex. 2002; Ex. 2003).

Co., Ltd., et al., Case No. 2:23-cv-00427 (E.D. Tex.). Pet. 1; Paper 8, 1; Prelim. Resp. 8.

C. Real Parties-in-Interest

Petitioner identifies Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. as the real parties-in-interest. Pet. 1. Patent Owner identifies the Board of Regents of the University of Texas System as the assignee of the '331 patent and Empire Technology Development LLC as “the exclusive licensee with all substantial rights to the '331 Patent, which includes the right to enforce for past, current, and future infringement, and the right to defend.” Paper 8, 1 (citing Ex. 2001 ¶¶ 3.3(b), 5.3, 6.1; Ex. 2002; Ex. 2003). Patent Owner identifies Empire Technology Development LLC as the real party-in-interest. *Id.*

D. The '331 Patent (Ex. 1001)

The '331 patent, titled “Inserting and Decoding Replicated Data Symbols in Wireless Communications,” is drawn to “methods, systems, devices, and/or apparatus generally related to use of replicated data as a pilot symbol in a communications system.” Ex. 1001, code (54), 4:3–5.

By way of background, the '331 patent describes that in Multiple-input multiple-output communication systems may have multiple antennas that transmit and receive data over a communication channel. Ex. 1001, 1:10–26. The communications channel, however, may introduce “non-idealities” such as interference, reflections, and motion of one or more stations. *Id.* at 1:27–30. The '331 patent further describes that “signals received by a receiver over the communications channel may be related to the transmitted signals by a channel matrix H ,” which refers to a matrix of data representing “the operation of the communications channel on the transmitted data symbols, including representations of such effects as

reflections.” *Id.* at 1:31–36. According to the ’331 patent, systems generally measure one or more properties of the communications channel, such as the channel matrix, by “insert[ing] pilot symbols into the transmitted data streams.” *Id.* at 1:63–2:1. Pilot symbols are known to the receiver and may be compared with the received signals to generate an estimate of the properties of the communications channel. *Id.* at 2:1–2:6. The ’331 patent notes that insertion of “pilot symbols into the transmitted data streams may adversely effect a data rate attainable in the communications system.” *Id.* at 2:4–6.

To address this problem, the ’331 patent describes a system configured for communication over a communications channel that uses replicated data as a pilot symbol. Ex. 1001, 4:14–6:18. Figure 1 of the ’331 patent, reproduced below, illustrates an embodiment of the ’331 patent’s system.

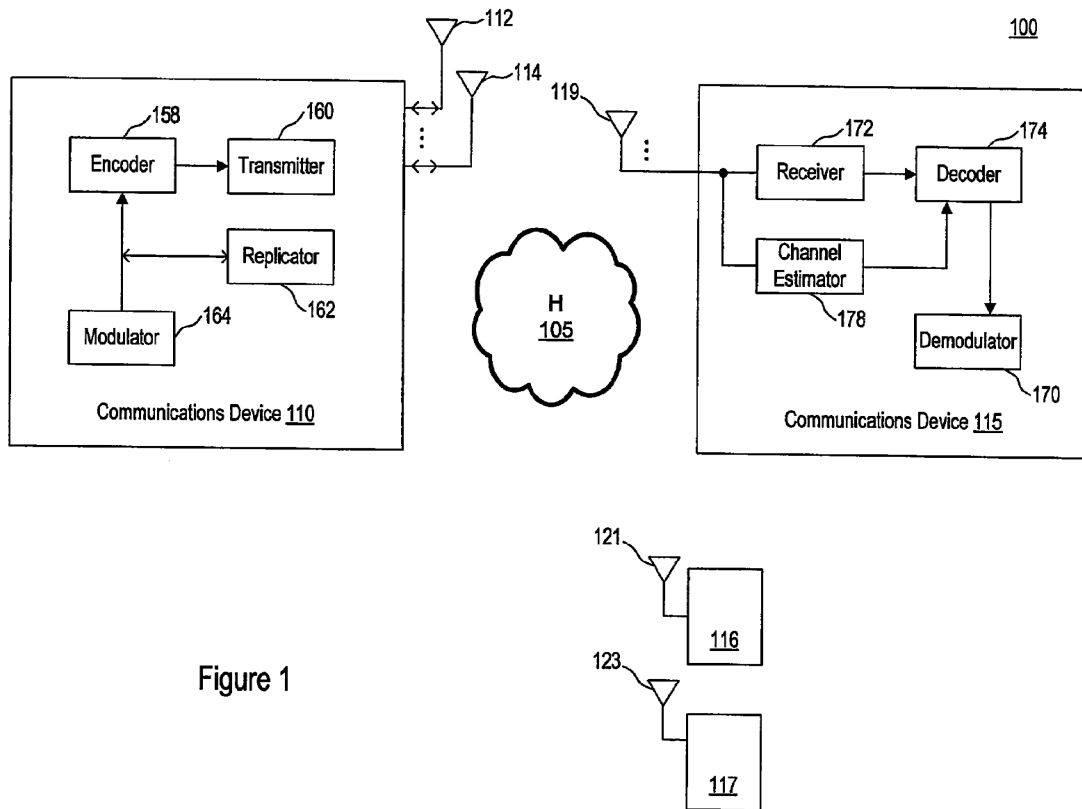


Figure 1

Figure 1, above, shows system 100 configured for communication over communication channel 105 including communication devices 110, 115, 116, 117. Ex. 1001, 4:14–22. Communications device 110 includes antennas 112 and 114, encoder 158, transmitter 160, a replicator 162, and modulator 164. *Id.* at 4:30–32. The '331 patent describes that replicator 162 is configured to receive one or more data streams generated by modulator 164 and “replicate at least a portion of data from one data stream and insert the replicated data into another data stream.” *Id.* at 4:50–54. The '331 patent further describes that encoder 158 is configured to encode the data streams in accordance with a block encoding technique and transmitter 160 is configured to transmit the encoded data over communication channel 105. *Id.* at 4:57–67.

As shown in Figure 1, above, communication device 115 includes antenna 119, receiver 172, decoder 174, channel estimator 178, and demodulator 170. Ex. 1001, 5:7–9. The '331 patent describes that “[t]he channel estimator 178 may be configured to estimate all or a portion of a channel matrix H associated with the communications channel 105” by using “pilot symbols.” *Id.* at 5:43–47. According to the '331 patent,

[t]he channel estimator 178 may also be configured to use decoded replicated data as a pilot symbol to estimate the channel matrix and/or update an estimate of the channel matrix. By utilizing replicated data to generate or update an estimate of the channel matrix, the communications device 115 may in some examples require fewer pilot symbols to be inserted into signals communicated over the communications channel 105. Reducing a number of pilot symbols inserted into the transmitted signals may advantageously improve the data rate of the communications system 100 in some examples.

Id. at 5:47–57; *see also id.* at 10:60–64 (“Because the replicated data symbols also transmit data over the communications channel, however, the use of replicated data symbols may not impair the overall data rate of the system as severely as the use of more pilot symbols.”).

Figure 3 of the '331 patent, reproduced below, illustrates signals transmitted over a communication channel, wherein the signals are encoded using a space-time block coding technique. Ex. 1001, 6:45–47, 6:49–51.

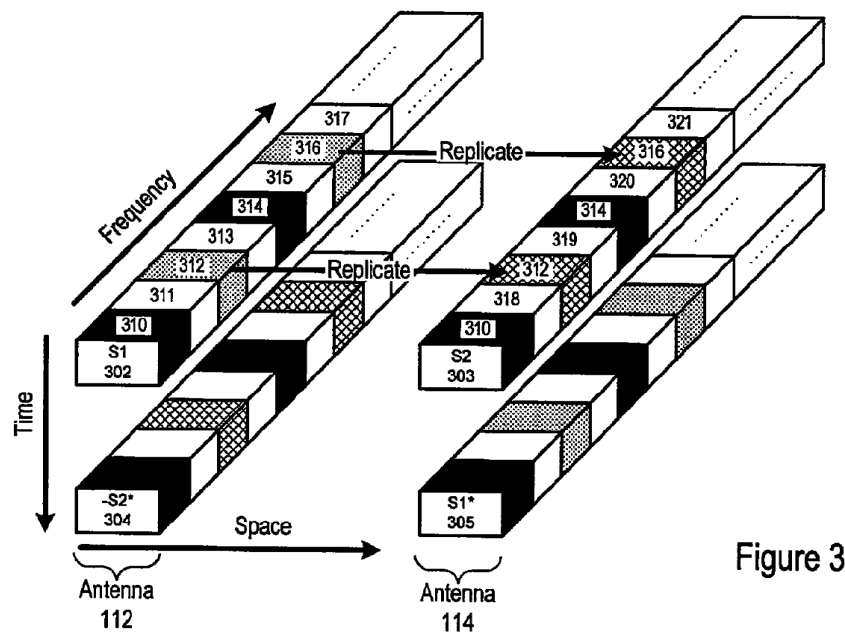


Figure 3

Figure 3, above, illustrates signals 302, 303, 304, and 305 transmitted by transmitter 160 of Figure 1 and received by receiver 172. Ex. 1001, 6:47–49. The '331 patent describes that “signals 302 and 303 may be transmitted during a first time period while signals 304 and 305 are transmitted during a second time period,” and “[s]ignals 302 and 304 may be transmitted from one location, such as by the antenna 112” of Figure 1 while “[s]ignals 303 and 305 may be transmitted from another location, such as by the antenna 114” of Figure 1. *Id.* at 6:51–57. The '331 patent describes that pilot symbols, such as symbols 310 and 314, may be encoded by the signals. *Id.* at 6:62–64. The '331 patent also describes that “replicated data symbols from the signal 302 may be included in the signal 303” as shown in Figure 3 where “the data symbols 312 and 316 may have been replicated to symbol locations at corresponding frequencies at the second spatial location.” *Id.* at 6:66–7:3. According to the '331 patent, “the replicated data symbols may be utilized in a manner similar to pilot symbols to estimate the communications channel” and “[s]ince the replicated data symbols also encode data, the use

of replicated data symbols as pilot symbols may increase the data rate of the over communications system in some examples.” *Id.* at 7:14–19.

Figure 5 of the ’331 patent, reproduced below, illustrates signals transmitted over a communication channel, wherein the signals are encoded using a space-frequency block coding technique. Ex. 1001, 7:62–66.

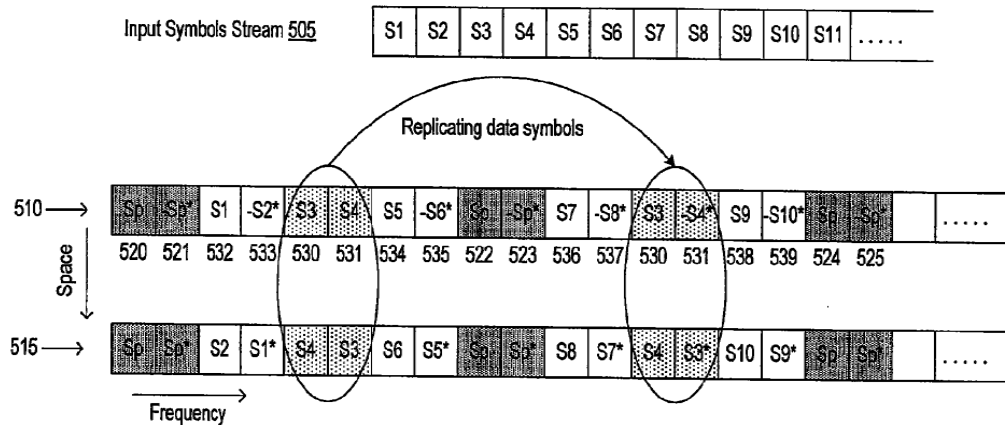


Figure 5

Figure 5, above, shows input data symbols 505 including symbols labeled S1-S11, which are provided to the modulator 164 of Figure 1. Ex. 1001, 7:66–8:1. According to the ’331 patent, “[f]ollowing modulation, pilot insertion, data replication, and coding in accordance with a space-frequency coding technique, one signal stream 510 may be generated for transmission from a first location, such as the antenna 112 of” Figure 1, and “a second signal stream 515 may be generated for transmission from a second location, such as the antenna 114 of” Figure 1. *Id.* at 8:1–7. The ’331 patent describes that pilot symbols 520–525 are inserted amongst data symbols 530–539. *Id.* at 8:13–15. The ’331 patent also describes that “[d]ata symbols 530 and 531 have been replicated from one frequency to another frequency in the data streams 510 and 515.” *Id.* at 8:15–17. According to the ’331 patent, “[r]eplicating a pair of data symbols,” as

shown in Figure 5, “may be advantageous in some examples for consistency with the coding technique employed to code the data stream.” *Id.* at 8:20–24.

E. Statutory Disclaimer

After the filing of the Petition in this proceeding, Patent Owner filed a statutory disclaimer, disclaiming claims 6–8 of the ’331 patent, effective October 15, 2024. Prelim. Resp. 22; Ex. 2010, 1. “No *inter partes* review will be instituted based on disclaimed claims.” 37 C.F.R. § 42.107(e). We do not analyze the patentability of claims 6–8 because these claims have been statutorily disclaimed.

F. Illustrative Claims

Petitioner challenges all the remaining non-disclaimed claims, that is, claims 1–5 of the ’331 patent. Claim 1, which is the only challenged independent claim of the ’331 patent, is illustrative of the challenged claims, and is reproduced below with limitation identifiers in brackets corresponding to claim analysis headings in the Petition. *See, e.g.*, Pet. i–ii.

1. [pre] A method of decoding a signal transmitted over a communications channel, the method comprising:

[a] receiving a pilot symbol over the communications channel;

[b] estimating a channel matrix of the communications channel based, at least in part, on the pilot symbol;

[c] receiving replicated data from multiple data streams transmitted over the communications channel;

[d] decoding the replicated data using the estimated channel matrix;

[e] generating an updated estimate of the channel matrix based, at least in part, on the replicated data; and

[f] decoding subsequently received signals over the communications channel using the updated estimate of the channel matrix.

Ex. 1001, 15:42–16:7.

G. Evidence

The Petition relies on the following reference:

Reference	Exhibit No.
EP 2114029 A1; filed April 28, 2008; published November 4, 2009; (“Haustein”).	1005
US 2008/0222482 A1; filed February 21, 2008; published September 11, 2008; (“Ban”)	1006
US 2002/0003774 A1; filed July 3, 2001; published January 10, 2002; (“Wang”)	1007
L. Tang & M. A. Abu-Rgheff, <i>Joint Pilot-Aided and Blind Decision-Directed Channel Estimation for MIMO-OFDM System</i> , The 18th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (2007) (“Tang”)	1008

Petitioner also relies on the Declaration of Matthew C. Valenti, Ph.D., (Ex. 1002) in support of its Petition. The parties may rely on other exhibits as noted below.

H. Asserted Grounds of Unpatentability

Petitioner asserts that claims 1–5 would have been unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. § ²	Reference(s)/Basis
1–5	103(a)	Haustein
1–5	103(a)	Ban, Wang
1–5	103(a)	Tang

² The Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. §§ 102 and 103 and became effective March 16, 2013. Because the ’331 patent was filed before this date, the pre-AIA versions of 35 U.S.C. §§ 102 and 103 apply. *See* Ex. 1001, code (22).

II. ANALYSIS OF ASSERTED GROUNDS

A. *Principles of Law*

Petitioner bears the burden of persuasion to prove unpatentability of the claims challenged in the Petition, and that burden never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

A patent claim is unpatentable under 35 U.S.C. § 103(a) 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. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) any objective evidence of obviousness or non-obviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. *Level of Ordinary Skill in the Art*

In determining the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (internal quotation marks and citation omitted).

Petitioner asserts that a person of ordinary skill in the art (“POSITA”) “would have had a bachelor’s degree in electrical engineering, computer science, computer engineering, or a related field, and two-three years of experience in the research, design, development, or testing of wireless data

communication systems at the physical layer, with additional education substituting for experience and vice versa.” Pet. 8 (citing Ex. 1002 ¶¶ 35–36). Patent Owner does not contest the characterization offered by Petitioner. *See* Prelim. Resp. 8.

For purposes of this Decision, we adopt Petitioner’s proposed level of ordinary skill because it is consistent with the level of skill in the art at the time of the invention as reflected by the ’331 patent and the cited prior art. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (explaining that specific findings regarding ordinary skill level are not required “where the prior art itself reflects an appropriate level and a need for testimony is not shown” (quoting *Litton Indus. Prods., Inc. v. Solid State Sys. Corp.*, 755 F.2d 158, 163 (Fed. Cir. 1985))).

C. Claim Construction

We apply the same claim construction standard used in district court actions under 35 U.S.C. § 282(b), namely that articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). *See* 37 C.F.R. § 42.100(b) (2020).

In applying that standard, claim terms generally are given their ordinary and customary meaning as would have been understood by a person of ordinary skill in the art at the time of the invention and in the context of the entire patent disclosure. *Phillips*, 415 F.3d at 1312–13. “In determining the meaning of the disputed claim limitation, we look principally to the intrinsic evidence of record, examining the claim language itself, the written description, and the prosecution history, if in evidence.” *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1014 (Fed. Cir. 2006) (citing *Phillips*, 415 F.3d at 1312–17). Only claim terms in controversy require express construction, “and only to the extent necessary to resolve the

controversy.” *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017); *see also Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.”).

Petitioner does not propose a specific construction for any terms and instead argues that “[t]o resolve this Petition, Petitioner does not believe that any term requires express construction.” Pet. 9. Patent Owner asserts that “[t]he term ‘replicated data’ has its plain and ordinary meaning of ‘duplicated data,’ *i.e.*, repeating the same data symbol more than once in a transmission.” Prelim. Resp. 9.

We determine that the dispute regarding whether the asserted prior art teaches limitation 1[f] is dispositive of this proceeding. Limitation 1[f] does not recite “replicated data” and we, therefore, determine that an explicit construction of that term is not necessary. Limitation 1[f] does, however, recite “subsequently received signals” and the construction of this term is material to the parties arguments and our analysis. We address the construction of “subsequently received signals,” to the extent necessary to resolve the dispute between the parties, in our analysis below. We determine no explicit constructions are required.

D. Ground 1 – Obviousness over Haustein

Petitioner argues claims 1–5 of the ’331 patent would have been obvious over Haustein. Pet. 15–34. Below we provide a brief overview of Haustein and then analyze Petitioner’s contentions in light of Patent Owner’s arguments.

1. Overview of Haustein (Ex. 1005)

Haustein relates to a method of transmitting data in a communication network. Ex. 1005, code (57). Haustein describes the method as comprising the steps of:

transmitting a data packet comprising a first plurality of pilot data and a second plurality of payload data a first time, receiving an indication signal indicating whether the data packet is decodable on the receiving side, and, in case that the indication signal indicates that it is determined that the data packet is not decodable, initiating a retransmission of the data packet comprising a third plurality of pilot signals, wherein some of the pilot signals of the third plurality of pilot signals are formed by converted payload data of the second plurality of payload data.

Id.

Figure 2B of Haustein, reproduced below, schematically illustrates a data grid in which pilot data or pilot signals are implemented. Ex. 1005

¶ 48.

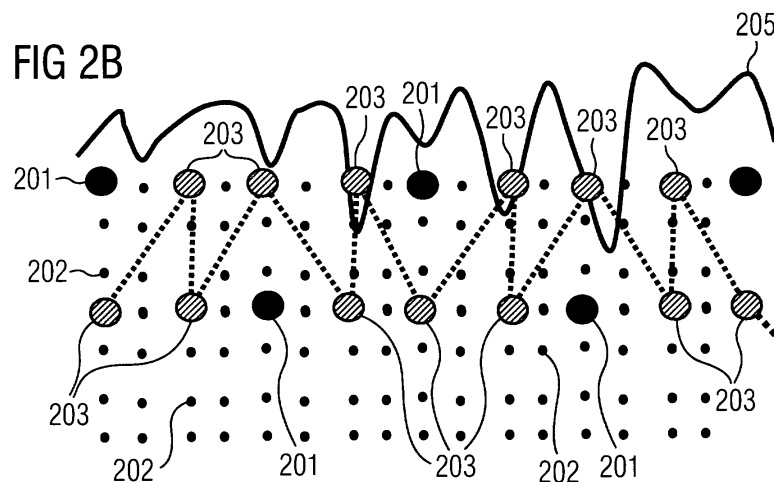


Figure 2B above shows the pilot signals 201, representing “a very frequency selective radio channel 205,” and the normal or payload data 202 indicated by the smaller dots. Ex. 1005 ¶ 48. Haustein also describes payload data that are “intended to be handled as pilot signals or reference

signals in a retransmission,” as “indicated by the hatched dots 203 which are connected by the dashed line 204” in Figure 2B. *Id.* According to Haustein, these “additional reference signals are transmitted already in the first transmission with a higher redundancy so that they can be used as pseudo reference signals in a potential retransmission.” *Id.*

Figure 3 of Haustein, reproduced below, illustrates an example of Haustein’s system.

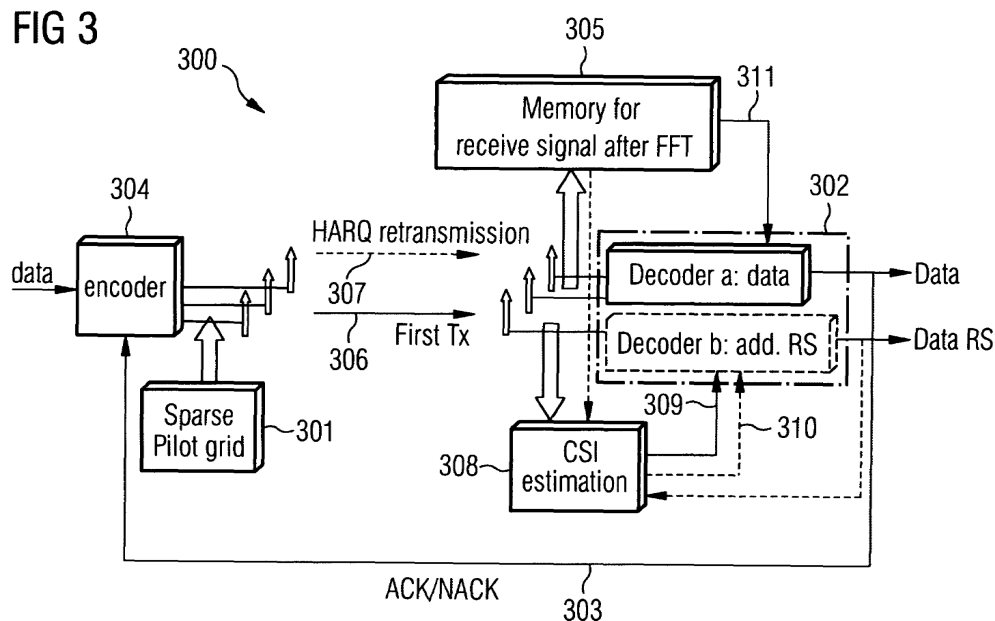


Figure 3 above illustrates an overall system design according to an exemplary embodiment of Haustein’s invention. Ex. 1005 ¶ 49. Haustein explains that “first a sparse pilot grid 301 is being sent 306 and in case of a successful decoding at the receiver or decoder 302 an ACK message 303 is fed back to the transmitter or encoder 304.” *Id.* According to Haustein, in case “the Cyclic Redundancy Check (CRC) fails, the receiver 302 checks whether this is fully or partly due to a bad channel estimation and sends back a NACK message together with the request for a denser pilot grid, so that a retransmission 307 may be initiated.” *Id.* Haustein further explains that

“[f]or the decoding firstly the data of the transmission are stored in a memory 305 after a Fast Fourier Transformation (FFT) and then the pilot signals are used for an estimation of a Channel State Information (CSI) 308.” *Id.* ¶ 50. According to Haustein,

[i]n the case of an ACK message, i.e. the case that the first transmission could be decoded, only the sparse pilot grid is used indicated by the arrow 311 leading from the memory 305 to the decoder 302, while in the case of the retransmission the pilots of the original sparse pilot grid and the pseudo pilot signals are used in the CSU estimation and thus for the decoding.

Id.

2. *Analysis of Claim 1*

Having reviewed the arguments and the evidence we determine Petitioner has not established a reasonable likelihood of prevailing on this ground. We turn to our analysis of limitation 1[f], which is dispositive of this ground. Before we do, we briefly describe Petitioner’s contentions for the earlier limitations to provide context for our analysis of limitation 1[f] below.

As explained in our summary above, in Haustein’s method, a first transmission is sent with pilot symbols and payload data where some of the payload data has additional redundancy. Ex. 1005, code (57). Petitioner contends, under limitation 1[d], that the pilot signals received in the first transmission are used to estimate a channel matrix that is used to decode, or attempt to decode, the first transmission. Pet. 25 (citing Ex. 1005 ¶ 50). The receiving side then sends back a signal indicating whether the first transmission could be decoded. Ex. 1005, code (57) ¶¶ 50, 59. If the first transmission could not be decoded, the first transmission is retransmitted but with additional pilot signals formed by converting some of the redundant

payload data into pilot signals. *Id.* ¶ 59. Petitioner contends, for limitation 1[e], that when this retransmission is received, Haustein uses the redundant payload data as pilot symbols to generate an updated channel estimate. Pet. 27–28 (citing Ex. 1005 ¶¶ 38, 50–52).

- a) *Limitation 1[f] – “decoding subsequently received signals over the communications channel using the updated estimate of the channel matrix”*

Petitioner contends that Haustein teaches “decoding subsequently received signals over the communications channel using the updated estimate of the channel matrix” for two reasons. First, Petitioner contends that the updated estimate of the channel matrix is used to decode retransmission signal 307. Pet. 29 (citing Ex. 1002 ¶¶ 115–118, Fig. 3). Second, Petitioner contends that the updated estimate of the channel matrix is also used to decode additional subsequently received signals. *Id.* at 30 (citing Ex. 1005 ¶ 3). Patent Owner disputes both of these contentions

Having reviewed the arguments and cited evidence we determine Petitioner has not sufficiently shown a reasonable likelihood that Haustein teaches limitation 1[f].

(1) *Decoding Retransmission Signal 307*

Petitioner contends that by decoding the retransmission signal 307, Haustein teaches decoding subsequently received signals using the updated channel estimate. Pet. 29 (citing Ex. 1002 ¶¶ 115–118, Fig. 3). Dr. Valenti testifies that retransmission 307 “comprises subsequently received signals that arrive at the receiver after first transmission 306, which includes the replicated data.” Ex. 1002 ¶ 59.

Patent Owner argues that “retransmission 307 is not a ***subsequently received*** signal” because “retransmission 307 itself is used in creating an

updated channel estimate, and decoding retransmission 307 does not constitute decoding *subsequently received* signals.” Prelim. Resp. 32 (citing Ex. 1005 ¶¶ 29, 59). Petitioner contends that the claim is not limited to preclude decoding of retransmission signal 307 (*see* Pet. 30) but does not offer a claim construction or analysis that supports such a contention. *See* 37 C.F.R. § 42.104(b)(3) (“the petition must set forth . . . [h]ow the challenged claim is to be construed.”)

Our review of the ’331 patent shows that Patent Owner has the better of the argument. In describing the method for receiving signals, the ’331 patent describes a six-step process. Ex. 1001, Fig. 7. Step 730 of this process involves “Decoding subsequently received data using the updated channel estimate.” *Id.* As part of this step, the ’331 patent explains that “signals received *following the updating of the channel estimate* may be decoded using the updated channel estimate.” *Id.* at 10:47–49 (emphasis added). This disclosure from the ’331 patent demonstrates that the plain meaning of “subsequently received signals,” refers to signals received *after* updating the channel estimate. We determine that Haustein’s retransmission 307, therefore, does not teach the recited “subsequently received signals” because it is used to update the channel estimate (as in element 1[e] of claim 1), and thus not received after updating the channel estimate.

(2) *Decoding Additional Subsequently Received Signals*

In addition to retransmission signal 307, Petitioner also contends that Haustein uses the updated channel estimate to decode “additional subsequently received signals.” Pet. 30 (citing Ex. 1005 ¶ 3). This is because, according to Petitioner, there is a time spacing called a “coherence time” after transmission during which the channel does not vary. *Id.* (citing Ex. 1005 ¶ 3; 1002 ¶ 115). Petitioner therefore argues that “after estimating

the channel matrix using the first set of pilot symbols (and potentially re-estimating it based on a retransmission), that estimated channel matrix is used to decode subsequently received data symbols for the duration of the coherence time, until the next set of pilot symbols is received.” *Id.* at 31 (citing Ex. 1002 ¶ 116). We are not persuaded by this contention for several reasons.

First, to make this contention, Petitioner relies on Haustein’s mention of a channel “coherence time” and its statement that it is common “to insert a pilot grid with certain spacing in time.” Pet. 30 (citing Ex. 1005 ¶ 3). The remainder of Petitioner’s contentions for this limitation are based on Dr. Valenti’s testimony regarding the knowledge of one of ordinary skill in the art. *See id.* at 30–31 (citing Ex. 1002 ¶¶ 115–117). Petitioner, therefore, relies on Dr. Valenti’s testimony to essentially supply a limitation that is missing from Haustein. Under the circumstances here, we determine this is insufficient to carry Petitioner’s burden. *See Xerox Corp. v. Bytemark, Inc.* IPR2022-00624, Paper 9, 16 (PTAB Aug. 24, 2022) (precedential) (explaining that relying on expert testimony “is particularly problematic in cases where, like here, expert testimony is offered not simply to provide a motivation to combine prior-art teachings, but rather to supply a limitation missing from the prior art.”)

Second, Petitioner’s arguments rest on Dr. Valenti’s testimony that “for a slowly fading channel (i.e. a channel with large coherence time), a POSITA would have . . . set[] the spacing between pilot grid transmissions large enough to enable the transmission of payload-only data between pilot grid transmissions.” Ex. 1002 ¶ 115 (citing Ex. 1032, 1:62–2:3; Ex. 1033 ¶ 4). Haustein, however, never expressly discloses signals that are “payload-only data between pilot grid transmissions,” as Dr. Valenti testifies. Instead,

Haustein discloses sending two types of signals. *See* Ex. 1005, Figs. 2A, 2B. The first, is a transmission with a “sparse pilot grid.” Ex. 1005 ¶ 59. Upon receipt of this transmission, “a channel estimation is performed” and the estimation is used to decode the first transmission. *Id.* If the transmission cannot be decoded, then Haustein sends a second type of signal, which is a retransmission of the first signal, but with a denser pilot grid where data is used as pseudo pilot signals. *Id.* Upon receipt of this retransmission, “again a channel estimation for the retransmitted data is performed” and this channel estimation is used to decode the retransmission signal. *Id.* Haustein, therefore, discloses only signals that are transmitted with pilot symbols and that a channel estimation will be performed to decode those signals. *See* Ex. 1005, Fig. 3 (depicting CSI estimation for both “First Tx” and “HARQ retransmission”). Haustein does not disclose “payload-only data between pilot grid transmissions” (Ex. 1002 ¶ 115) and there is insufficient reason to believe that any subsequent signals sent after a channel estimation is performed would be unlike the types of signals disclosed in Haustein by being devoid of pilot symbols. Thus, for this additional reason, Petitioner does not meet its burden.

Finally, Dr. Valenti’s testimony is conditioned on Haustein’s channel being a “slowly fading channel” that has a large enough coherence time. Ex. 1002 ¶ 115. But Petitioner does not demonstrate that Haustein’s channel is, in fact, “slowly fading.” Petitioner does not provide any information about the length of the channel coherence time in Haustein, nor do we find any such information based on our own review of Haustein.

For each of the aforementioned reasons we determine Petitioner has not established a reasonable likelihood that Haustein teaches the limitation 1[f] of claim 1. The remaining challenged claims depend from claim 1 and

suffer from the same deficiency. Petitioner, therefore, has not established a reasonable likelihood of prevailing on this ground.

E. Ground 2 – Obviousness over Ban and Wang

Petitioner argues claims 1–5 of the '331 patent would have been obvious over Ban and Wang. Pet. 45–66. Below we provide a brief overview of Ban and Wang and then analyze Petitioner's contentions in light of Patent Owner's arguments.

1. Overview of Ban (Ex. 1006)

Ban relates to “a transmitter and a receiver which carry out single carrier communication using a cyclic prefix.” Ex. 1006 ¶ 3. By way of background, Ban describes conventional methods for extending a cyclic prefix (CP) length, such as:

a method of fixing a data block size and increasing the number of symbols added to the head of the data block as a cyclic prefix (first conventional extension method) and a method of fixing a total size of a cyclic prefix and data block size and reducing the data block size by an amount corresponding to the increase in the number of cyclic prefix symbols (second conventional extension method).

Id. ¶ 5. According to Ban, when the conventional methods are used, “interference occurs among signals when the receiver collectively performs FFT (Fast Fourier Transform) processing on a plurality of frequency multiplexed single carrier signals or a single carrier signal and an OFDM (Orthogonal Frequency Division Multiplexing) signal.” *Id.* ¶ 80.

Ban discloses an embodiment of its invention that “substantially change[s] a cyclic prefix length in data block units while fixing a data block size and a CP size.” Ex. 1006 ¶ 81. Using this embodiment, “[w]hen the receiver collectively performs FFT processing on a plurality of frequency multiplexed single carrier signals or a single carrier signal and an OFDM

signal, it is thereby possible to obtain the same effect as extending the CP size while preventing the occurrence of interference among signals.” *Id.*

Ban discloses several examples of its invention. Figure 2 of Ban is reproduced below.

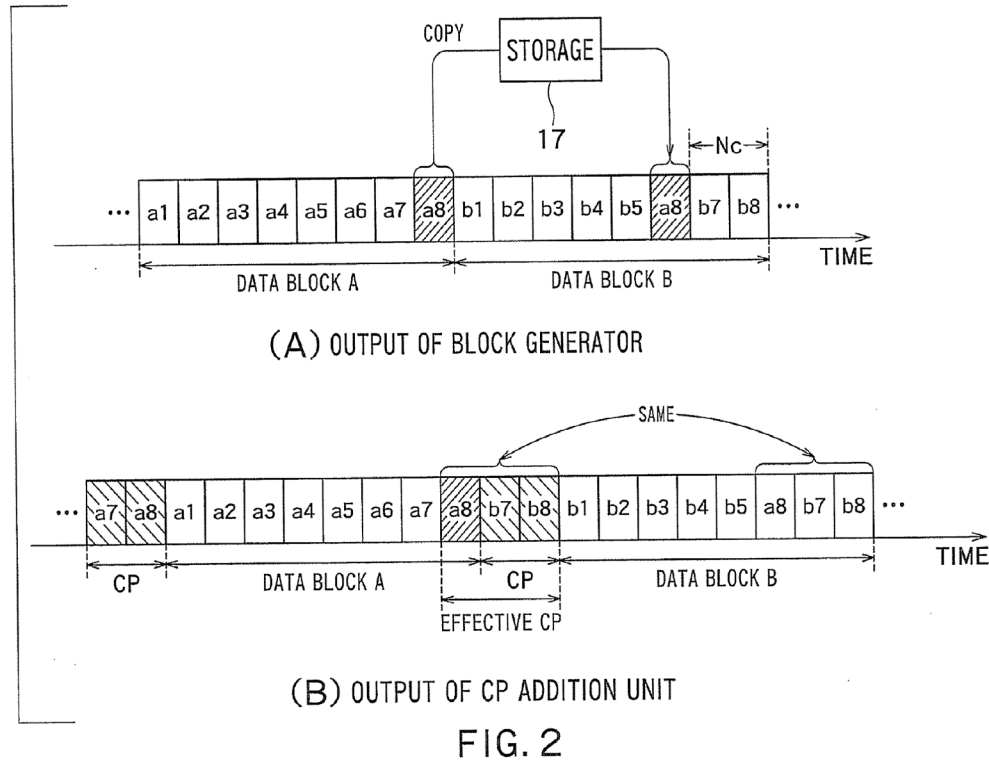


Figure 2 above illustrates an operation example of a block generator, which generates one data block from a plurality of data symbols outputted from a data modulator. Ex. 1006 ¶¶ 72, 92. Figure 2 also shows an example of “substantially extending the CP size of the data block B by one data symbol,” where “the data block size is 8 ($N=8$), the CP size added at the CP addition unit . . . is 2.” *Id.* ¶ 92. According to Ban, “a CP addition unit . . . adds a copy (duplicate) of one or more data symbols at the end in the data block to the head of the data block as a cyclic prefix.” *Id.* ¶ 73.

Specifically, Figure 2(A) above shows data blocks A and B outputted from the block generator. Ex. 1006 ¶ 93. Ban describes that “[a]s the third

symbol from the end of the data block B, that is, the sixth symbol from the head, a copy (duplicate) of a data symbol a8 at the end of the data block A that precedes the data block B is used.” *Id.*

Figure 2(B) above shows the output of the CP addition unit. Ex. 1006 ¶ 95. Ban describes that “[c]opy (duplicate) of the last two data symbols a7, a8 of the data block A are added to the head of the data block A as a cyclic prefix and the last two data symbols b7, b8 of the data block B are added to the head of the data block B as a cyclic prefix.” *Id.* As shown in Figure 2(B) above, the last three data symbols a8, b7, b8 of the data block B are the same as the last three data symbols that precede the data block B. *Id.* Ban explains that “the cyclic prefix length of the data block B has been substantially extended to three data symbols,” even though “the data block size and the CP size added at the CP addition unit . . . have not been changed unlike the aforementioned conventional first and second extension methods.” *Id.*

2. Overview of Wang (Ex. 1007)

Wang relates to “a transmitting device and a receiving device of a wireless orthogonal frequency division multiplex (OFDM) communication system with space time transmit diversity (STTD)” and “a channel estimation method for performing a channel estimation in a wireless OFDM communication system in which a transmitting device comprising a first and a second antenna transmits signals with space time transmit diversity.”

Ex. 1007 ¶ 1.

Wang describes a scheme called “transmit diversity” to use only a single antenna on the receiving side, such as a mobile terminal, and use more than one antenna on the transmitting side, such as a base station, “so that the diversity gain can be used for a better transmission quality.” Ex. 1007 ¶ 2.

According to Wang, a “specific approach in the transmit diversity scheme is the use of a so-called space time coding” and “[t]he resulting space time transmit diversity (STTD) has been adapted and is part of the UMTS standard for the next generation of mobile telecommunication.” *Id.*

In a space time transmit diversity system, a transmitting device comprises two antennas arranged spaced apart from each other in a space diversity arrangement and generates two parallel data streams. Ex. 1007 ¶ 3. Wang describes that “data symbols to be transmitted are mapped or coded slightly differently on the signals transmitted by each of the antennas,” thereby allowing “a receiving device receiving the signals transmitted from the two antennas with only a single antenna to distinguish and separate signals coming from one of the transmitting antennas from signals coming from the other of the transmitting antennas.” *Id.* ¶ 4. Wang explains that “[s]ince the two transmitting antennas are arranged in a space diversity arrangement, cross interference is avoided and the receiving device can then, after a corresponding channel estimation, distinguish and combine the signals from the two transmitting antennas to obtain a better transmission quality.” *Id.*

According to Wang, “[t]he channel estimation in the receiving device is usually performed on the basis of pilot symbols transmitted from the transmitting device” and “[t]he receiving device performs a channel estimation by comparing received pilot symbols with an expected pilot symbol to measure the channel response and to tune the receiving device to the best transmission channel, i.e. the transmitting antenna to which the better connection exists.” *Id.*; *see also id.* ¶ 24 (“The general idea of the present invention is that some of the pilot symbols transmitted by the first antenna 5 and the second antenna 6 are orthogonal to each other so that the

cross-interference from both antennas 5 and 6 is eliminated, the signals from the first, (non-diversity) antenna 5 and the second (diversity) antenna 6 can be differentiated and consequently a separate channel estimation for each antenna 5, 6 can be achieved in a receiving device.”), FIG. 1.

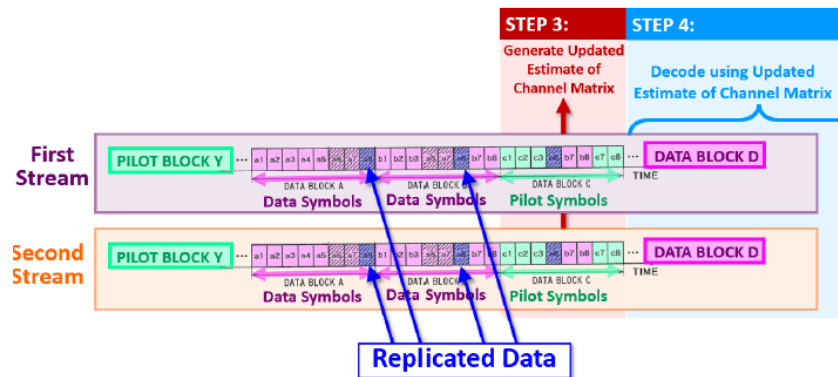
3. *Analysis of Claim 1*

Having reviewed the arguments and the evidence we determine Petitioner has not established a reasonable likelihood of prevailing on this ground. As for Ground 1, we turn to our analysis of limitation 1[f], which is dispositive of this ground.

- a) *Limitation 1[ff] - “decoding subsequently received signals over the communications channel using the updated estimate of the channel matrix”*

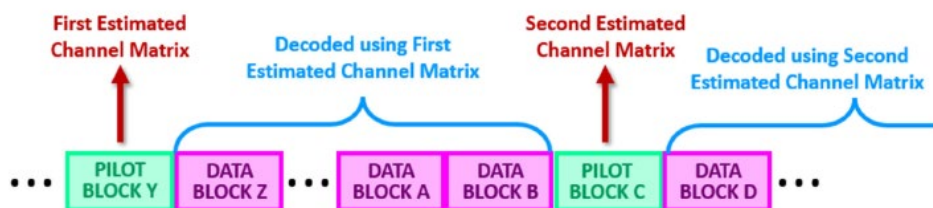
Petitioner argues “after receiving a block of pilot symbols . . . and using those symbols to generate an updated estimate of the channel matrix, that updated estimate of the channel matrix is used in the decoding process . . . to decode subsequently received blocks of data symbols . . . until the next block of pilot symbols are received and used to generate a new estimate of the channel matrix.” Pet. 62; *see also id.* at 58 (“A POSITA would have understood that the channel estimate from a first set of pilot symbols may be used to decode several data blocks.”).

In support of its argument that “updated estimate of the channel matrix is used in the decoding process . . . to decode subsequently received blocks of data symbols” Petitioner provides the figure below:



Pet. 63. In the figure above, which is based on Ban’s Figure 3A, Petitioner depicts first and second streams of data in which a Pilot Block of symbols Y is followed by Data Blocks A and B, which are then followed by a Pilot Block of symbols C, which is then followed by Data Block D. Petitioner annotates the figure to describe that an updated estimate of the channel matrix will be generated from the Data Block of symbols C in a “Step 3” and then will be used to decode Data Block D in “Step 4.”

Petitioner uses another figure when discussing limitation 1[d]³, reproduced below.



Pet. 59. In this figure Petitioner depicts a Pilot Block Y followed by Data Blocks Z, A, and B, followed by Pilot Block C, and finally Data Block D. The figure states that Data Block D would be decoded using a second estimated channel matrix.

³ Petitioner incorporates its analysis of limitation 1[d] in its analysis of limitation 1[f]. See Pet. 62 (“As explained for Element 1[d] . . .”).

With respect to the first figure above, Patent Owner argues that “Ban does not disclose a ‘data block D’ and neither does Wang. There is no support for a ‘step 4’ in either Ban or Wang. Petitioners simply add to the discussion of Ban and Wang without any suggestion or hint in Ban or Wang justifying Petitioners’ extrapolation.” Prelim. Resp. 41.

We determine Petitioner’s analysis does not find sufficient support in the proposed combination of Ban and Wang. As Patent Owner argues, the first figure reproduced above is heavily modified with significant additions by Petitioner, including the critical step 4, which is intended to illustrate decoding of subsequently received data using the updated channel matrix, that do not find support from Ban or Wang. The second figure reproduced above is not found in Ban or Wang and is, instead, created by Dr. Valenti. Dr. Valenti’s testimony, however, regarding the figure is not sufficiently supported by the asserted prior art references. *See* Ex. 1002 ¶¶ 181–182, 187. Specifically, the illustrated sequence in the figure is not supported by sufficient disclosure from Ban or Wang. For example, this figure illustrates a Pilot Block Y and a Data Block D, which do not appear in any figures of Ban. The figure also describes block C as “Pilot Block C” while Ban discloses this block as a “Data Block C.” *See* Ex. 1006 ¶ 96–99, Figs. 3(A), 3(B). The only citations provided to the prior art are to Ban’s paragraphs 134 and 135 which do not discuss updating a previous channel estimate and using it to decode subsequently received signals. Again, we find Dr. Valenti’s testimony insufficient to supply a limitation that is missing from the proposed combination. *See Xerox Corp.*, 16.

For the foregoing reasons, we determine Petitioner has not established a reasonable likelihood that the combination of Ban and Wang teaches the limitation 1[f] of claim 1. The remaining challenged claims depend from

claim 1 and suffer from the same deficiency. Petitioner, therefore, has not established a reasonable likelihood of prevailing on this ground.

F. Ground 3 – Obviousness over Tang

Petitioner argues claims 1–5 of the '331 patent would have been obvious over Tang. Pet. 78–94. Below we provide a brief overview of Tang and then analyze Petitioner's contentions in light of Patent Owner's arguments.

1. Overview of Tang (Ex. 1008)

Tang discloses “a joint pilot-aided and blind decision-directed channel estimation (PA-DDCE) scheme” to “achieve a good tradeoff between the pilots overhead and the system performance.” Ex. 1008, 1.⁴ According to Tang, the proposed scheme uses “the initial estimated channel obtained by the conventional channel estimation to detect the transmitted data symbol in the middle sub-carrier between any two adjacent pilot sub-carriers” and applies these symbols as “extra pilot symbols” to “estimate the channel on the whole frequency band.” *Id.*

Systems called the multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) system use multiple antennas at both the transmitter and the receiver to significantly increase the channel capacity. Ex. 1008, 1. According to Tang, “the system performance depends on the quality of channel estimation and hence the number of pilot symbols.” *Id.* Figure 1 of Tang showing a MIMO-OFDM system is reproduced below. *Id.*

⁴ The cited page numbers in Exhibit 1008 refer to page numbers added by Petitioner at the bottom right corner of the reference.

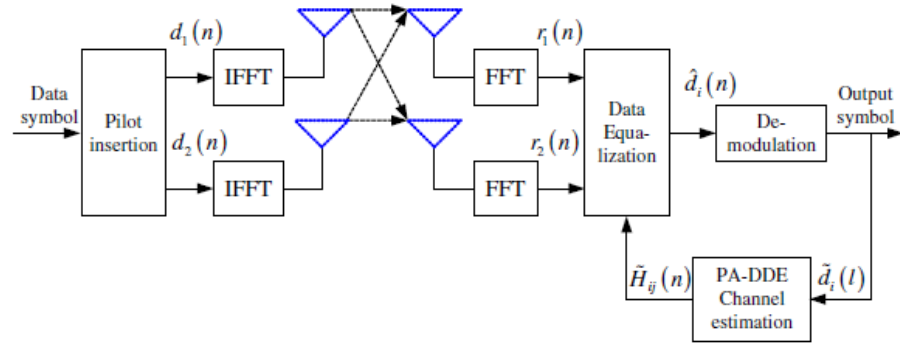


Figure 1: MIMO-OFDM system with PA-DDCE scheme

Figure 1 above illustrates an OFDM system with two transmitters and two receivers. Ex. 1008, 1. According to Tang, “[t]he two transmit antennas simultaneously transmit the OFDM signals modulated by inverse fast Fourier transform (IFFT),” and the signal is demodulated by fast Fourier transform (FFT) at the receiver side. *Id.* at 2.

Figure 2 of Tang, reproduced below, illustrates the pilot structure of the conventional channel estimation. Ex. 1008, 2.

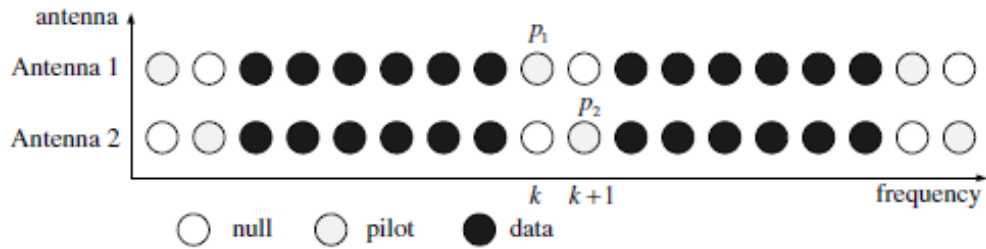


Figure 2: Pilot structure of the conventional channel estimation

Tang explains that to keep the pilot orthogonality in the conventional channel estimation, “a training pilot from one antenna is transmitted at a sub-carrier while the remaining transmit antennas are idle at the same sub-carrier,” as shown in Figure 2 above, where p_1 and p_2 are pilot symbols at the first and the second antenna respectively. Ex. 1008, 2.

Figure 5 of Tang, reproduced below, illustrates the pilot structure of the PA-DDCE scheme with space frequency block code (SFBC)-data format. Ex. 1008, 1, 3.

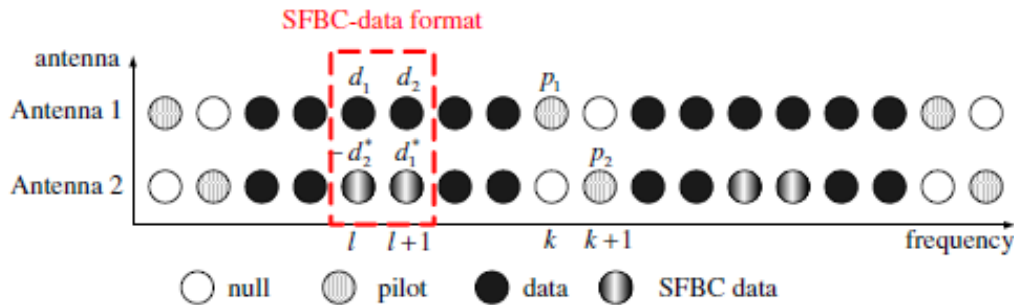


Figure 5: Pilot structure of PA-DDCE scheme with SFBC-data format

Tang describes that “[i]n the middle of any two adjacent pilot sub-carriers, the data symbol d_1 and d_2 on the sub-carriers l and $l + 1$ are encoded by the SFBC.” Ex. 1008, 3. Tang describes derivation of extra pilot symbols that can be used to compute the channel frequency response at the sub-carriers l and $l + 1$. *Id.* at 4.

2. Analysis of Claim 1

Having reviewed the arguments and the evidence we determine Petitioner has not established a reasonable likelihood of prevailing on this ground. We turn to our analysis of limitation 1[f] which is dispositive of this ground.

- a) *Limitation 1[f] – “decoding subsequently received signals over the communications channel using the updated estimate of the channel matrix”*

Petitioner argues

As explained in Section XII.A.1.g (Ground 1 based on Haustein), a POSITA would have understood that, following receipt of the pilot symbols and replicated data symbols that are used to generate the final estimated channel frequency response

$\tilde{H}_{ij}(n)$, Tang's receiver would use $\tilde{H}_{ij}(n)$ to decode subsequently received signals $r_{j(n)}$ over a coherence time over which the channel is assumed not to be varying (i.e., the time over which $\tilde{H}_{ij}(n)$ is assumed not to change), until a new set of pilot symbols and replicated data symbols are received. POSITA would have understood that, by waiting a coherence time interval between pilot signal transmissions, during which time interval received signals are decoded using the latest estimate of the channel matrix, "pilot overhead," which Tang teaches "diminishes the system spectrum efficiency," may be reduced.

Pet. 91–92 (citing Ex. 1002 ¶ 249).

Patent Owner argues that "***Petitioners do not have any support from Tang for claim limitation 1[f].***" Prelim. Resp. 46. Patent Owner points out that Petitioner's argument rests on the same assumptions regarding "coherence time" made for the Haustein reference in Ground 1 and therefore suffers from the same deficiencies, except here "coherence time" is "a concept not even mentioned in Tang." *Id.*

We agree with Patent Owner. Petitioner relies on the same arguments made with respect to Haustein and these arguments suffer from the same deficiencies. Tang, like Haustein, does not expressly discuss using an updated estimate of the channel matrix to decode subsequently received signals that fall into the spacing in time between pilot symbols. Unlike Haustein, however, Tang does not even mention a "coherence time" so Petitioner's arguments here are even further divorced from the disclosure of Tang than its arguments in Ground 1 are from Haustein.

For the foregoing reasons, we determine Petitioner has not established a reasonable likelihood that Tang teaches or suggests the limitations of claim 1. The remaining challenged claims depend from claim 1 and suffer from

the same deficiency. Petitioner has, therefore, not established a reasonable likelihood of prevailing on this ground.

III. CONCLUSION

Petitioner has not demonstrated a reasonable likelihood of prevailing in showing the unpatentability of at least one challenged claim of the '331 patent.

IV. ORDER

For the foregoing reasons, it is

ORDERED that, pursuant to 35 U.S.C. § 314(a), the Petition is denied and *inter partes* review of claims 1–5 of the '331 patent is not instituted.

IPR2024-00897
Patent 8,565,331 B2

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