

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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MEDIATEK INC. and MEDIATEK USA, INC.,  
Petitioner,

v.

NIPPON TELEGRAPH AND TELEPHONE CORPORATION,  
Patent Owner.

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IPR2020-01607  
Patent 7,242,720 B2

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Before GREGG I. ANDERSON, CHARLES J. BOUDREAU and  
NORMAN H. BEAMER, *Administrative Patent Judges*.

ANDERSON, *Administrative Patent Judge*.

JUDGMENT  
Final Written Decision  
Determining All Challenged Claims Unpatentable  
35 U.S.C. § 318(a)

## I. INTRODUCTION

MediaTek Inc. and MediaTek USA, Inc. (collectively “Petitioner”) filed a Petition requesting *inter partes* review of claims 10–11, 18–20, 22–23, and 31–32 of U.S. Patent No. 7,242,720 B2 (Ex. 1001, “the ’720 patent”). Paper 2 (“Pet.”). Nippon Telegraph and Telephone Corporation (“Patent Owner”) filed a Preliminary Response. Paper 6 (“Prelim. Resp.”). We instituted *inter partes* review on February 16, 2021. Paper 12 (“Inst. Dec.”). Patent Owner filed a Response (Paper 18, “PO Resp.”), Petitioner filed a Reply (Paper 25, “Reply”), and Patent Owner filed a Sur-Reply (Paper 30, “Sur-Reply”).

A hearing was held on January 4, 2022, and a transcript has been filed into the record. Paper 37 (“Tr.”). Patent Owner filed objections to certain demonstrative exhibits used at the hearing. Paper 36. We did not rely on any argument made in the demonstratives objected to and the objection is overruled as moot.

We have jurisdiction under 35 U.S.C. § 6. Upon considering the record, for reasons discussed below, we find claims 10–11, 18–20, 22–23, and 31–32 unpatentable.

## II. BACKGROUND

### *A. Real Parties in Interest*

The real parties in interest for Petitioner are MediaTek Inc. and MediaTek USA, Inc. Pet. 1. The real parties in interest for Patent Owner are Nippon Telegraph and Telephone Corporation and Essential WiFi, LLC. Paper 3, 2.

### *B. Related Matters*

Petitioner advises us that the ’720 patent is the subject of two civil actions between Petitioner and Patent Owner in the Western District of

Texas captioned *Nippon Telegraph & Telephone Corp. v. MediaTek, Inc.*, No. 1:20-cv-00632-ADA (W.D. Tex.) ('632 lawsuit") and *Nippon Telegraph & Telephone Corp. v. MediaTek Inc.*, Civil Action No. 6:20-cv-00225 (W.D. Tex.). Pet. 2. Petitioner identifies another four lawsuits where Patent Owner is plaintiff that may be affected by the outcome of this proceeding. Pet. 3–4. Patent Owner identifies the '632 lawsuit above and two of the other four lawsuits listed by Petitioner. Paper 3, 2.

Petitioner identifies two *inter partes* review proceedings between the same parties, *MediaTek Inc. and MediaTek USA, Inc. v. Nippon Telegraph & Telephone Corp.*, IPR2020-01404 and IPR2020-01555 (respectively "'1404 IPR" and "'1555 IPR").<sup>1</sup> Pet. 2. We instituted trial in the '1404 IPR on February 16, 2021, and a final decision finding no challenged claim unpatentable was mailed on February 3, 2022. '1404 IPR, Papers 14, 31. We declined to institute trial in the '1555 IPR. '1555 IPR, Paper 12.

### *C. The '720 Patent*

The application for the '720 patent was filed April 5, 2002. Ex. 1001 at [22]. The application for the '720 patent claims priority to Japanese applications JP 2001-109679, filed April 9, 2001; JP 2001-202260, filed July 4, 2001; JP 2001-246408, filed August 15, 2001; and JP 2001-319610, filed October 17, 2001. *Id.* at [30].<sup>2</sup>

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<sup>1</sup> The parties are reminded of their obligation to "identify any other judicial or administrative matter that would affect, or be affected by, a decision in the proceeding." 37 C.F.R. § 42.8(b)(2).

<sup>2</sup> Petitioner does not concede any priority date based on the Japanese applications, alleging only a level of skill in the art would be as of 2001 or 2002. Pet. 17. Patent Owner does not object to Petitioner's proposed level of skill in the art or its reference to 2001 or 2002. *See generally* PO Resp. None of Patent Owner's arguments contest the prior art status of the references relied upon for the challenge.

### *1. Background Technology*

The '720 patent describes and claims an orthogonal frequency division multiplexing ("OFDM") signal communication system. Ex. 1001, 1:9–11. In multiple input multiple output ("MIMO") systems, multiple channels transmit over the same frequency using a plurality of transmitting antennas and a corresponding number of receiving antennas. *Id.* at 1:31–36, 2:1–6, Fig. 37. "[E]ach of the channels is separated by an equalizer and an interference canceller to achieve a large capacity." *Id.* at 1:36–37. For N transmitting antennas and N receiving antennas, interference cancelling is achieved by encoding the signal through a like number of encoders, interleavers, and modulators prior to transmitting the signal. *Id.* at 2:1–9. The received signal is processed by a series of equalizers, deinterleavers, decoders, and interference cancellers. *Id.* at 2:10–17, 2:35–44. This repetitive processing both increases the reliability of the output from the decoder and removes interfering signals from the decoded signal. *Id.* at 2:64–3:6.

According to the '720 patent, problems existed with prior methods, including difficulties in providing high accuracy equalization for frequency characteristics of the amplitude and phase. Ex. 1001, 3:52–54. As a result, the signal-to-interference-noise ratio deteriorates. *Id.* at 3:54–55.

### *2. Overview of '720 Patent*

Patent Owner's expert, James Geier, explains how the '720 patent achieves interference cancellation:

[T]he '720 Patent teaches that an interference canceller may cancel interference based on applying an inverse matrix, obtained from inverting matrices constituted by propagation

coefficients. [3] These propagation coefficients may be determined using pilot signals, which, when received through a wireless channel, can be compared to reference values as part of gauging characteristics for signal transmission. [] Thus, it is readily apparent to a person skilled in the art (POSA) that, in contrast to prior art systems, this interference cancellation method need not be performed sequentially based on equalizer output. Thus, interference cancellation may be achieved without having to involve equalizers, and is not as vulnerable to the problems afflicting equalizers.

Ex. 2001 ¶ 66 (Geier Declaration).

Similarly, Petitioner's expert, Dr. Gary Lomp, describes the '720 patent as follows:

[P]ilot signals [are used] to determine the channel interference to form the channel matrix in an MIMO-OFDM system, determining an inverse of the channel matrix (at the transmitter or receiver) and then using that inverse (at the transmitter or receiver) to cancel the interference the channel imposes on signals transmitted or to be transmitted over the channel.

Ex. 1003 ¶ 54 (Lomp Declaration).

### *3. The '720 Patent Communication System*

The '720 patent describes an OFDM system for “signal communication system without using an equalizer” to “achieve substantial frequency utilization under a multipath fading<sup>[4]</sup> environment.” Ex. 1001, 1:14–17, 4:63–65.

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<sup>3</sup> Citations to the '720 patent omitted.

<sup>4</sup> “Frequency-selective fading” is a type of interference arising from transmission of a signal through the air. Ex. 2001 ¶ 47 (citing Ex. 1001, 3:23–27).

*a. OFDM transmission*

Numerous embodiments<sup>5</sup> are described, but all generally relate to “an OFDM signal transmitting device” with “N transmitting antennas,” “an OFDM signal receiving device” with “N receiving antennas,” “an inverse matrix computer for computing each of inverse matrices. . . for each subcarrier,” and “an interference canceller for cancelling interference components . . . , based on the inverse matrix.” Ex. 1001, 4:5–20. The embodiments also include “a pilot signal generator for generating N kinds of pilot signals.” *Id.* at 4:36–39. The ’720 patent describes the use of inverse fast Fourier transforms (“IFFTs”) in the transmitting device for converting frequency-domain OFDM symbols<sup>6</sup> to time-domain OFDM symbols and fast Fourier transforms (“FFTs”) in the receiving device for the inverse operation. *Id.* at 17:5–8, 17:35–38 (described in connection with the Seventh Embodiment).

OFDM signals are transmitted over the same frequency, and the phase noise and the frequency variation of the transmitted OFDM signal are all the same. Ex. 1001, 7:63–67. The signal is also received at the same frequency. *Id.* at 7:67–8:3. Thus, there is a common frequency variation, which simplifies interference cancellation and coherent detection between subcarriers. *Id.* at 8:8–12.

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<sup>5</sup> Sixteen separate embodiments are described. *See, e.g.*, Ex. 1001, 54:40 (“Sixteenth Embodiment”). Unless otherwise indicated, all citations are to the “First Embodiment.”

<sup>6</sup> Data bits may be represented as a “symbol” (the “basic unit of information transmitted”), and symbols are transmitted from a transmitter to a receiver. Ex. 1003 ¶ 32 (citing Seagraves, US 2001/0031016 A1, pub. Oct. 18, 2001 (Ex. 1048) ¶ 46).

*b. “propagation coefficient matrix”*

“[P]ilot signals  $P_1, P_2, \dots, P_N$  are used in order to find the propagation coefficient matrix from the transmitting antenna 5-i to the receiving antenna 8-j.” Ex. 1001, 8:39–43, Fig. 2. The received pilot signal is separated for each of the respective subcarriers so that “[b]y detecting the amplitude and phase of these respective received subcarrier signals, the propagation coefficients for each of the subcarriers can be measured as complex numbers.” *Id.* at 8:57–62. For a given subcarrier represented by  $M$  complex numbers  $s_{i,j}$ , an  $(N \times N)$  propagation coefficient matrix is obtained “corresponding to the product of the number  $N$  of transmitting antennas and the number  $N$  of receiving antennas.” *Id.* at 9:1–8.

$$S^i = \begin{pmatrix} S_{1,1} & S_{1,2} & \cdots & S_{1,N-1} & S_{1,N} \\ S_{2,1} & S_{2,2} & \cdots & \vdots & \vdots \\ \vdots & \vdots & \cdots & \vdots & \vdots \\ S_{N-1,1} & \vdots & \cdots & \vdots & S_{N-1,N} \\ S_{N,1} & \vdots & \cdots & S_{N,N-1} & S_{N,N} \end{pmatrix}$$

*Id.* at 9:18–33. The Matrix  $S^i$  for the  $i$  th subcarrier for 1 to  $N$  transmitting and receiving antennas is shown in equation (3) reproduced above. *Id.* at 9:21–23.

*c. “inverse matrix”*

The  $N$  OFDM signals from the transmitting antennas are superposed on each other when received at the  $N$  receiving antennas. Ex. 1001, 9:46–48. The superposed signals are demodulated to reconstruct the original transmitted signals. *Id.* at 9:49–52. The transmitted signals are reconstructed by an inverse matrix computer, which calculates an inverse matrix  $(S^i)^{-1}$  of  $S^i$  for each subcarrier using equation (5) reproduced below.

$$\begin{pmatrix} t_1 \\ t_2 \\ \vdots \\ t_N \end{pmatrix} = (S^i)^{-1} \cdot \begin{pmatrix} r_1 \\ r_2 \\ \vdots \\ r_N \end{pmatrix}$$

*Id.* at 9:52–64.

In the inverse matrix computer, all the combinations of the N transmitting antennas and receiving antennas are normalized with the known amplitude and phase of the known pilot signals of all subcarriers. Ex. 1001, 9:65–10:2. “In this way, the (N×N) matrix  $S^i$  with elements of complex numbers being the propagation coefficients for each of the  $i$  th subcarriers is calculated.” *Id.* at 10:2–5. “[T]he inverse matrix  $(S^i)^{-1}$  is calculated and stored.” *Id.* at 10:5–6.

Using the inverse matrix calculated by the inverse matrix computer, “the amplitude-phase output based on the pilot signal which becomes the reference for the amplitude-phase is obtained, and this becomes the demodulation output which is coherent detected for each subcarrier.” Ex. 1001, 10:12–16. Thus, the cancellation of interference between channels and the restoration of the transmitted signals ( $t_{i1}, t_{i2}, \dots, t_{iN}$ ) in the receiver can be achieved only by the computation of  $((r_{i1}, r_{i2}, \dots, r_{iN}) \times (S^i)^{-1})$ . *Id.* at 11:21–25; *see* equation (5) above.

#### *D. Illustrative Claim*

Claims 10–11, 18–20, 22–23, and 31–32 of the ’720 patent are challenged.<sup>7</sup> Pet. 3. Claims 10, 18, 22, 31, and 32 are independent claims to a “receiving device.” Claim 11 depends from claim 10, claim 19 depends

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<sup>7</sup> According to Petitioner, claims 10–11, 20, and 23 are not at issue in the District Court Lawsuit. Pet. 94; *see also* Prelim. Resp. 48 (acknowledging the assertion regarding claims 10 and 11).

from claim 18, and claim 23 depends from claim 22. Claim 18 is reproduced below as illustrative.

[18a<sup>8</sup>] An OFDM signal transmitting device used in an OFDM signal communication system for transmitting OFDM signals over the same radio frequency from the OFDM signal transmitting device comprising a plurality of N transmitting antennas to an OFDM signal receiving device comprising N receiving antennas,

[18b] the OFDM signal transmitting device comprises at least an interference canceller among an inverse matrix computer, the interference canceller, and a pilot signal generator,

[18c] wherein the inverse matrix computer computes each of inverse matrices of N-dimensional square matrices for each subcarrier constituted by the propagation coefficients for the respective propagation paths between the respective transmitting antennas and the respective receiving antennas, and

[18d] the interference canceller cancels interference components which occur between the OFDM signal transmitting device and the OFDM signal receiving device, based on the inverse matrix computed by the inverse matrix computer, and

[18e] the pilot signal generator generates N kinds of pilot signals for use by the inverse matrix computer to compute the inverse matrix, and

[18f] wherein the OFDM signal transmitting device further comprises: a data converter for respectively converting the transmission information signals of N systems into OFDM symbols;

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<sup>8</sup> For purposes of this Decision, we follow Petitioner's format as shown in the Claim Listing, using only brackets for claim limitations. Pet. 100–107. Patent Owner generally adopts Petitioner's format. *See, e.g.*, PO Resp. 59 (element [18g]).

[18g] the interference canceller for multiplying the respective subcarriers of the respective OFDM symbols generated by the data converter, by the inverse matrix obtained by the inverse matrix computer;

[18h] inverse fast Fourier transformers for performing inverse Fourier transformation on the outputs from the interference canceller; and

[18i] transmission frequency converters for converting the frequency band of the output from the inverse fast Fourier transformers, into radio frequency.

Ex. 1001, 68:9–47; Pet. 39–62; *see also* Pet. 100–107 (Claim Listing reproducing claims 18, 19, 22, 31, 32).

#### *E. Evidence*

This proceeding relies on the following prior art references and expert testimony:

Raleigh (Ex. 1005): Raleigh, US 6,144,711, issued November 7, 2000;

Ma (Ex. 1006): Ma, US 2002/0041635, published April 11, 2002.

Petitioner also relies on the Declaration of Gary R. Lomp, Ph.D. (Ex. 1003, “Lomp Declaration”) and the Reply Declaration of Gary R. Lomp, Ph.D. (Ex. 1097, “Lomp Reply Declaration”). Patent Owner relies in part on the Declaration of James T. Geier in Support of Patent Owner’s Response to Petition for *Inter Partes* Review of U.S. Patent No. 7,242,720 (Ex. 2001, “Geier Declaration”) and Declaration of Edwin A. Hernandez, Ph.D., in Support of Patent Owner’s Response to Petition for *Inter Partes* Review of U.S. Patent No. 7,242,720 (Ex. 2034, “Hernandez Declaration”).

*F. Prior Art and Asserted Ground*

Petitioner asserts that claims 10, 11, 18–20, 22, 23, 31, and 32 would have been unpatentable on the following ground (Pet. 3, 18–91):

| <b>Claim(s) Challenged</b>    | <b>35 U.S.C. §</b> | <b>Reference(s)/Basis</b> |
|-------------------------------|--------------------|---------------------------|
| 10–11, 18–20, 22–23,<br>31–32 | 103                | Raleigh, Ma               |

III. OBVIOUS ANALYSIS

*A. Legal Standard for Obviousness*

A patent claim is unpatentable as obvious 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.” 35 U.S.C. § 103(a).

The ultimate determination of obviousness is a question of law, but that determination is based on underlying factual findings. . . . 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) (citing *inter alia* *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 Federal Circuit found, in quoting from the Supreme Court’s decision in *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418–419 (2007),

“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.”

*Personal Web Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 991–92 (Fed. Cir. 2017).

#### *B. Level of Ordinary Skill in the Art*

Petitioner alleges a person having ordinary skill in the art “would have had at least a B.S. in Electrical Engineering, or the equivalent, and 3–4 years of experience designing wireless packet communication devices, including 802.11-compliant devices. More education could substitute for less experience, and vice versa.” Pet. 17–18 (citing Ex. 1003 ¶¶ 27–31). Patent Owner accepts Petitioner’s proposal. Prelim. Resp. 22. On this record, and for purposes of this Decision, we also adopt Petitioner’s proposal.

#### *C. Claim Construction*

In an *inter partes* review based on a petition filed on or after November 13, 2018, a claim shall be construed 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 (2019). The Petition was accorded a filing date of September 10, 2020. Paper 2. Thus, we apply the claim construction standard set forth in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc).

*“interference canceller”*

The District Court issued a Claim Construction Order in the related District Court Lawsuit, construing “interference canceller” as follows:

Plain-and-ordinary meaning wherein the plain-and-ordinary meaning is “a device for reducing interference from unwanted signals or noise.”

Ex. 1066, 3 (“Construction Order”). The Construction Order added “plain and ordinary meaning” to the construction of the term as proposed by Patent Owner. *See* Ex. 1066, 3 (Patent Owner’s proposed construction of “interference canceller”). We preliminarily determined the District Court’s Construction Order was consistent with the Specification and adopted it in the Institution Decision. Inst. Dec. 22 (citing Ex. 1001, 2:10–15 (differentiating equalizers and interference cancellers), 3:52–55, 4:63–5:4), 25.

Petitioner argues that zero-forcing (“ZF”) taught by Raleigh is an “interference canceller” because “it removes interference between signals transmitted by different MIMO-antennas, which is referred to herein as *spatial*-Inter-Symbol-Interference (‘spatial-ISI’)” and also removes interference caused by “antenna correlation” or “crosstalk.” Reply 1 (citing Inst. Dec. 26–27; Pet. 56–57). In other words, Petitioner contends that Raleigh’s disclosure of a ZF algorithm to reduce ISI teaches the “interference canceller” limitation of the challenged claims.

Patent Owner proposes that our preliminary construction be “clarified” to add that an “interference canceller” is a “device for reducing interference from unwanted signals or noise, as opposed to equalizing the channel.” PO Resp. 2. Patent Owner argues that Raleigh’s ZF algorithm is an equalizer, not an “interference canceller.” PO Resp. 2 (citing Ex. 2034 ¶ 11; Ex. 2033, 62:18–21).

We are not persuaded Patent Owner’s proposed modification is necessary. Indeed, Patent Owner contends that even without the proposed addition, the preliminary construction of “interference canceller” excludes equalizers. *Id.* (citing Ex. 2034 ¶¶ 11, 12; Lomp Deposition (Ex. 2033), 62:18–20). Accordingly, we adopt the District Court’s construction as our final construction of interference canceller.

Notwithstanding our now-final construction, a dispute remains between the parties with respect to whether or not a specific type of interference, namely, “inter-symbol interference” (“ISI”), is “interference from unwanted signals or noise” as that phrase is used in the construction. Petitioner argues that ISI is included in the construction of “interference canceller” and that the challenge based on Raleigh’s teaching of cancelling ISI falls within the scope of an “interference canceller.” Reply 1. Patent Owner argues ISI is not “interference from unwanted signals or noise.” PO Resp. 1. For the reasons discussed below, we find that ISI is a type of “interference from unwanted signals or noise.”

Patent Owner’s supporting evidence and argument that ISI should be excluded is based on the ’720 patent and extrinsic evidence including Raleigh, the Hernandez Declaration, and the Lomp Deposition. Patent Owner argues Raleigh’s ZF algorithm is not an “interference canceller” because the ZF algorithm bears “well-known hallmarks of ZF equalizers,”

that relate to amplification noise and antenna crosstalk interference related to the transmitted signals between antenna pairs rather than interference from other, i.e., “unwanted,” signals. *Id.* (citing Ex. 2033 ¶ 12; Ex. 2034, 200:25–201:6).

Patent Owner contends ISI is “termed ‘inter-*symbol* interference’ because it refers to the phenomenon of *symbols* comprising the *same signal* interfering with each other.” PO Resp. 46 (citing Ex. 2034 ¶ 125). Patent Owner argues that excluding ISI from “interference” is consistent with ordinary usage. *Id.* at 48 (citing Ex. 2034 ¶ 126; Ex. 2016,<sup>9</sup> 241). Patent Owner cites Raleigh as also supporting ISI as “self interference” separate from interference generally. *Id.* (citing Ex. 1005, 12:11–14 (“Thus, delayed and scaled versions of one symbol interfere with other symbols. This self interference effect is termed intersymbol interference.”)).

Patent Owner further argues equalizers, not “interference cancellers,” address ISI. PO Resp. 48. More specifically, Patent Owner argues, equalizers “are generally defined as devices *for addressing ISI*.” *Id.* (citing Ex. 2034 ¶ 127; Ex. 2003,<sup>10</sup> 759; Ex. 2001 ¶ 75). Patent Owner also cites the Specification as distinguishing an “interference canceller” from an “equalizer.” *Id.* at 50 (citing PO Resp. 20–30).

Petitioner identifies three types of noise and interference in MIMO systems.

- (1) “spatial-ISI” (antenna “crosstalk”) – receiving superpositions of different signals transmitted by different MIMO-system transmitting-antennas;
- (2) “temporal-ISI” – receiving

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<sup>9</sup> Microsoft COMPUTER DICTIONARY (4<sup>th</sup> Ed. 1999) (“interference n. 1. Noise or other external signals that affect the performance of a communications channel. . .”).

<sup>10</sup> Proakis, *Digital Communications* (4<sup>th</sup> Ed. 2001).

temporally-spaced “reflected” versions of a same MIMO-antenna-transmitted signal; and (3) external interferences (*e.g.*, external transmitters) and “noise” (*e.g.*, imperfections in receiving equipment).

Reply 3 (citing Ex. 1097 ¶¶ 15–16; Ex. 2047,<sup>11</sup> 10–12). Petitioner contends that Raleigh’s ZF algorithm cancels “spatial-ISI” and meets what we have adopted as the construction of “interference canceller.” Reply 4 (citing Pet. 55–56). More specifically, the Petition alleges “Raleigh’s transmit spatial processor (TSP) comprises an interference canceller that cancels interference by multiplying each SOP [substantially orthogonalizing procedure] bin (OFDM subcarrier) with an inverse channel matrix ( $W_T(n)$ ) computed by the inverse matrix computer.” Pet. 55 (citing Pet. 53–55 (showing on limitation [18c]); Ex. 1005, 12:2–4, 2:37–40 (“[S]patial processing techniques...*reduce[s]* radiated *interference*...”), 13:24–28 (“[T]he processing substantially *eliminates the ISI* [Inter-Symbol *Interference*] caused by the channel correlation across space (antenna correlation) . . .”); Ex. 1003 ¶¶ 161–166).

Petitioner alleges Patent Owner concedes that “spatial-ISI” is interference. Reply 4 (citing PO Resp. 2, 43 (“[T]he  $R_I$  term clearly accounts for the interference that occurs [between] spatial subchannels that are not orthogonal, *i.e.*, when there is crosstalk between antenna pairs.”). Petitioner sums up the issue by stating that Raleigh’s zero-forcing cancels

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<sup>11</sup> Edfors, *An introduction to orthogonal frequency-division multiplexing*, (September 1996) (incomplete copy).

spatial-ISI and is an “interference canceller.” *Id.* at 5 (citing PO Resp. 1–2); Ex. 2033 ¶¶ 6–7, 19–34, 39 (citing Ex. 1082,<sup>12</sup> 33–34).

We find nothing in the Specification of the ’720 patent that discusses ISI, let alone precludes ISI from being “interference.” By definition, ISI is “inter-symbol *interference*.” We find that “symbols” are transmitted as part of a signal. Ex. 1003 ¶ 32 (“symbol” is the “basic unit of information transmitted” from a transmitter to a receiver). We are not persuaded by Patent Owner’s contention that transmitting a symbol is not transmitting a “signal” which contains information. *See* PO Resp. 46 (citing Ex. 2034 ¶ 125).

The ’720 patent invention is described by Patent Owner as “an OFDM method [that] is used to realize a signal communication system for MIMO channels without using an equalizer.” PO Resp. 23–24 (quoting Ex. 1001, 4:63–5:4). Absent the construction Patent Owner proposes, equalizers are not recited as a negative limitation in any of the claims. Even if we determined that a proper construction did preclude equalization, Petitioner’s citation to Raleigh does not rely on “equalization” but instead on Raleigh’s TSP/RSP multiplication of a communications signal by inverse channel matrices, which is what is claimed. Pet. 24–28, 47–57; Ex. 1003 ¶¶ 77–87, 141–172.

Finally, we would need to read a limitation from the Specification into our construction to preclude an “equalizer.” *See, e.g.*, Ex. 1001, 4:63–65. “While claim terms are understood in light of the specification, a claim construction must not import limitations from the specification into the

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<sup>12</sup> Devillers, *Cyclic Prefixed Block Transmission for Wireless Commutations: Performance Analysis and Optimization*, (Mar. 2009) (Unpublished Ph.D. thesis, Université Catholique de Louvain).

claims.” *Energy Transp. Grp., Inc. v. William Demant Holding A/S*, 697 F.3d 1342, 1349 (Fed. Cir. 2012) (declining to limit a claim “to external or fixed programming”) (citations omitted).

On this record, we are not persuaded that a proper construction of “interference canceller” precludes ISI from being interference. Nor are we persuaded that equalizers should be excluded. We adopt the District Court claim construction of “interference canceller” as our final construction.

*D. Obviousness of Claims 10–11, 18–20, 22–23, and 31–32 over Raleigh and Ma*

Petitioner alleges claims 10–11, 18–20, 22–23, and 31–32 would have been obvious over Raleigh and Ma. Pet. 18–91; generally Reply. Petitioner also relies on the Lomp Declaration and the Lomp Reply Declaration. Ex. 1003 ¶¶ 71–309; Ex. 1097 ¶¶ 15–34, 85–151.

*1. Raleigh (Ex. 1005)*

Raleigh “provides a space-time signal processing system with advantageously reduced complexity.” Ex. 1005, 1:66–67. Raleigh explains that “[m]any wireless communication channels are characterized by multi-path, where each path has associated fading and propagation delay.” *Id.* at 10:16–18. Multi-path occurs when, for example, a base “transmits information to and receives information from a remote unit.” *Id.* at 10:22–24; *see id.* at Figs. 4–6 (multi-path examples).

Raleigh describes a system of “multiple transmitter antenna elements and/or multiple receiver antenna elements, or multiple polarizations of a single transmitter antenna element and/or single receiver antenna element.” Ex. 1005, 2:1–4. In a wireless embodiment, a substantially orthogonalizing procedure (“SOP”) defined, in part, as playing “a part in transforming a time domain sequence into a parallel set of substantially orthogonal bins, wherein

the signals in one bin do not substantially interfere with the signals from other bins.” *Id.* at 2:10–15, 4:60–67. “[E]ach SOP bin is [] associated with a frequency bin.” *Id.* at 2:46–47; *see also* Ex. 1003 ¶ 77 (SOP bins correspond to OFDM subcarrier signals). Spatial processing provides “substantially independent spatial subchannels within each SOP bin even in the presence of significant cross talk interference between two or more physical transmit and receive antenna pairs.” *Id.* at 2:51–55.

A “‘matrix channel’ refers to a channel with multiple inputs and multiple outputs (MIMO).” Ex. 1005, 4:17–19. “[E]ach SOP bin may be characterized by a matrix of complex values, with each value representing the path gain from a given transmit antenna element to a given receive antenna element in that particular SOP bin.” *Id.* at 15:4–10. “Each entry  $H_{i,j}$  in the matrix  $H$  describes the complex path gain from input  $j$  to output  $i$ .” *Id.* at 4:19–20. Raleigh’s transmitter-side spatial processing<sup>13</sup> “multiplies one or more symbols that are destined for transmission in a given SOP bin with one or more spatial vector weights,” which are collectively “referred to as a matrix.” *Id.* at 6:42–48. Combining OFDM and SOP “with multiple input antennas, or multiple output antennas, or both multiple input and multiple output antennas” is described as “matrix-OFDM (MOFDM).” *Id.* at 14:9–13.

SOP can be used to transmit with IFFT (inverse fast Fourier transforms) and receive with FFT (fast Fourier transforms). Ex. 1005, 2:45–50. The “SOP decomposes the time domain space-time communication channel that may have intersymbol interference (ISI)” into parallel SOP bins

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<sup>13</sup> Raleigh describes “spatial processing” in the context of a Transmitter Space-Frequency Pre-Processor (TSFP) block. Ex. 1005, 6:21–23, 6:41–42.

“wherein the ISI is substantially reduced and the signal received at a receiver in one bin of the SOP is substantially independent of the signal received in any other bin in the SOP.” *Id.* at 2:15–21.

The effect of the SOP is to substantially remove the ISI between any two symbols assigned to different bins, for any pair of transmit and receive antennas. Therefore, for each IFFT-FFT bin  $n$ , the received signal values for each antenna,  $x(n)$ , are related to the transmitted frequency-domain symbols,  $z(n)$ , through the expression,

$$x(n)=H(n)z(n)+I(n) \quad \forall^{[14]}n \quad (10)$$

where  $x(n)$  is a complex  $M_R$ -element vector at SOP bin  $n$ ,  $z(n)$  is a complex  $M_T$ -element symbol vector at bin  $n$ , and  $I(n)$  is the interference and noise at all receive antennas for bin  $n$ .

*Id.* at 14:58–15:2.

Spatial sub-channels, “ $H(n)$ , are  $M_R$  by  $M_T$  element matrices that describe the spatial correlation remaining in the wireless channel after the SOP.” Ex. 1005, 15:4–6. Per the Lomp Declaration, this disclosure supports that “ $H(n)$  is an  $N$  by  $N$  (i.e.,  $N$ -dimensional square) matrix for each subcarrier  $n$ .” Ex. 1003 ¶ 157.

A matrix defines transmission and receiving operations at the receiver. Ex. 1005, 15:41–45. For example, the matrix below expresses “a pre-multiplication of a  $NM_R \times NM_R$  block diagonal FFT matrix.”

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<sup>14</sup> A turned A,  $\forall$ , is a logical constant which is interpreted as “for all”. Miller, *Earliest Uses of Various Mathematical Symbols* (last updated October 2019).

$$Y_{(M_R)} = \begin{bmatrix} Y & 0 \\ & \ddots \\ 0 & Y \end{bmatrix}.$$

*Id.* at 15:45–50. The input-output relationship between the transmitter,  $M_T$  IFFT, and receiver,  $M_R$  FFT, is described by

$$Y_{(M_R)} \tilde{G} Y_{M_T}^H = \begin{bmatrix} D_{1,1} & \dots & D_{1,M_T} \\ \vdots & \ddots & \vdots \\ D_{M_R,1} & \dots & D_{M_R,M_T} \end{bmatrix},$$

*Id.* at 15:51–61. “ $D_{i,j}$  is the diagonal matrix containing the SOP bin strengths for the antenna pair (i,j).” *Id.* at 15:61–62.

The composite channel, represented by  $H'(n)$ , can be the MIMO channel between bases and remote units. Ex. 1005, 11:42–50, 18:56. The composite channel in bin  $n$  for the transmit antenna  $M_T$  inputs to  $M$  outputs, is described by the equation “ $H'(n) = U(n)H(n)$ ,” where “ $U(n)$  is composed of the RSW row vectors,  $u(n,m)$ ,” and  $H(n)$  is the standard spatial channel matrix for each subcarrier  $n$ . *Id.* at 18:56–61, 14:60–15:6, 19:41–42, 25:5–7, 28:23–27, 29:32–35, Fig. 12 (“Receiver Spatial Weights (RSWs)”). “The transmitter can substantially orthogonalize th[e] composite channel,  $H'(n)$ , by applying appropriate TSWs [transmitter spatial weights],” which “are the column vectors of the weighting matrix,  $W_T(n)$ .” *Id.* at 18:61–19:6. “The transmit weighting can be determined by ZF [“zero-forcing solution”] approach, the weighting matrix is equal to the pseudo-(right)-inverse of  $H'(n)$ .” *Id.* at 18:66–19:5, 18:9 (ZF).

According to the Lomp Declaration,

the composite channel matrix is equal to the channel matrix (i.e.,  $H'(n) = H(n)$ ). Thus, when the spatial orthogonalization is only performed in the transmitting device, the pseudo-inverse of the composite channel matrix is the pseudo-inverse of the channel matrix.

Ex. 1003 ¶ 80. The Lomp Declaration further explains that “a true inverse only exists for a square matrix, but Raleigh has embodiments with non-square matrices (e.g., when the number of transmitting antennas does not equal the number of receiving antennas), which does not have a true inverse.” *Id.*

Raleigh discloses “a Training Symbol Injection block 20 [that] may be used to place a set of known training symbol values in the transmitter symbol stream.” Ex. 1005, 6:6–9. “The purpose of the training symbols is to provide a known input within a portion of the transmitted symbol stream so that a receiver may estimate the communication channel parameters.” *Id.* at 6:9-14. Raleigh teaches that both transmit and receive channels are estimated. *Id.* at 29:48–50.

## 2. *Ma (Ex. 1006)*

Ma relates to “Preamble Design for Multiple Input – Multiple Output (MIMO), Orthogonal Frequency Division Multiplexing (OFDM) System.” Ex. 1006, code (54). Ma teaches a system for wireless delivery of data “that has the advantages of both an OFDM system as well as those of a MIMO system.” *Id.* ¶¶ 2, 9. Ma “transmits OFDM symbols over a plurality of channels with either spatial diversity or temporal diversity between the symbols.” *Id.* ¶ 9.

Upon receipt at the remote station, “the signals may be distorted because of transmitter imperfections as well as because of environmental effects and interference which change the frequencies of the channels and

may also increase the bit error rate (BER).” Ex. 1006 ¶ 9. “[W]hen the signals are detected by the multiple antenna, they may be distorted and must also be synchronized and framed properly to avoid errors.” *Id.* ¶ 24. To deal with this problem, Ma teaches the following:

one or more preambles which are is inserted between the OFDM data symbols within OFDM frames in the time domain. The preamble includes training symbols which include a training sequence for different antennas, also known as pilot symbols.

*Id.* ¶ 25. Ma explains that distortion is compensated for by using “detected sub-symbols and the known values of the subsymbols to estimate the values of channel responses vectors that are delivered to the STC decoder 713 to compensate for distortions in the received signal.” *Id.* ¶ 48.

### 3. Claim 18

Claim 18 is an independent device claim illustrative of the claimed subject matter. *See* Section II.D above. Patent Owner specifically disputes the showing made with respect to limitations 18c, 18d and 18g. PO Resp. 55–62.

The technology claimed lends itself to expert testimony. We exercise our discretion and find that Dr. Lomp’s testimony is credible on the technical issues presented. *See Shoes by Firebug LLC v. Stride Rite Children's Group, LLC*, 962 F.3d 1362, 1372 (Fed. Cir. 2020) (citing *Yorkey v. Diab*, 601 F.3d, 1284 (Fed. Cir. 2010)). We disagree with PO’s attempts to misinterpret and discredit Dr. Lomp’s testimony. *See, e.g.*, PO Resp. 1 (“[T]he deposition testimony of Petitioner’s own expert (EX2033, ‘Lomp’) clearly shows that Raleigh’s ZF algorithm is *not* the ’720’s ‘interference canceller.’”), 2 (“Petitioner’s expert . . . admits that he failed to consider this in his analysis”), 12–13; Ex. 1097 ¶¶ 48–56 (Dr. Lomp highlighting his

deposition testimony that was taken out of context), 215, 233. For example, Dr. Lomp testified that “Raleigh’s zero-forcing embodiments remove spatial-ISI (unquestionably ‘interference’), entirely consistent with the opinions I offered in my opening declaration.” Ex. 1097 ¶ 56 (citing Ex. 1003 ¶¶ 41, 78–80, 85–86, 161–166, 222–224). We are persuaded that Raleigh does teach an interference canceller and Dr. Lomp’s testimony consistently supports that finding.

a. *“inverse matrix computer computes each of inverse matrices”  
(Limitation 18c)*

*(1) Petitioner’s Argument and Evidence*

With respect to the “inverse matrix calculator” of limitation 18c, Petitioner alleges “interference is a known fact of life of digital transmission systems,” specifically including MIMO systems where multiple transmitter antennas interfere with each other. Pet. 5 (citing Ex. 1003 ¶ 32 (citing Ex. 1011,<sup>15</sup> 1:26–27)). Petitioner alleges that one approach is to estimate the interference in the transmission channel and cancel the interference, leaving “an accurate estimate of the transmitted symbols.” *Id.* at 6 (citing Ex. 1003 ¶ 37 (citing Ex. 1042,<sup>16</sup> 7:21–38)).

Petitioner alleges Raleigh teaches an inverse matrix computer because Raleigh “computes inverse matrices  $W_T(n)$  of the N-dimensional square channel matrices  $H(n)$  for each subcarrier  $n$ , where  $H(n)$  reflects the impact the channel has on the transmitted signal on subcarrier  $n$ .” Pet. 53 (citing Pet. 5–9; Ex. 1003 ¶ 157). Petitioner argues Raleigh’s teaching of  $H(n)$  “represent[s] ***the path gain from a given transmit antenna element to a given receive antenna element in that particular SOP bin*** [OFDM

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<sup>15</sup> Polydoros, US 5,432,821, issued Jul. 11, 1995.

<sup>16</sup> Gesbert, US 6,963,619 B1, issued Nov. 8, 2005.

subcarrier],” as recited in limitation 18c. *Id.* (citing Ex. 1005, 15:4–10, 4:16–20; Ex. 1003 ¶ 157 (citing Ex. 1005, 15:4–10, 4:16–22, 19:39–40)).

Petitioner looks to Raleigh’s teaching that “composite channel is defined by the equation  $H'(n) = U(n)H(n)$  [which] describes the MIMO channel in bin  $n$  from the  $M_T$  [transmit antenna] inputs to  $M$  outputs [transmitted signals] and reflects the impact of the channel ( $H(n)$ ), and the impact of any processing done at the receiver ( $U(n)$ ).” Pet. 54 (citing Ex. 1005, 18:55–61). Petitioner further cites Raleigh for its disclosure that the “transmitter can substantially orthogonalize th[e] composite channel,  $H'(n)$  [and therefore  $H(n)$  as well], by applying appropriate TSWs [transmitter spatial weights],” which Petitioner contends “are the column vectors of . . .  $W_T(n)$ ’ (the inverse matrices).” *Id.* (quoting Ex. 1005, 18:61–65; citing Ex. 1003 ¶ 159–160).

Petitioner quotes from Raleigh that “[t]he transmit weighting [ $W_T(n)$ ] can be determined using the ZF . . . approach,” whereby “the weighting matrix is equal to the pseudo-(right)-inverse of  $H'(n)$ .” Pet. 54–55 (quoting Ex. 1005, 18:66–19:1; citing Ex. 1003 ¶ 159). Relying on the Lomp Declaration, Petitioner asserts that “pseudo-inverse” refers to “non-invertible (e.g., non-square) channel matrices,” and it relies on Raleigh’s teaching of  $H'(n) = H(n)$  in the square matrices embodiment as showing that the “ZF approach computes true (not pseudo) inverses of  $H(n)$ , thereby meeting the limitation [18c].” *Id.* at 55 (citing Ex. 1003 ¶¶ 159–160 (citing Ex. 1018,<sup>17</sup> 3:24–26; Ex. 1042, 7:38; Ex. 1021,<sup>18</sup> 7:33–39, 20:39–49; Ex. 1028,<sup>19</sup> 4:26–

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<sup>17</sup> Raghavan, US Patent No. 6,038,269, issued March 14, 2000.

<sup>18</sup> Thomsen, US Patent No. 6,292,754 B1, issued September 18, 2001.

<sup>19</sup> Davis, US Patent No. 6,449,368 B1, issued September 10, 2002.

52; Ex. 1027,<sup>20</sup> 5:43–67)). In addition, Petitioner quotes Raleigh for its teaching that “the processing substantially *eliminates the ISI* [Inter-Symbol *Interference*] caused by the channel correlation across space (antenna correlation).” Pet. 56 (citing Ex. 1005, 13:24–28; Ex. 1003 ¶¶ 162–166) (emphasis in original).

*(2) Patent Owner’s Argument and Evidence*

Patent Owner explains that the channel matrix is further understood through “singular-value decomposition (SVD)” and that “SVD decomposes this matrix into smaller, simpler matrices that retain the image’s essential features.” PO Resp. 4, 7–8. Patent Owner alleges that Raleigh “describes essentially the same concept in characterizing a MIMO channel in terms of a spatial channel matrix  $H(n)$ .” *Id.* at 5–6 (citing Ex. 2034 ¶ 56 (citing Ex. 1005, 14:63–15:10)). *Id.* at 6.

Patent Owner works equalizers into its argument by alleging “that Raleigh’s ZF algorithm does not operate on propagation coefficients because it is a linear equalizer, which is a linear filter.” PO Resp. 14–18. This position is a contention related to temporal ISI (“temporal-ISI” – receiving temporally-spaced “reflected” versions of a same MIMO-antenna-transmitted signal”). *See* Section III.C; Reply 5. Patent Owner then contends that the ZF algorithm in Raleigh is a linear filter. PO Resp. 15–16 (citing Ex. 2034 ¶¶ 66–68; Ex. 2033, 60:7–10, 37:21–23, 176:24–177:5; (other citations omitted)).

Specific to limitation 18c and relying on the Hernandez Declaration, Patent Owner alleges that Raleigh’s ZF algorithm does not compute an inverse matrix. PO Resp. 55 (citing Ex. 2034 ¶ 137). Support for this

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<sup>20</sup> Das, US Patent No. 6,418,171 B1, issued Jul. 9, 2002.

position is based on the assertion that “Raleigh’s ZF algorithm is not applied to a matrix constituted of propagation coefficients, such as a channel matrix, but rather a ‘composite matrix’  $H'(n)$  that is the product of  $U(n)*H(n)$ .” *Id.* (citing PO Resp. 35–40).

*(3) Determination Regarding Limitation 18c*

Contrary to the premise for Patent Owner’s argument, Petitioner does not rely on SVD teachings from Raleigh as the only way to orthogonalize the transmission and remove “spatial-ISI.” SVD is irrelevant to Petitioner’s argument. Rather, Petitioner cites Raleigh for teaching that “[t]he transmit weighting  $[W_T(n)]$  can be determined using the ZF . . . approach,” whereby “the weighting matrix is equal to the pseudo-(right)-inverse of  $H'(n)$ .” Pet. 54–55 (quoting Ex. 1005, 18:66–19:1; citing Ex. 1003 ¶ 159); *see also* Reply 27–29. We credit Dr. Lomp’s deposition testimony that SVD is “an alternative” to zero-forcing (152–153); he had “no opinions” on SVD because he relied on Raleigh’s zero-forcing and did not find SVD particularly relevant. Ex. 2034, 152–153, 193–194.

We credit the Lomp Declaration, which is based on Raleigh’s teachings, to find that the claimed inverse matrix is based on Raleigh’s TSWs, which ““can be determined using the ZF [zero forcing] . . . approach,” whereby ‘the weighting matrix is equal to the pseudo-(right)-inverse of  $H'(n)$ .’” Ex. 1003 ¶ 159 (citing Ex. 1005, 18:66–19:1). The “ZF approach computes true (not pseudo) inverses of  $H(n)$ , thereby meeting the limitation [18c].” *See* Pet. 55.

Based on the preceding, we find that the “ZF solution . . . orthogonalizes the spatial channel.” Reply 5 (citing Ex. 1005, 18:20–22 (additional citations to Petition omitted); Pet. 24 (citing Ex. 1005, 6:48–62)). As a result, spatially orthogonal channels crosstalk, or spatial ISI, is

removed.” Reply 6 (citing Ex. 2034 ¶ 117 (citing Ex. 1005, 22:54–56); Ex. 1087, 189–190, 203).<sup>21</sup> We credit Dr. Lomp’s testimony that orthogonalization includes interference cancellation. Ex. 1003 ¶ 41; Ex. 1097 ¶¶ 120–132.

Further, we find that Raleigh’s “composite matrix” computes an inverse matrix for interference cancellation because “it is applied to a ‘composite matrix’  $H'(n)$  that is the product of  $U(n)*H(n)$ .” See PO Resp. 55. “ $U(n)/V(n)$  are Raleigh’s labels for matrices of spatial-weights.” Reply 25 (citing Ex. 1005, 18:56–61); *see also* Pet. 26, 54 (citing Ex. 1005, 18:56–67, 17:65–67–71), *see also* 25–28, 48–56, 67–71 (also citing Ex. 1005, 18:56–61, 17:65–67). We find that “ $U(n)$  has ‘RSWs,’ while  $V(n)$  has ‘TSWs.’” Reply 25 (citing Ex. 1005, 18:56–61, 17:65–67). We further find that “RSWs and TSWs are spatial weights multiplying signals at the receiver and transmitter, respectively.” *Id.*

We find that Raleigh’s channel “matrix  $H$  describes . . . **complex** path gains” that are “propagation coefficients for the respective propagation paths.” Reply 30 (citing Pet. 51, 53–54, 70–71 (citing Ex. 1005, 4:16–20, 15:4–10); PO Resp. 4–6; Ex. 2034 ¶¶ 106–110; Ex. 1087, 134–135). We further find that a person of ordinary skill would know how to use computers to perform the claimed complex number computations. Ex. 1097, 69–76; Ex. 2034 ¶¶ 200–201.

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<sup>21</sup> Q: So if the spatial channels are not orthogonal, does that mean there’s crosstalk between antenna pairs? A: There would be crosstalk, correct? Q: Okay. So when Raleigh says orthogonal spatial channels, he means no crosstalk between antenna pairs. Is that correct? A: That’s what he’s trying to convey with his formula, correct. Ex. 1087, 189:4–190:9.

As discussed above, that Raleigh is an interference canceller and whether or not Raleigh also “equalizes” a signal is irrelevant. *See* Section III.C above. Petitioner relies on the ZF algorithm procedure in Raleigh to cancel ISI interference and does not rely on equalization.

Petitioner has sufficiently shown that Raleigh teaches limitation 18c.

*b. “interference canceller” (Limitation 18d)*

Limitation 18d recites that “the *interference canceller* cancels interference components which occur between the OFDM signal transmitting device and the OFDM signal receiving device, based on the inverse matrix computed by the *inverse matrix computer*.” We finalized our construction of “interference canceller” as meaning “plain-and-ordinary meaning wherein the plain-and-ordinary meaning is ‘a device for reducing interference from unwanted signals or noise.’” *See* Section III.C above. The “interference canceller” of limitation 18d is also recited in limitations 18c above and 18g below. Ex. 1001, 68:19–24 (limitation 18c), 68:38–41 (limitation 18g).

*(1) Petitioner’s Argument and Evidence*

For limitation 18d, Petitioner argues it is shown by “Raleigh’s transmit spatial processor (TSP) which is an interference canceller that cancels interference by multiplying each SOP bin (OFDM subcarrier) with an inverse channel matrix ( $W_T(n)$ ) computed by the inverse matrix computer.” Pet. 55 (citing Ex. 1003 ¶ 61). The inverse matrix computer is recited in connection with limitation 18c discussed above in Section III.D.3.a.(1)–(3). *See* Pet. 55 (citing Ex. 1003 ¶¶ 159–161 (citing

Ex. 1018,<sup>22</sup> 3:24–26; Ex. 1042,<sup>23</sup> 7:38; Ex. 1021,<sup>24</sup> 7:33–39, 20:39–49; Ex. 1028,<sup>25</sup> 4:26–52; Ex. 1027,<sup>26</sup> 5:43–67)); *see also id.* at 59 (regarding limitation 18g).

Petitioner argues that limitation 18d is shown in Raleigh’s “interference canceller” where the TSP “cancels interference components which occur between transmitting and receiving devices.” Pet. 55 (citing Pet. 53–55 (showing regarding limitation 18c)). According to Petitioner, interference is cancelled because “[t]he channel impulse response [used to compute  $WTT(n)$ ] includes *the effects of the propagation environment*,’ such as interferences from other transmitted signals.” *Id.* (citing Ex. 1005, 12:2–4, 2:37–40 (“[S]patial processing techniques...*reduce[s]* radiated *interference*...”), 13:24–28 (“[T]he processing substantially *eliminates the ISI* [Inter-Symbol *Interference*] caused by the channel correlation across space (antenna correlation)...”); Ex. 1003 ¶¶ 162–166 (citing Ex. 1029,<sup>27</sup> 1:64–2:1; Ex. 1045,<sup>28</sup> 11:46–49; Ex. 1046,<sup>29</sup> 4:65–66).

## (2) Patent Owner’s Argument and Evidence

Relative to limitation 18d, Patent Owner argues as it did for claim construction that Raleigh’s ZF algorithm is an equalizer, not an “interference canceller.” PO Resp. 59; *see also* Section III.C. above (construing “interference canceller”). According to Patent Owner, Raleigh does not

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<sup>22</sup> Raghavan, US Pat. No. 6,038,269 B1, issued Mar. 14, 2000.

<sup>23</sup> Gesbert, US Pat. No. 6,963,619 B1, issued Nov. 8, 2005.

<sup>24</sup> Thomsen, US Pat. No. 6,292,754 B1, issued Sep. 18, 2001.

<sup>25</sup> Davis, US Pat. No. 6,449,368 B1, issued Sep. 10, 2002.

<sup>26</sup> Das, US Pat. No. 6,418,171 B1, issued Jul. 9, 2002.

<sup>27</sup> Wallace, US 6,473,467 B1, issued Oct. 29, 2002.

<sup>28</sup> Monsen, US 7,072,410 B1, issued Jul. 4, 2006.

<sup>29</sup> Chan, US 7,292,661 B1, issued Nov. 6, 2007.

cancel interference based on an inverse matrix but rather “mechanisms *not involving the claimed inverse matrix*—such as SOPs and weight vectors determined using RI, to cancel interference.” *Id.*

Patent Owner advances two arguments in support of its position. PO Resp. 59–62. First is that Raleigh’s ZF equalizer does not meet the construction of “interference canceller.” *Id.* at 59–60 (citing Ex. 2034 ¶ 146). Second, Patent Owner contends, as it did in connection with limitation 18c, that use of the ZF algorithm amplifies interference and noise where the signal is “nearly orthogonal” to begin with. *Id.* at 60–62 (citing Ex. 2034 ¶ 146).

### *(3) Determination Regarding Limitation 18d*

We are persuaded by Petitioner’s argument and evidence with respect to this limitation. Whether or not Raleigh “equalizes” a signal is irrelevant. That “equalization” is used to combat ISI is not dispositive as to whether or not Raleigh teaches an “interference canceller.” *See* PO Resp. 14–18 (citing Ex. 2034 ¶ 65; Ex. 2003, 583 (other citations omitted)). The question is whether or not Raleigh cancels “interference.” Petitioner relies on the ZF algorithm to cancel ISI interference and does not rely on equalization. We agree with Petitioner that Raleigh’s “*zero-forcing*, always ‘orthogonalizes the spatial channel,’” cancelling interference. Reply 19–20 (citing Ex. 1005, 18:11–22; Pet. 26–28; Ex. 2034 ¶ 192).

Virtually all, if not all, of Patent Owner’s arguments require that we determine an “interference canceller” cannot be an equalizer. We construed “interference canceller” above without accepting this argument. *See* Section III.C above. Based on that determination, the arguments related to the ZF algorithm all presuppose an exclusive relationship to equalization.

Even if we accept Patent Owner’s clarification to the construction of “interference canceller,” which we do not, Petitioner has shown that Raleigh’s “ZF equalizer” is also an “interference canceller” because it reduces ISI, which is a form of interference. *See* Reply 5–7. Patent Owner relies on arguments we reject that Raleigh is limited to teaching an equalizer and ISI is not interference. We do not repeat that analysis here. *See* Sections III.C and III.D.3.a.(1)–(3) above. Raleigh teaches computing the claimed inverse matrix based on Raleigh’s TSWs, which “‘*can* be determined using the ZF [zero forcing] . . . approach,’ whereby ‘the weighting matrix is equal to the pseudo-(right)-inverse of  $H'(n)$ .’” Ex. 1003 ¶ 159 (citing Ex. 1005, 18:66–19:1) (emphasis added).

Petitioner has sufficiently shown that Raleigh teaches limitation 18d.  
*c. “the interference canceller for multiplying the respective subcarriers . . . by the inverse matrix” (Limitation 18g)*

Patent Owner disputes that Raleigh “discloses methods of dealing with interference, they do not operate by applying the claimed inverse matrix.” PO Resp. 62 (citing Ex. 2034 ¶ 151); PO Resp. 59–62 (argument and evidence for limitation 18d). The Hernandez Declaration alleges that “Raleigh’s ZF solution, which Petitioner claims provides an ‘inverse matrix,’ is not an ‘interference canceller’ but a linear equalizer.” Ex. 2034 ¶ 151. We find Patent Owner’s argument and supporting evidence is not persuasive for the reasons discussed in Sections III.C, III.D.3.a.(1)–(3) and III.D.3.b.(1)–(3) above. Petitioner argues “Raleigh’s TSP in the OFDM signal transmitting device includes an interference canceller that processes OFDM symbols generated by Modulation and RF System blocks (data converters).” Pet. 59 (citing Ex. 1005, 6:21–27, 6:41–45; Ex. 1003 ¶ 179).

Petitioner has sufficiently shown that Raleigh teaches limitation 18g.

*d. Remaining Limitations of Claim 18*

The remaining limitations are 18a, 18b, 18e, 18f, 18h, and 18i. Petitioner argues that Raleigh and Ma teach the preamble, limitation 18a. Pet. 39–47 (limitation 18a (“OFDM signal communication system” and MIMO)). Regardless of whether the preamble is limiting, Petitioner has shown that the prior art satisfies the recitation in the preamble. We also find that Petitioner has sufficiently shown limitations 18b, 18e, 18f, 18h, and 18i. *Id.* at 47–52 (limitation 18b (“an interference canceller in a system that also includes an inverse matrix computer and a pilot signal generator”)), 56–57 (limitation 18e (pilot signals used by the inverse matrix computer)), 58–59 (limitation 18f (data converter to convert N signals into OFDM symbols)), 59–61 (limitation 18h (inverse fast Fourier transformers)), 61–62 (limitation 18i (transmission frequency converter)). Patent Owner does not argue or specifically dispute Petitioner’s showing on any of the remaining limitations or, where relevant, the reasons or motivation for the Raleigh and Ma combination. *See generally* PO Resp. Each limitation is discussed below.

Limitation 18a is the preamble of the claim and recites in pertinent part

An OFDM signal transmitting device used in an OFDM signal communication system for transmitting OFDM signals over the same radio frequency from the OFDM signal transmitting device comprising a plurality of N transmitting antennas to an OFDM signal receiving device comprising N receiving antennas.

Ex. 1001, 68:9–15. With respect to OFDM signals over the same radio frequency, Petitioner cites to Raleigh’s transmitting system shown in Figure 11, which applies a “substantially orthogonalizing procedure (SOP)” that “is commonly referred to as discrete orthogonal frequency division multiplexing (OFDM).” Pet. 39 (citing Ex. 1005, 1:18–20, 2:44–48, 6:32–34, 12:45–50,

13:66–67, 14:9–13; Ex. 1003 ¶ 114). Petitioner also cites Ma as disclosing “transmitting OFDM signals over the same radio frequency, a [person of ordinary skill] had reasons to implement Raleigh/Ma to do so.” *Id.* at 40 (citing Ex. 1003 ¶ 117).

Petitioner alleges “N transmitting antennas” are shown in an annotation of Figure 11 of Raleigh. Pet. 41–42 (Fig. 11 annotated with red highlighting of two “Transmit Antenna 51”) (citing Ex. 1005, 2:1–2, 2:9–15, 5:16–17, 17:18–22, 27:64–67, Figs. 1, 4–6, 8–11, 13; Ex. 1003 ¶¶ 124–126). Corresponding recited “N receiving antennas” are shown in an annotation of Figure 12 of Raleigh. *Id.* at 43 (Fig. 12 annotated with red highlighting of two “Receive Antenna”).

That the transmitting and receiving antennas are both N, and therefore equal in number, is shown by the use of the same reference number for both transmission and receiving antennas,  $M_T$  and  $M_R$ . Pet. 43–45 (citing Ex. 1003 ¶¶ 129–132; Ex. 1005, Figs. 4 and 6 (annotated to highlight reference numbers 55 for transmitting and receiving antennas)).

Alternatively, Petitioner cites to Ma as teaching equal number of transmitting and receiving antennas. Ma is cited for its teaching of “a symmetric OFDM-MIMO system having  $N = 2$  transmitting and receiving antennas.” Pet. 45 (citing Ex. 1006 ¶¶ 31, 35–36, 42, Figs. 1, 7).

Limitation 18b recites that “the OFDM signal transmitting device comprises at least an interference canceller among an inverse matrix computer, the interference canceller, and a pilot signal generator.” Ex. 1001, 68:15–18. As already discussed in connection with limitation 18d, Petitioner argues Raleigh’s “Transmit Spatial Processor” (TSP) includes an interference canceller. Pet. 47 (citing Ex. 1003 ¶ 141; Ex. 1005, 16:34–35, 18:53–19:1), 48 (Fig. 11 annotated with red line surrounding the TSP).

Petitioner acknowledges the recited “inverse matrix computer” is not expressly shown by Raleigh, e.g., in a block diagram. Pet. 48 (citing Ex. 1003 ¶ 142). Rather, it is alleged Raleigh’s TSP “multiplies one or more symbols that are destined for transmission in a given SOP bin with’ TSW weight vectors that together form a ‘*matrix*’ ( $W_T(n)$ ), which is an inverse channel matrix.” *Id.* (citing Ex. 1005, 6:42–48, 16:24–29, 18:64–65; Ex. 1003 ¶ 143). Petitioner relies on the Lomp Declaration to conclude that a person of ordinary skill would have understood that the disclosed computation of  $W_T(n)$  is an inverse matrix computer. *Id.* at 49 (citing Ex. 1003 ¶ 144 (citing Ex. 1005, 32:39–40)). Alternatively, Petitioner argues three reasons why a person of ordinary skill would implement  $W_T(n)$  with a computer. *Id.* at 49–50 (citing Ex. 1003 ¶¶ 146–150). For example, the first reason is “it would have been the application of a known technique to a known device, because TSWs are numbers (amplitude and phase values), which computers compute.” *Id.* at 49 (citing Ex. 1003 ¶ 146 (citing Ex. 1029,<sup>30</sup> 13:3–14:39, 28:58–29:4; Ex. 1014,<sup>31</sup> 7:14–17; Ex. 1047, 24:34–43); *In re Yufa*, 452 F. App’x. 998, 1001 (Fed. Cir. 2012) (affirming obviousness because prior art disclosed “every element of the claims except” the location for “processing” data, which was “nothing more than a reconfiguration of a known system”) (citing *KSR*, 550 U.S. at 417)).

For the “interference canceller” of limitation 18b, Petitioner cites to its showing regarding limitation 18d above. Pet. 50 (citing Ex. 1003 ¶ 151). For limitation 18b’s recitation of a “pilot signal generator,” Petitioner points to Raleigh’s “Training Symbol Injector Block 20” shown in Figure 1

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<sup>30</sup> Wallace, US 6,473,467 B1, issued Oct. 29, 2002.

<sup>31</sup> Miki, US 5,724,378, issued Mar. 3, 1998.

highlighted in red at page 51 of the Petition. Raleigh is also cited for its teaching regarding sending “training symbols,” which Ma teaches and are “also known as pilot symbols.” *Id.* at 51–52 (citing Ex. 1005, 4:18–20; Ex. 1006 ¶ 25; Ex. 1003 ¶¶ 153–155 (citing Ex. 1040,<sup>32</sup> 1:30–32; Ex. 1031,<sup>33</sup> 5:4–6)).

Limitation 18e recites that “the pilot signal generator generates N kinds of pilot signals for use by the inverse matrix computer to compute the inverse matrix.” Ex. 1001, 68:31–33. Petitioner again cites to Raleigh’s “Training Symbol Injector” in combination with Ma’s preamble injector. Pet. 56 (citing Ex. 1003 ¶ 168). According to Petitioner, channel identification or channel matrices are sent in a single burst where “ **$M_T$  mutually exclusive sets of  $v$  bins . . . carry training symbols**” and “[e]ach transmitter antenna carries training symbols in **a unique one of the  $M_T$  sets of bins**, while transmitting no energy in the’ other bins (subcarriers).” *Id.* (citing Ex. 1005, 31:26–31; Ex. 1003 ¶ 169). Petitioner relies on the Lomp Declaration to conclude that the preceding teaches using pilot signals that are used by the inverse matrix computer to compute the claimed inverse matrix, which inverse matrix is Raleigh’s  $W_T(n)$ . *Id.* at 56–57 (citing Ex. 1003 ¶ 169). Ma is also cited for teaching that training symbols, as taught by Raleigh, are “pilot carrier signals.” *Id.* at 57 (citing Ex. 1006 ¶¶ 35, 48, Figs. 3–6; Ex. 1003 ¶¶ 171–172); *see also* Ex. 1001, 33:29–31 (disclosing a “preamble” of pilot signals).

Limitation 18f recites “a data converter for respectively converting the transmission information signals of N systems into OFDM symbols.” Again

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<sup>32</sup> Nadgauda, US 6,901,122 B2, issued May 31, 2005.

<sup>33</sup> Koga, US 6,577,686 B1, issued Jun. 10, 2003.

citing Figure 1 of Raleigh, Petitioner relies on Raleigh’s “Encoder & Interleaving” apparatus, which receives an information signal and encodes/converts the signal to a symbol stream. Pet. 58 (citing Ex. 1005, 6:21–24, 16:16–18, Fig. 13; Ex. 1003 ¶¶ 173–175, 177). Petitioner refers to its earlier showing regarding “N systems into OFDM symbols.” *Id.* at 58–59 (citing Ex. 1003 ¶¶ 176–178 (citing Ex. 1036,<sup>34</sup> 1:33–37; Ex. 1037,<sup>35</sup> 1:21–28, 5:22–23)).

Limitation 18h recites “inverse fast Fourier transformers for performing inverse Fourier transformation on the outputs from the interference canceller.” Ex. 1001, 68:42–44. In Raleigh, the transmit antennas “transmit with *IFFT [inverse fast Fourier transformer] basis functions*,” for performing inverse Fourier transformation. Ex. 1005, 2:44–48, 6:32–34, 13:53–55 (emphasis added). Petitioner cites the preceding from Raleigh along with Raleigh’s Figure 10 and the Lomp Declaration to show the SOP-IFFT is performed on the TSP outputs, i.e., the interference canceller. Pet. 59–60 (citing Pet. 55–56 (showing for limitation [18d]; Ex. 1005, Fig. 10 (annotated at Pet. 60); Ex. 1003 ¶ 180). Petitioner also argues the “interference canceller outputs for the other  $N - 1$  bins (OFDM subcarriers) are also output to IFFT-SOPs.” *Id.* at 60 (citing Ex. 1005, 16:66–67, Fig. 11 annotated at Pet. 60; Ex. 1003 ¶ 181).

Limitation 18i recites “transmission frequency converters for converting the frequency band of the output from the inverse fast Fourier transformers, into radio frequency.” Ex. 1001, 68:45–47. Petitioner argues “Raleigh’s transmitting device includes Modulation and RF System blocks

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<sup>34</sup> Larsson, US 6,842,487 B1, issued Jan. 11, 2005.

<sup>35</sup> Gardner, US 6,862,297 B1, issued Mar. 1, 2005.

40, which are transmission frequency converters.” Pet. 61 (citing Ex. 1005, Fig. 11 (annotated at Pet. 62)). As shown in Figure 11, “the output of each Transmitter SOP (IFFT), ‘is fed into one input of a Modulation and RF System block 40 [annotated red],’ which ‘includes *a set* of independent *RF upconverter chains* that *frequency convert* the digital baseband signal sequence up to the *RF [radio frequency] carrier frequency*’ band.” *Id.* at 61–62 (citing Ex. 1005, 7:24–35, 27:64–67; Ex. 1006 ¶ 4; Ex. 1003 ¶¶ 183–184). In sum, Petitioner relies on Raleigh’s Modulation and RF System blocks to meet limitation [18i]. *Id.* at 62 (citing Ex. 1003 ¶ 185).

One of several reasons given by Petitioner for the combination of Raleigh and Ma is that “Ma teaches transmitting ‘OFDM symbols . . . over the same subcarriers.” Pet. 40 (citing Ex. 1006 ¶ 24; Ex. 1003 ¶ 118; *KSR*, 550 U.S. at 417–18). Three additional reasons are provided, including as a fourth reason “that using the same RF was one of a finite number (two) of identified predictable choices for transmitting signals in a MIMO communication system (the other being to use different RFs).” *Id.* at 41 (citing Ex. 1003 ¶ 121; *KSR*, 550 U.S. at 422); *see also id.* at 40–41 (identifying second and third reasons for the combination).

Another reason for the combination asserted by Petitioner is to provide equal transmitting and receiving antennas. Petitioner alleges this teaching would have suggested to a person of ordinary skill to implement a system based on Ma where there are equal numbers of transmitting and receiving antennas. Pet. 45 (citing Ex. 1003 ¶ 134; *KSR*, 550 U.S. at 417–418). Additional reasons and motivation for the combination include that such a configuration would have motivated a person of ordinary skill as “the simplest and cheapest implementation, which uses an equal number of

transmitting and receiving antennas.” *Id.* at 46 (citing Ex. 1003 ¶ 135 (citing Ex. 1005, 17:18–22); *KSR*, 550 U.S. at 417–418).

On this record, Petitioner has shown sufficiently that the combination of Raleigh and Ma teaches limitations 18a, 18b, 18e, 18f, 18h, and 18i. We find Petitioner has sufficiently shown reasons with rational underpinnings for combining Raleigh and Ma.

#### 4. Claim 22

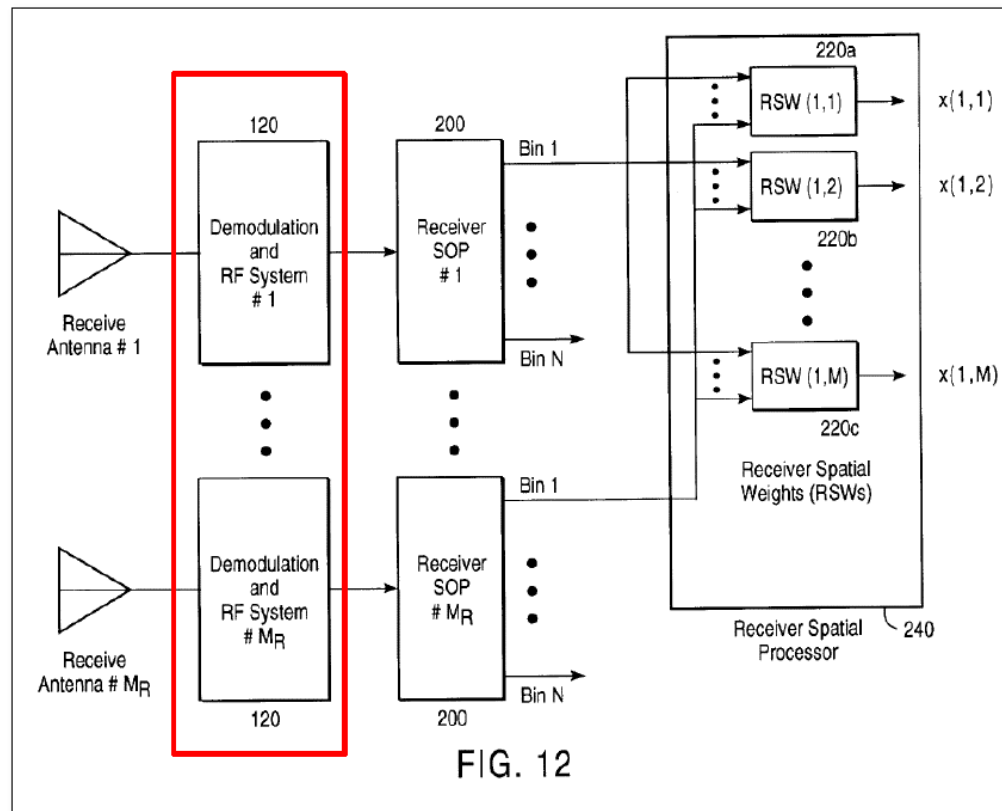
Independent claim 22 is similar to claim 18 and Patent Owner relies, in part, on its argument and supporting evidence discussed in arguing claim 22 is patentable.<sup>36</sup> PO Resp. 64 (citing Ex. 2034 ¶ 157). In addition, Patent Owner argues “the combination of Raleigh and Ma fails to disclose the claimed ‘local oscillator’ and ‘OFDM symbol timing generator.’” PO Resp. 64–69 (limitation 22f, “local oscillator”), 69–70 (limitation 22h, “OFDM symbol timing generator”).

##### a. “local oscillator” (Limitation 22f)

Petitioner argues limitation 22f is shown in Raleigh’s Figure 12, annotated at Pet. 73 and reproduced below.

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<sup>36</sup> With respect to claim 22, Petitioner asserts it differs from claim 18 in that “the ZF algorithm applies to a product of  $H(n)*V(n)$  rather than  $U(n)*H(n)$ , but the reasoning applicable to  $U(n)$  also holds true for  $V(n)$ .” Pet. 64 (citing Ex. 2034 ¶ 157). No argument regarding this difference is made, and we need not further address the difference.



**Raleigh Figure 12 (annotated) depicts the application of spatial processing to a particular SOP bin at the receiver.**

Ex. 1005, 3:29–31, Fig. 12 (annotated at Pet. 73). According to Petitioner, annotated Figure 12 “illustrates Demodulation and RF System blocks (annotated red [above]) in Raleigh’s receiving device ‘connected to each of the receiving antennas’ . . . which are ‘receiving frequency converters connected to each of the receiving antennas for frequency converting radio frequency of a received signal received by the receiving antennas. . . .’ ” Pet. 72 (citing Ex. 1005, 7:54–57, Fig. 3). Petitioner argues “[d]emodulation and RF System 120 includes the RF signal processing apparatus to *downconvert* the RF carrier signal *to a baseband* IF [intermediate frequency] . . . ” *Id.* at 73 (citing Ex. 1005, 7:58–60; Ex. 1003 ¶ 228). Petitioner alleges a person of ordinary skill would have understood “baseband IF is a ‘frequency suitable

for demodulation.” *Id.* (citing Ex. 1001, 46:25–27; Ex. 1003 ¶ 228).

Petitioner alleges “Ma discloses a common local oscillator for generating its local frequency . . . , which POSAs understood supplies ‘all of the receiving frequency converters.’” *Id.* at 74 (citing Ex. 1006 ¶ 46; Ex. 1003 ¶ 230 (citing Ex. 1015,<sup>37</sup> 9:10–14; Ex. 1037,<sup>38</sup> 1:38–40)).

Petitioner alleges even if Ma was not considered to use its common local oscillator, there are multiple reasons “for down converting, that would have been the conventional and obvious way to implement Raleigh/Ma’s demodulation.” Pet. 74–75 (citing Ex. 1003 ¶¶ 232–236 (identifying reasons a local oscillator would have been obvious)). Some of Petitioner’s reasons rely on Barratt (Ex. 1013)<sup>39</sup> as support that “the downconverters with an RF signal from a common local oscillator to minimize costs and device size, and ‘ensure that signals . . . are coherently down-converted to baseband.’” *Id.* at 74 (citing Ex. 1013, 7:29–32; Ex. 1003 ¶ 233). Petitioner alleges a person of ordinary skill “would have had a reasonable expectation of success because it would have required ordinary skill to connect frequency converter inputs to a common local oscillator.” *Id.* at 75 (citing Ex. 1003 ¶ 236).

Patent Owner relies on the Hernandez Declaration to assert “Ma teaches that ‘RF signals received by receiver antennas A and B . . . are delivered to **respective circuits 701, 703.**’” PO Resp. 65 (citing Ex. 1006 ¶ 42, Fig. 7); *see also* Sur-Reply 26–27. Thus, Patent Owner alleges Ma’s paragraph 46 is “actually describing the operation of *two distinct local oscillators*, rather than a single oscillator.” PO Resp. 66 (citing Ex. 2034 ¶ 161). Further, Patent Owner alleges “it is unlikely that circuits 701 and

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<sup>37</sup> Takahashi, US Pat. No. 5,732,068, issued Mar. 24, 1998.

<sup>38</sup> Gardner, US Pat. No. 6,862,297 B1, issued Mar. 1, 2005.

<sup>39</sup> Barratt, US Pat. No. 5,592,490, issued Jan. 7, 1997.

703 are implemented as a single piece of hardware, as Fig. 7 suggests that signals are processed simultaneously.” *Id.* at 66–67 (citing Ex. 2033, 217:22–23 (“I think that the two—that they’re processing two different signals **most likely at the same time...**”), 219:4–6 (“... [I]t could be done with **one circuit that is time shared** between two signals **or it could be done with two circuits.**”)). Patent Owner also disputes that use of a single oscillator would have been obvious given Barratt’s alleged teaching of a single common oscillator. *Id.* at 67 (citing Ex. 2034 ¶ 163). Patent Owner also contends Barratt does not provide motivation for the combination. *Id.* at 68.

We agree with Petitioner and find that “[w]hether Ma’s ‘two circuits’ 701/703 are one or two physical components is irrelevant because the Petition argued Ma’s ‘local oscillator’ (singular) supplies a ‘common’ frequency to *both* circuits.” Reply 33 (citing Pet. 34–35, 73–77; Ex. 1097 ¶¶ 245–249; Ex. 1087, 270–271). Patent Owner’s argument is contrary to the “general rule” of claim construction that “a” or “an” before an element (here “a local oscillator” or “a common local oscillator frequency” in limitation 22f means one or more. *See Baldwin Graphic Sys., Inc. v. Siebert, Inc.*, 512 F.3d 1338, 1343–44 (Fed. Cir. 2008) (“That ‘a’ or ‘an’ can mean ‘one or more’ is best described as a rule, rather than merely as a presumption or even a convention.”)). We also credit the Lomp Declaration testimony as supporting that, even if Ma has two circuits and therefore does not teach “*an*” oscillator, use of a single “common oscillator” would have been obvious to a person of ordinary skill. Ex. 1003 ¶¶ 230, 232–236.

*b. “OFDM symbol timing generator” (Limitation 22h)*

Petitioner argues Raleigh’s “timing and frequency synchronization apparatus” and Ma’s synchronization circuits 701 and 703 teach is an

“OFDM symbol timing generator” because it “‘is used to recover the *timing* of the transmitted’ OFDM signal . . . and to supply ‘the FFT window’ . . . as common OFDM symbol timing to all FFTs.” Pet. 78 (citing Ex. 1005, 7:60–65; Ex. 1006 ¶¶ 37, 45; Ex. 1003 ¶¶ 244–245). Further, Petitioner alleges “[t]he pilot/training signals processed by the timing and frequency synchronization apparatus are used as the reception symbol timing.” *Id.* at 79 (citing Ex. 1003 ¶¶ 247–249).

Patent Owner repeats its argument that the two circuits of Ma, circuits 701 and 703, are distinct pieces of hardware. PO Resp. 69 (citing Ex. 2033 ¶ 166). Patent Owner alleges use of a single “OFDM timing generator supplying common timing was also emphasized during prosecution.” *Id.* (citing Ex. 1002,<sup>40</sup> 47).

We agree with Petitioner’s arguments and find that the record supports that Barratt is “a common local oscillator for a single carrier system like Raleigh/Ma was well-known.” Reply 33 (citing Pet. 74–75; Ex. 2034 ¶¶ 250–252); *see also Baldwin Graphic*, 512 F.3d at 1343–44. We also credit the Lomp Declaration and Lomp Reply Declaration testimony that use of a single “common oscillator” would have been obvious to a person of ordinary skill, including that a reasonable expectation of success would have been expected, the combination is a simple substitution, and implementing a known technique by having one oscillator feed multiple demodulation blocks. Ex. 1097 ¶ 253; *see also* Ex. 1003 ¶¶ 234–237 (why a common oscillator would have been obvious). That the “common oscillator” argument was made during prosecution has not been shown to be the reason for allowance of the claim.

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<sup>40</sup> File history of ’720 patent.

On this record, Petitioner has shown sufficiently that the combination of Raleigh and Ma teaches limitations 22f and 22h.

*5. Claims 10, 31, 32*

Patent Owner refers to its arguments regarding claim 18 in responding to the assertions made with respect to independent claims 10, 31, and 32. *See, e.g.*, PO Resp. 63 (claim 10 (“These arguments fail for reasons similar to those for claim 18.”)). The same reliance on the argument and evidence presented regarding claim 18 is presented in connection with claims 31 and 32. *Id.*

On this record, Petitioner has shown sufficiently that the combination of Raleigh and Ma teaches independent claims 10, 31, and 32.

*6. Claims 11, 19–20, 23*

Claims 11, 19–20, and 23 all depend from independent claims analyzed above. Patent Owner argues their patentability based only on their dependency from the corresponding independent claim. PO Resp. 63 (claims 11, 19–20), 70 (claim 23).

On this record, Petitioner has shown sufficiently that the combination of Raleigh and Ma teaches independent claims 11, 19–20 and 23.

#### IV. CONCLUSION<sup>41</sup>

For the reasons discussed above, Petitioner has shown by a preponderance of the evidence that claims 10–11, 18–20, 22–23, and 31–32 of the '720 patent are unpatentable over Raleigh and Ma.

#### V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner has shown that challenged claims 10, 11, 18–20, 22, 23, 31, and 32 are unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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<sup>41</sup> Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

In summary:

| <b>Claims</b>              | <b>35 U.S.C. §</b> | <b>Reference(s)/Basis</b> | <b>Claims Shown Unpatentable</b> | <b>Claims Not Shown Unpatentable</b> |
|----------------------------|--------------------|---------------------------|----------------------------------|--------------------------------------|
| 10–11, 18–20, 22–23, 31–32 | 103                | Raleigh, Ma               | 10–11, 18–20, 22–23, 31–32       |                                      |

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