

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NXP USA, Inc.

Petitioner

v.

Bell Northern Research, LLC

Patent Owner

Inter Partes Review No.: IPR2024-01044

**PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO.
RE48,629 UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. §§ 42.1-100, ET SEQ**

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1025	https://www.air802.com/ieee-802.11-standards-facts-amp-channels.html (IEEE 802.11 Standards Facts & Channels)
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U.S. Patent No. US RE48,629
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Exhibit No.	Description
1027	Commission Determination Not to Review Initial Determination Granting Motion to Withdraw Complaint and Terminate Investigation as to NXP, ITC Inc. No. 337-TA-1367
1028	International Application No. PCT/US2004/021026 (“Boer PCT Application”)
1029	U.S. Provisional Application No. 60/634,102 (“’629 December 2004 Provisional”)
1030	U.S. Provisional Application No. 60/462,286 (“Jones Provisional”)
1031	U.S. Patent No. 7,646,703 (“Parent of ’629 Patent”)

CLAIMS LISTING

[1pre] A wireless communications device, comprising:

[1a] a signal generator that generates an extended long training sequence; and

[1b] an Inverse Fourier Transformer operatively coupled to the signal generator,

[1c] wherein the Inverse Fourier Transformer processes the extended long training sequence from the signal generator and provides an optimal extended long training sequence with a minimal peak-to-average ratio, and

[1d] wherein at least the optimal extended long training sequence is carried by a greater number of subcarriers than a standard wireless networking configuration for an Orthogonal Frequency Division Multiplexing scheme,

[1e] wherein the optimal extended long training sequence is carried by exactly 56 active sub-carriers, and

[1f] wherein the optimal extended long training sequence is represented by encodings for indexed sub-carriers -28 to $+28$, excluding indexed sub-carrier 0 which is set to zero, as follows:

<i>Sub-carrier</i>	-28	-27	-26	-25	-24	-23	-22
<i>Encoding</i>	$+1$	$+1$	$+1$	$+1$	-1	-1	$+1$
<i>Sub-carrier</i>	-14	-13	-12	-11	-10	-9	-8
<i>Encoding</i>	$+1$	$+1$	$+1$	-1	-1	$+1$	$+1$
<i>Sub-carrier</i>	1	2	3	4	5	6	7
<i>Encoding</i>	$+1$	-1	-1	$+1$	$+1$	-1	$+1$
<i>Sub-carrier</i>	15	16	17	18	19	20	21
<i>Encoding</i>	$+1$	$+1$	-1	-1	$+1$	-1	$+1$
<i>Sub-carrier</i>	-21	-20	-19	-18	-17	-16	-15
<i>Encoding</i>	$+1$	-1	$+1$	-1	$+1$	$+1$	$+1$
<i>Sub-carrier</i>	-7	-6	-5	-4	-3	-2	-1
<i>Encoding</i>	-1	$+1$	-1	$+1$	$+1$	$+1$	$+1$
<i>Sub-carrier</i>	8	9	10	11	12	13	14
<i>Encoding</i>	-1	$+1$	-1	-1	-1	-1	-1
<i>Sub-carrier</i>	22	23	24	25	26	27	28
<i>Encoding</i>	-1	$+1$	$+1$	$+1$	$+1$	-1	-1

[4] The wireless communications device according to claim 1, wherein the optimal extended long training sequence has a minimum peak-to-average power ratio of 3.6 dB.

[8] The wireless communications device according to claim 1, wherein a binary phase shift key encoding is used for each sub-carrier above the $+26$ indexed sub-

carrier and below the -26 indexed sub-carrier.
[9] The wireless communications device according to claim 1, wherein the Inverse Fourier Transformer comprises an Inverse Fast Fourier Transformer or an Inverse Discrete Fourier Transformer.
[10] The wireless communications device according to claim 1, wherein the wireless communications device comprises one or more of the following: a personal digital assistant, a laptop computer, a personal computer, a processor, and a cellular phone.
[11] The wireless communications device according to claim 1, wherein the wireless communications device comprises a wireless mobile communications device.
[12] The wireless communications device according to claim 1, wherein the wireless communications device comprises one or more of the following: an access point and a base station.
[13] The wireless communications device according to claim 1, wherein the wireless communications device is backwards compatible with legacy wireless local area network devices.
[14] The wireless communications device according to claim 1, wherein the optimal extended long training sequence is longer than a long training sequence used by a legacy wireless local area network device in accordance with a legacy wireless networking protocol standard.
[15] The wireless communications device according to claim 14, wherein the legacy wireless local area network device uses the optimal extended long training sequence to estimate a carrier frequency offset even though the optimal extended long training sequence is longer than the long training sequence that is specified by the legacy wireless networking protocol standard.
[16] The wireless communications device according to claim 15, wherein the long training sequence that is specified by the legacy wireless networking protocol standard is maintained in the extended long training sequence or the optimal extended long training sequence
[17] The wireless communications device according to claim 1, wherein the wireless communications device decreases power back-off.
[18] The wireless communications device according to claim 1, wherein the wireless communications device registers with one or more of the following: an access point and a base station.
[19] The wireless communications device according to claim 1, wherein the extended long training sequence or the optimal extended long training sequence is encoded using binary phase shift key encoding on each of the 56 active subcarriers.

[20] The wireless communications device according to claim 1, comprising: a symbol mapper operatively coupled to the signal generator, wherein the symbol mapper receives coded bits and generates symbols for each of 64 subcarriers of an Orthogonal Frequency Division Multiplexing sequence.

[21] The wireless communications device according to claim 14, wherein the legacy wireless networking protocol standard for the Orthogonal Frequency Division Multiplexing scheme corresponds to exactly 52 active subcarriers.

[22] The wireless communications device according to claim 21, wherein, for a long training sequence of the legacy wireless networking protocol standard, the indexed sub-carrier 0 is set to zero and encodings for the indexed sub-carriers -26 to $+26$ excluding the indexed sub-carrier 0 are:

<i>Sub-carrier</i>	-26	-25	-24	-23	-22	-21	-20
<i>Encoding</i>	$+1$	$+1$	-1	-1	$+1$	$+1$	-1
<i>Sub-carrier</i>	-13	-12	-11	-10	-9	-8	-7
<i>Encoding</i>	$+1$	$+1$	-1	-1	$+1$	$+1$	-1
<i>Sub-carrier</i>	1	2	3	4	5	6	7
<i>Encoding</i>	$+1$	-1	-1	$+1$	$+1$	-1	$+1$
<i>Sub-carrier</i>	14	15	16	17	18	19	20
<i>Encoding</i>	-1	$+1$	$+1$	-1	-1	$+1$	-1
<i>Sub-carrier</i>	-19	-18	-17	-16	-15	-14	
<i>Encoding</i>	$+1$	-1	$+1$	$+1$	$+1$	$+1$	
<i>Sub-carrier</i>	-6	-5	-4	-3	-2	-1	
<i>Encoding</i>	$+1$	-1	$+1$	$+1$	$+1$	$+1$	
<i>Sub-carrier</i>	8	9	10	11	12	13	
<i>Encoding</i>	-1	$+1$	-1	-1	-1	-1	
<i>Sub-carrier</i>	21	22	23	24	25	26	
<i>Encoding</i>	$+1$	-1	$+1$	$+1$	$+1$	$+1$	

[23pre] The wireless communications device according to claim 22, wherein:

[23a] the Inverse Fourier Transformer comprises an Inverse Fast Fourier Transformer or an Inverse Discrete Fourier Transformer;

[23b] the wireless communications device comprises one or more of the following: a personal digital assistant, a laptop computer, a personal computer, a cellular phone, an access point, a processor, and a base station;

[23c] the wireless communications device is backwards compatible with the legacy wireless local area network device;

[23d] the legacy wireless local area network device uses the optimal extended

long training sequence to estimate a carrier frequency offset even though the optimal extended long training sequence is longer than the long training sequence that is specified by the legacy wireless networking protocol standard;

[23e] the wireless communications device decreases power back-off;

[23f] the extended long training sequence or the optimal extended long training sequence is encoded using binary phase shift key encoding on each of the 56 active subcarriers; and

[23g] the wireless communications device further comprises a symbol mapper operatively coupled to the signal generator, wherein the symbol mapper receives coded bits and generates symbols for each of 64 subcarriers of an Orthogonal Frequency Division Multiplexing sequence.

[27] The wireless communications device according to claim 1, wherein an output of the Inverse Fourier Transformer is operatively coupled to a time-domain windower.

I. INTRODUCTION

NXP USA, Inc. (“Petitioner”) requests *inter partes* review of claims 1, 4, 8-23 and 27 (“Challenged Claims”) of U.S. Patent No. RE48,629 (“’629 patent,” EX1001), purportedly owned by Bell Northern Research, LLC. (“PO”).

II. STATEMENT OF PRECISE RELIEF REQUESTED

In accordance with 35 U.S.C. § 311, Petitioner requests cancelation of claims 1, 4, 8-23 and 27 of the ’629 patent in view of the following grounds:

Ground	Claims	Stat. Basis	Prior Art
1	1, 4, 8-23, 27	35 U.S.C. § 103	Jones, 802.11a, 802.11-1999, Zelst, and Boer
2	1, 4, 8-23, 27	35 U.S.C. § 103	Jones, 802.11a, 802.11-1999, and Boer

III. THE ’629 PATENT

A. Overview of the ’629 Patent

The ’629 patent is generally directed toward wireless orthogonal frequency division multiplexing (OFDM) transmissions. “OFDM works by spreading a single data stream over a band of subcarriers, each of which is transmitted in parallel.” EX1001, 2:22-24; EX1005, ¶ 38.

In one embodiment, the ’629 patent purports to improve on the prior art 52-subcarrier long training sequence used in 802.11a (and 802.11g) by adding 4 (for a total of 56) or 11 (for a total of 63) subcarriers. EX1001, FIG. 4, 5:30-35; EX1005, ¶ 39.

Figure 4 (56-subcarrier embodiment) is annotated below with the prior art 52 subcarriers (-26 to 26) highlighted in blue, the four new subcarriers (-28, -27, 27, 28 with the values +1, +1, -1, -1, respectively) highlighted in yellow, and the indexed subcarrier zero highlighted in red.

+1	+1	1	1	-1	-1	1	1	-1	1	-1	1	1	1		
-28	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15		
Sub-carrier index															

1	1	1	-1	-1	1	1	-1	1	-1	1	1	1	1	0	
-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	
Sub-carrier index															

-1	-1	-1	1	1	-1	1	-1	1	-1	-1	-1	-1	-1		
1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Sub-carrier index															

1	1	-1	-1	1	-1	1	-1	1	1	1	1	1	-1	-1	
15	16	17	18	19	20	21	22	23	24	25	26	27	28		
Sub-carrier index															

LONG TRAINING SEQUENCE FOR 56 ACTIVE
FIGURE 4

EX1001, FIG. 4. EX1005, ¶ 40.

Figure 5 (63-subcarrier embodiment) is annotated below in the same way, showing the 11 new subcarriers (-32 to -27 and 27 to 31) highlighted in yellow, the legacy subcarriers highlighted in blue and the indexed subcarrier zero highlighted in red.

-1	-1	+1	+1	+1	+1	1	1	-1	-1	1	1	-1	1	-1	1	1	1
-32	-31	-30	-29	-28	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15

Sub-carrier index

1	1	1	-1	-1	1	1	-1	1	-1	1	1	1	1	1	0
-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	0

Sub-carrier index

+1	-1	-1	1	1	-1	1	-1	1	-1	-1	-1	-1	-1	-1
1	2	3	4	5	6	7	8	9	10	11	12	13	14	

Sub-carrier index

1	1	-1	-1	1	-1	1	-1	1	1	1	1	-1	-1	-1	+1	-1
15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Sub-carrier index

LONG TRAINING SEQUENCE FOR 63 ACTIVE
FIGURE 5

EX1001, FIG. 5; EX1005, ¶ 41.

One should note that the 52, 56, and 63 value sequences discussed above are 53, 57, and 64 value sequences if the “0” subcarrier is counted. The “0” subcarrier is not counted because it is set to zero and does not carry any data because of complications with converting between RF and baseband. EX1005, ¶ 42.

B. Overview of Related File Histories

1. The '104 Provisional – EX1002

The earliest claim of priority in the '629 patent is to 60/591,104, filed 7/27/2004 (“the '104 Provisional”). EX1001, Cover. No claim of the '629 patent is entitled to the filing date of the '104 Provisional, at least for the reason that it does not disclose limitations [1a]-[1c]. EX1005, ¶ 43; see, e.g., *Los Angeles Biomedical Rsch. Inst. at Harbor-UCLA Med. Ctr. v. Eli Lilly & Co.*, 849 F.3d 1049, 1057 (Fed. Cir. 2017), citing *Tronzo v. Biomet, Inc.*, 156 F.3d 1154, 1158 (Fed. Cir.

1998) (“A disclosure in a parent application is not sufficient if it ‘merely renders the later-claimed invention obvious ...; the disclosure must describe the claimed invention with all its limitations’”). Regardless, the references asserted herein qualify as prior art even if a claim is so entitled.

2. The ’842 Patent – EX1003

The ’629 patent is a reissue of U.S. Patent No. 7,990,842 (“the ’842 patent”). EX1001, Cover. The independent claim of the ’842 patent was not explicitly limited to 56 subcarriers or a specific encoding. EX1003, Claim 1; EX1005, ¶ 44.

3. IPRs on the ’842 Patent

IPR2019-01174, -01345, and -01437 were filed between June and August 2019 and challenged certain claims of the ’842 patent. See EX1019-EX1021. These IPRs were dismissed prior to institution. EX1005, ¶ 45.

4. U.S. Patent Reissue Application No. 16/686,468

On 11/18/2019, PO filed Reissue Application No. 16/686,468, which eventually issued as the ’629 patent. EX1001, Cover. EX1005, ¶ 46.

Through a preliminary amendment dated 11/18/2019 (EX1004, 414) and a second amendment dated 4/22/2021 (*id.*, 66), PO amended the claims to explicitly claim the 56-subcarrier embodiment with the encodings in Figure 4 of the patent. EX1005, ¶ 46.

On 5/17/2021, the examiner allowed the claims. EX1004, 27-35. EX1005, ¶
46.

C. Claim Construction Under 37 C.F.R. § 42.104(b)(3)

The Challenged Claims are interpreted using the same claim construction standard that is used to construe the claims in a civil action in federal district court. 37 C.F.R. § 42.100(b).

Petitioner does not contend its proposed constructions are complete constructions of these limitations or the claims for any other purpose, including for issues that have been raised in the related litigations. Because the prior art asserted herein discloses the preferred embodiment within the indisputable scope of the claims, the Board need not construe the outer bounds of the claims as part of these proceedings. The district court may have to address other bounds of the claims. *See, e.g., Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

Any claim terms not listed below should be construed according to their plain and ordinary meaning to a POSITA at the time of the '629 patent.

1. “an optimal extended long training sequence with a minimal peak-to-average power” (claim 1)

The Board need not construe the outer bounds of “optimal” or “a minimal peak-to-average power” to resolve the challenges raised in this IPR because the

challenges are based on the encoding scheme explicitly recited in the table in claim 1 (see [1f]), which the patent admits is “optimal” and as having a minimal PAPR. EX1001, 5:30-35, claims 1, 4; EX1005, ¶ 48.

It should be noted that, in the related ITC Investigation, the ALJ found “the recited encoding scheme [in the table of claim 1] provides clear boundaries for the claimed invention” and that “the patentee’s use of the word optimal cannot reasonably be read to implicitly claim a different, unrecited encoding sequence.” EX1017, 39. The ALJ concluded this phrase “does not need to be construed because it is adequately defined by the claim itself.” *Id.*, 40; EX1005, ¶ 48.

Similarly, the ALJ also construed the term “optimal” in the claims of the original ’842 patent to “encompass” the explicitly recited sequence. E1018, 8. The ALJ found that there was no basis for construing “optimal” to require anything else. *Id.*, 7-8; EX1005, ¶ 49.

IV. OVERVIEW OF THE PRIOR ART

A. 802.11-1999-EX1006

The 802.11-1999 standard was published by IEEE in 1999 (“802.11,” EX1006) and is prior art under pre-AIA 35 U.S.C. § 102(b). EX1006, Cover; EX1007. 802.11-1999 is admitted prior art. EX1001, 1:59-2:45; EX1005, ¶ 50.

B. 802.11a-EX1008

The 802.11a standard was published in 1999 by the Institute of Electrical and Electronics Engineers (“802.11a,” EX1008) and is prior art under pre-AIA 35 U.S.C. § 102(b). EX1008, Cover; EX1009. 802.11a is admitted prior art. EX1001, 1:59-2:45; EX1005, ¶ 51.

The 802.11a standard is a “Supplement to IEEE Std. 802.11-1999,” stating “Changes and additions to IEEE Std. 802.11-1999 are provided to support the new high-rate physical layer (PHY) for operation in the 5GHz band.” EX1008, Cover; *see also* EX1001, 1:59-63; EX1005, ¶ 52.

Alternatively, it would have been obvious to combine the teachings of 802.11a with 802.11-1999 based on the express teaching of 802.11a that it is a supplement to 802.11-1999. A POSITA would have had a reasonable expectation of success in making the combination because 802.11a was designed so that a POSITA could perform that very combination and the industry did, in fact, successfully make that combination. EX1001, 1:59-2:45 (admitting the extension is prior art); EX1005, ¶ 53.

802.11a is incorporated by reference by Boer (EX1012, 1:33-36) and Jones. EX1014, 5:34-37; EX1005, ¶ 54.

C. 802.11n and Applicant Admitted Prior Art (AAPA)

The '629 patent admits in its Background section that “802.11n, a new extension of 802.11, is being developed to address, among other things, higher throughput and compatibility issues.” EX1001, 1:67-2:2. The '104 Provisional specifically acknowledges that “56 active subcarriers” were “under consideration for 802.11n.”

Design Goal (2)

- **Two different numbers of active subcarriers are under consideration for 802.11n:**
 - 56 active subcarriers
 - 63 active subcarriers (“extended long training” or ELTS)
- **802.11a/g uses 52 active subcarriers**
 - (indices -26 to +26, with the 0-index subcarrier, which is at the carrier frequency, set to 0).
- **Let's say that we want to use the same subcarrier values for positions -26..+26.**
 - Now, we can perform a search to find the 56- and 63-active-subcarrier sequences that have minimum PAPR.
 - We use the same +1 or -1 BPSK encoding for each new subcarrier.



BROADCOM CONFIDENTIAL AND PROPRIETARY

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EX1002, 3 (highlighting added); EX1005, ¶ 55.

In July 2003, IEEE created the 802.11n Task Group and called for proposals by August 2004. EX1024. The World Wide Spectrum Efficiency (WWiSE) Consortium submitted an 802.11n proposal in August 2004. EX1016. WWiSE was led by Airgo Networks (at that time, the employer of one or more of the named inventors of Boer, Zelst, and Jones) and included Broadcom (employer of the

named inventors). EX1023. The WWiSE Proposal included the claimed extended long training sequence. EX1016, 37; EX1005, ¶ 56.

The claimed extended long training sequence originated with the inventors of Boer, Zelst, and Jones because those references predate the '629 patent's earliest priority dates. These references and the WWiSE Proposal also demonstrate contemporaneous development by others who were also working on improvements to 802.11a. EX1005, ¶ 57.

D. Zelst-EX1010

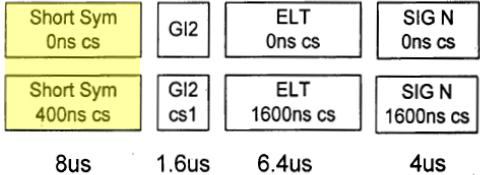
U.S. Patent No. 7,599,332 to Zelst, et al. ("Zelst") was filed 5/27/2005, issued 10/6/2009, and claims priority to, and incorporates by reference, U.S. Provisional Patent Application No. 60/575,608 ("Zelst Provisional," EX1011), filed 5/27/2004. EX1010, 1:20-27. Because Zelst incorporates the Zelst Provisional, all citations to the Zelst Provisional herein are also citations to Zelst itself. Zelst is prior art under pre-AIA 35 U.S.C. § 102(e) as of its filing date (5/27/2005) relative to the '629 patent's earliest non-provisional filing date (7/26/2005). EX1005, ¶ 58.

Zelst is also prior art under pre-AIA 35 U.S.C. § 102(e) as of the Zelst Provisional filing date of 5/27/2004 under *Dynamic Drinkware, LLC v. National Graphics, Inc.*, 800 F.3d 1375, 1381-82 (Fed. Cir. 2015). Zelst was filed within one year of the Zelst Provisional, names at least one inventor in common, and

includes a specific reference to the Zelst Provisional. EX1010, Cover; EX1005, ¶
59.

Under step one of *Dynamic Drinkware*, at least claim 1 of Zelst is fully
supported and enabled by the Zelst Provisional, as shown below.

Zelst (EX1010)	Zelst Provisional (EX1011)
1. A method for transmitting a training sequence, the method comprising:	See, e.g., Zelst Provisional, 3: “In accordance with one embodiment of the present invention, each of a number of preambles is adapted to be used in packets sent over a wireless network, such as an 802.11a compliant wireless network. Packets containing preambles of the present invention may be received by legacy receivers that are not configured to receive and interpret these preambles. The preambles may be used to distinguish between two transmit antennas (TX), and 3 or 4 TXs, by using a double long-training sequence compared to 11a in the latter case. To detect that 3 or 4 TX antennas are used, the presence of another (8 us) long-training sequence is detected. In some embodiments, the number of TX antennas in the SIGNAL field is also signaled to verify the number of antenna detection. The preambles are described in the following pages.”
transmitting from at least first and second transmit antennas of a wireless communications system at least first and second preambles configured respectively for transmission from said at least first and second transmit antennas, each	See, e.g., Zelst Provisional, 3: “In accordance with one embodiment of the present invention, each of a number of preambles is adapted to be used in packets sent over a wireless network, such as an 802.11a compliant wireless network. Packets containing preambles of the present invention

Zelst (EX1010)	Zelst Provisional (EX1011)
of the at least first and second preambles further comprising:	may be received by legacy receivers that are not configured to receive and interpret these preambles. The preambles may be used to distinguish between two transmit antennas (TX), and 3 or 4 TXs, by using a double long-training sequence compared to 11a in the latter case. To detect that 3 or 4 TX antennas are used, the presence of another (8 us) long-training sequence is detected. In some embodiments, the number of TX antennas in the SIGNAL field is also signaled to verify the number of antenna detection. The preambles are described in the following pages.”
a short training field sequence field;	See, e.g., Zelst Provisional, 3-4: “The preambles may be used to distinguish between two transmit antennas (TX), and 3 or 4 TXs, by using a double long-training sequence compared to 11a in the latter case.”  See, e.g., Zelst Provisional, 5:

Zelst (EX1010)	Zelst Provisional (EX1011)																																																
	3 TX case <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 200ns cs</td><td>GI2 cs1</td><td>ELT 1050ns</td><td>SIG N 1050ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs2</td><td>ELT 2100ns</td><td>SIG N 2100ns cs</td></tr><tr><td>8us</td><td>1.6us</td><td>6.4us</td><td>4us</td></tr></table> 4 TX case <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 200ns cs</td><td>GI2 cs1</td><td>ELT 800ns</td><td>SIG N 800ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs2</td><td>ELT 1600ns</td><td>SIG N 1600ns cs</td></tr><tr><td>Short Sym 600ns cs</td><td>GI2 cs3</td><td>ELT 2400ns</td><td>SIG N 2400ns cs</td></tr><tr><td>8us</td><td>1.6us</td><td>6.4us</td><td>4us</td></tr></table>	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 200ns cs	GI2 cs1	ELT 1050ns	SIG N 1050ns cs	Short Sym 400ns cs	GI2 cs2	ELT 2100ns	SIG N 2100ns cs	8us	1.6us	6.4us	4us	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 200ns cs	GI2 cs1	ELT 800ns	SIG N 800ns cs	Short Sym 400ns cs	GI2 cs2	ELT 1600ns	SIG N 1600ns cs	Short Sym 600ns cs	GI2 cs3	ELT 2400ns	SIG N 2400ns cs	8us	1.6us	6.4us	4us												
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a guard interval field;	See, e.g., Zelst Provisional, 4: <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs1</td><td>ELT 1600ns cs</td><td>SIG N 1600ns cs</td></tr><tr><td>8us</td><td>1.6us</td><td>6.4us</td><td>4us</td></tr></table> See, e.g., Zelst Provisional, 5: 3 TX case <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 200ns cs</td><td>GI2 cs1</td><td>ELT 1050ns</td><td>SIG N 1050ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs2</td><td>ELT 2100ns</td><td>SIG N 2100ns cs</td></tr><tr><td>8us</td><td>1.6us</td><td>6.4us</td><td>4us</td></tr></table> 4 TX case <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 200ns cs</td><td>GI2 cs1</td><td>ELT 800ns</td><td>SIG N 800ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs2</td><td>ELT 1600ns</td><td>SIG N 1600ns cs</td></tr><tr><td>Short Sym 600ns cs</td><td>GI2 cs3</td><td>ELT 2400ns</td><td>SIG N 2400ns cs</td></tr><tr><td>8us</td><td>1.6us</td><td>6.4us</td><td>4us</td></tr></table>	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 400ns cs	GI2 cs1	ELT 1600ns cs	SIG N 1600ns cs	8us	1.6us	6.4us	4us	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 200ns cs	GI2 cs1	ELT 1050ns	SIG N 1050ns cs	Short Sym 400ns cs	GI2 cs2	ELT 2100ns	SIG N 2100ns cs	8us	1.6us	6.4us	4us	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 200ns cs	GI2 cs1	ELT 800ns	SIG N 800ns cs	Short Sym 400ns cs	GI2 cs2	ELT 1600ns	SIG N 1600ns cs	Short Sym 600ns cs	GI2 cs3	ELT 2400ns	SIG N 2400ns cs	8us	1.6us	6.4us	4us
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a long training sequence field; and	See, e.g., Zelst Provisional, 4:																																																

[illegible]

Zelst (EX1010)	Zelst Provisional (EX1011)												
	Efficient Green-field Preamble based on Cyclic Shift (Option 1) “Green-field” preamble for 2 TX case (20 and 40 MHz) - Minimal overhead in long training (LT) sequence - On TX2: a cyclic shift (cs) in Extended Long Training (ELT) of 1.6 μs - SIG N field uses same cyclic shift as long training sequence - Use Extended Long Training to prevent interpolation issues <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs1</td><td>ELT 1600ns cs</td><td>SIG N 1600ns cs</td></tr><tr><td>8us</td><td>1.6us</td><td>6.4us</td><td>4us</td></tr></table>	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 400ns cs	GI2 cs1	ELT 1600ns cs	SIG N 1600ns cs	8us	1.6us	6.4us	4us
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Short Sym 400ns cs	GI2 cs1	ELT 1600ns cs	SIG N 1600ns cs										
8us	1.6us	6.4us	4us										
wherein the short training sequence field of the second preamble has a cyclic shift with respect to the short training sequence field of the first preamble;	See, e.g., Zelst Provisional, 4: Efficient Green-field Preamble based on Cyclic Shift (Option 1) “Green-field” preamble for 2 TX case (20 and 40 MHz) - Minimal overhead in long training (LT) sequence - On TX2: a cyclic shift (cs) in Extended Long Training (ELT) of 1.6 μs - SIG N field uses same cyclic shift as long training sequence - Use Extended Long Training to prevent interpolation issues <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs1</td><td>ELT 1600ns cs</td><td>SIG N 1600ns cs</td></tr><tr><td>8us</td><td>1.6us</td><td>6.4us</td><td>4us</td></tr></table>	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 400ns cs	GI2 cs1	ELT 1600ns cs	SIG N 1600ns cs	8us	1.6us	6.4us	4us
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Short Sym 400ns cs	GI2 cs1	ELT 1600ns cs	SIG N 1600ns cs										
8us	1.6us	6.4us	4us										
wherein the long training sequence field of the second preamble has a cyclic shift;	See, e.g., Zelst Provisional, 4: Efficient Green-field Preamble based on Cyclic Shift (Option 1) “Green-field” preamble for 2 TX case (20 and 40 MHz) - Minimal overhead in long training (LT) sequence - On TX2: a cyclic shift (cs) in Extended Long Training (ELT) of 1.6 μs - SIG N field uses same cyclic shift as long training sequence - Use Extended Long Training to prevent interpolation issues <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs1</td><td>ELT 1600ns cs</td><td>SIG N 1600ns cs</td></tr><tr><td>8us</td><td>1.6us</td><td>6.4us</td><td>4us</td></tr></table>	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 400ns cs	GI2 cs1	ELT 1600ns cs	SIG N 1600ns cs	8us	1.6us	6.4us	4us
Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs										
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8us	1.6us	6.4us	4us										
and wherein the signal field of	See, e.g., Zelst Provisional, 4:												

Zelst (EX1010)	Zelst Provisional (EX1011)												
the second preamble has a cyclic shift with respect to the signal of the first preamble.	Efficient Green-field Preamble based on Cyclic Shift (Option 1) “Green-field” preamble for 2 TX case (20 and 40 MHz) - Minimal overhead in long training (LT) sequence - On TX2: a cyclic shift (cs) in Extended Long Training (ELT) of 1.6 μs - SIG N field uses same cyclic shift as long training sequence - Use Extended Long Training to prevent interpolation issues <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs1</td><td>ELT 1600ns cs</td><td>SIG N 1600ns cs</td></tr><tr><td>8us</td><td>1.6us</td><td>6.4us</td><td>4us</td></tr></table>	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 400ns cs	GI2 cs1	ELT 1600ns cs	SIG N 1600ns cs	8us	1.6us	6.4us	4us
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8us	1.6us	6.4us	4us										

EX1005, ¶ 60.

Pursuant to step two of *Dynamic Drinkware*, citations to the disclosures in Zelst relied on herein are followed by a parallel citation to where that subject matter is disclosed in the Zelst Provisional. EX1005, ¶ 61.

E. Boer-EX1012

U.S. Patent No. 8,014,267 (“Boer”) was filed on 6/30/2004 as PCT/US2004/021026 (EX1028) in English, designating the U.S., and at the USPTO as the national receiving office. Boer was assigned 10/562,619 and issued 9/6/2011. Boer is therefore prior art under pre-AIA 35 U.S.C. § 102(e) based on its actual filing date of 6/30/2004. Boer claims priority to, and incorporates by reference, U.S. Provisional Patent Application No. 60/483,719 (“Boer Provisional,” E1013), filed 6/30/2003. EX1012, 1:10-18. To the extent PO attempts to antedate Boer’s 6/30/2004 filing date, Petitioner will show Boer is

entitled to the filing date of the Boer Provisional. Because Boer incorporates the Boer Provisional, all citations to the Boer Provisional herein are also citations to Boer itself. EX1005, ¶ 62.

Boer incorporates 802.11a by reference. EX1012, 1:30-36. Thus, Boer includes the entire disclosure of 802.11a, which is a supplement to 802.11-1999, as if fully reproduced therein. EX1005, ¶ 63.

F. Jones-EX1014

U.S. Patent No. 7,453,793 (“Jones”), filed 4/12/2004, issued 11/18/2008, is prior art under pre-AIA 35 U.S.C. § 102(e). Jones was assigned to Airgo. EX1015; EX1005, ¶ 64.

Jones claims priority to, and incorporates by reference, U.S. Provisional Patent Application No. 60/483,719 (“Jones Provisional,” EX1030), filed 4/10/2003. EX1014, 1:9-13; EX1005, ¶ 65.

Jones incorporates 802.11a by reference. EX1014, 5:33-37. Thus, Jones includes the entire disclosure of 802.11a, which is a supplement to 802.11-1999, as if fully reproduced therein. EX1005, ¶ 66.

G. Analogous Art

Each of the prior art references asserted herein is analogous art because each is in the field of wireless communication systems. EX1001, 1:28-34; EX1005, ¶ 67.

V. BACKGROUND OF THE PRIOR ART AND A POSITA

Petitioner provides the timeline below as it relates to extended long training sequences (ELTS), which is the subject of the prior art and challenged patent. The two relevant aspects of the ELTS are the number of subcarriers (exactly 56 is required by [1e]) and their specific encodings of $+1/-1$ (specified in [1f]). EX1005, ¶ 68.

In 1999, IEEE adopted 802.11-1999 (EX1006). EX1005, ¶ 69.

In 1999, IEEE adopted 802.11a (EX1008), which added OFDM in the 5Ghz band. 802.11a defined 20MHz channels containing 64 subcarriers with 0.3125 MHz spacing, but only used 52 of them to carry information. 802.11a defined a “short training sequence” (STS) on 12 subcarriers for AGC convergence, diversity selection, timing acquisition, and coarse frequency acquisition and a “long training sequence” (LTS) on 52 subcarriers for fine synchronization and channel estimation. EX1005, ¶ 70.

On 4/10/2003, the Jones inventors filed the Jones Provisional teaching 802.11a could be improved by extending the long training sequence, and disclosed the same 56-subcarrier encoding sequence claimed in the '629 patent by disclosing the full 63-subcarrier sequence. EX1014, Fig. 2 (L2); EX1005, ¶ 71.

In July 2003, the IEEE created the Task Group n (TGn) to develop 802.11n with the goal of significantly increasing the throughput rate, including via

multiple-input multiple-output (MIMO) and spatial multiplexing. EX1025; EX1005, ¶ 72.

On 6/30/2003, the Boer inventors (including Allert van Zelst) filed the Boer Provisional teaching that the 802.11a long training sequence could be extended to 56 subcarriers by adding 4 additional subcarriers. EX1013, 23-25. The Boer Provisional taught that, as of 2003, reasonable filtering enabled the use of the four extra subcarriers within the spectral mask provided by 802.11a. *Id.*, 23-25. The Boer Provisional explicitly disclosed all 16 of the possible encodings for the additional 4 subcarriers. *Id.*, 45-46 (including (1,1,-1,-1), the encoding claimed in the '629 patent for the 4 new subcarriers). EX1005, ¶ 73.

On 4/12/2004, the Jones inventors (including Vincent Jones and Richard van Nee) filed the non-provisional application that issued as Jones. EX1014, cover. Jones, like the Jones Provisional, disclosed the precise encoding sequence for 56 subcarriers claimed in the '629 patent by disclosing the full 63-subcarrier sequence. *Id.*, Fig. 4 (L2). Jones additionally disclosed that any of 53 to 63 subcarriers could be used, explicitly teaching (or at least rendering obvious) the use of exactly 56 subcarriers. *Id.*, 6:11-23, 8:23-41. EX1005, ¶ 74.

On 5/27/2004, the Zelst inventors (including Allert van Zelst, who by then worked for Airgo, Vincent Jones and Richard van Nee) filed the Zelst Provisional. The Zelst Provisional taught (like Boer and Jones) that an “Extended Long

Training Sequence” of 56 subcarriers could be used. EX1011, FIG. 3. The Zelst Provisional disclosed the precise encoding claimed in the ’629 patent by disclosing the full 63-subcarrier sequence and disclosing that exactly 56 subcarriers could be used for the ELTS (the “Zelst 56-subcarrier ELTS”). *Id.*, 4, FIG. 3; EX1005, ¶ 75.

Thus, by 5/27/2004, there is no question that the overlapping Jones/Zelst inventors at Airgo had already identified the precise encoding sequence, and identified with specificity that exactly 56-subcarriers could be used. EX1005, ¶ 76.

On 7/27/2004, the named inventors of the ’629 patent filed the ’104 Provisional disclosing a 56-subcarrier sequence and a 63-subcarrier sequence. EX1002, 2. The 56-subcarrier sequence is the same sequence disclosed earlier by Boer, Jones, and Zelst and eventually claimed in the ’629 patent. *Id.*, 7. However, the 63-subcarrier sequence differs from Jones and Zelst and the ’629 patent by encoding subcarrier 27 as +1. EX1002, 9; EX1005, ¶ 77.

In August 2004, the WWiSE industry consortium submitted a proposal to the IEEE TGn. EX1016. The WWiSE proposal included the same 56-subcarrier sequence previously disclosed in Boer, Zelst and the ’104 Provisional. *Id.*, 37. The WWiSE consortium was led by Airgo, the assignee of Jones and Zelst, and included Broadcom, the assignee of the ’104 Provisional. *Id.* The WWiSE proposal identified named inventors from each reference as contributors. *Id.*, 2; EX1005, ¶ 78.

On 12/8/2004, the named inventors of the '629 patent filed a second provisional, disclosing significant new matter and changing the 63-subcarrier sequence to match the 63-subcarrier sequence previously disclosed by Jones, Zelst and WWiSE. EX1030, FIG. 5 (changing the encoding of subcarrier 27 to -1). EX1005, ¶ 79.

On 7/26/2005, the named inventors filed the first non-provisional application to which the '629 patent claims priority. EX1001, Cover; EX1005, ¶ 80.

A. Person of Ordinary Skill in the Art

A person of ordinary skill in the art ("POSITA") at the time of the alleged invention would have had a bachelor's degree in electrical engineering, computer engineering, computer science, or a related field, and at least 2-4 years of experience in the field of wireless communication. Equivalent education, work, or experience in this field could substitute for the foregoing qualifications. EX1005, ¶¶ 81-82.

This definition of a POSITA would apply regardless of whether the time of the alleged invention was in 2004 (when the two provisionals were filed) or 2005 (when the first non-provisional was filed). EX1005, ¶¶ 81-82.

VI. LEGAL STANDARD FOR OBVIOUSNESS

A claim is unpatentable under 35 U.S.C. § 103 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 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) where in evidence, so-called secondary considerations. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

Factor (3) is discussed above. Regarding factor (4), PO has not provided any evidence of any nexus between any alleged secondary consideration and the challenged claims. The inclusion of the claimed sequence in 802.11n does not support patentability because that inclusion was the result of prior artists Zelst, Boer, and Jones via the WWiSE Proposal. Regardless, the showing of invalidity in this Petition is strong and any alleged secondary considerations are insufficient to establish non-obviousness. Factors (1) and (2) are addressed below.

VII. GROUND 1: JONES, 802.11A, 802.11-1999, ZELST AND BOER

A. Combination Rationale

Jones and Boer incorporate by reference 802.11a (EX1014, 5:32-38; EX1012, 1:33-36) which is an extension of 802.11-1999. 802.11a and 802.11-1999 should be considered a single reference or, in the alternative, it would have been obvious to combine them. *See* Section IV.A&B. EX1005, ¶ 83.

Jones, Zelst and Boer each explicitly teaches improvements to 802.11a. These references were from the same field, include common inventors, and were all directed to improving 802.11a to add extended long training sequences. See Section IV (Overview), V (Background). Thus, it would have been obvious to a POSITA to consider their teachings for that common purpose. EX1005, ¶ 84.

Jones teaches the prior art functional blocks used to create and transmit an 802.11a preamble including a long training sequence, including 1) a symbol mapper (Encoder 312) to map symbols to 64 subcarriers (some of which can be zero), which is coupled to 2) a signal generator (Packet Formation block 314) to generate the training symbol using only 52 subcarriers and inserting zeros for unused subcarriers, which is coupled to 3) a 64-value Inverse Fourier Transformer (IFFT 316) for converting from frequency to time domain. *Id.*, Fig. 3, 1:29-39, 5:5-6:10; EX1005, ¶ 85.

Jones teaches 802.11a should be improved by increasing the data rate which also requires an extended long training sequence. *Id.*, 6:11-23, 8:23-42. Jones explains this improvement can be implemented by having the symbol generator (Packet Formation block 312) use “any or all” of the currently unused subcarriers to transmit data as well as generate a longer training sequence and continue (as it did in 802.11a) to fill any unused subcarriers with zeros. *Id.*, 6:11-23. Jones discloses the encodings for the full sequence (63 subcarriers if one does not count

the zero subcarrier). *Id.*, Fig. 4 (L2), 8:23-42. The sequence in L2 includes the 56-value sequence required by limitation [1f] in the '629 patent. EX1005, ¶ 86.

Jones's teaching that "any or all" of the additional subcarriers defined in L2 could be used (1 extra for 53 subcarriers or up to 11 extra for 63 subcarriers), discloses to a POSITA that exactly 4 subcarriers could be used for a total of exactly 56 subcarriers as required by limitation [1e] in the '629 patent.

Alternatively, disclosing such a small range (53-63) renders obvious each value in that range, including exactly 56, given the predictable nature of this art. Further, based on the spectral mask provided in 802.11a, a POSITA would have found 56 to be an obvious choice, since the spectral mask supports up to 56 subcarriers. EX1005, ¶ 87.

Based on its positions in the ITC, PO is expected to argue that Jones's teaching is insufficient to show "exactly 56 subcarriers." Accordingly, Petitioner additionally relies on the teachings of Zelst and Boer as described below. Because Zelst and Boer each disclose precisely the same encodings as Jones for limitation [1f], the only question is whether the combination of teachings of Jones, Zelst and Boer sufficiently render "exactly 56 subcarriers" obvious. They do. EX1005, ¶ 88.

1. It would have been obvious in the combination to use the Zelst 56-Subcarrier ELTS

It would have been obvious to combine Jones (along with the incorporated 802.11a standard and original 802.11-1999 standard) with the teachings of Zelst and Boer, which each teach that an extended long training sequence for 802.11a of the type disclosed in Jones should use exactly 56-subcarriers because that is the number that will fit within the spectral mask of 802.11a. EX1005, ¶ 89.

Zelst teaches an improvement on 802.11a, including an “Extended Long Training Sequence” (ELTS) that is “carried by exactly 56 subcarriers” and is represented by the claimed encoding scheme (the “Zelst 56-subcarrier ELTS”). EX1005, ¶ 90.

Figure 15A of Zelst (below, annotated) has its center 56 values highlighted. The same encoding sequence is disclosed in Jones and the Zelst Provisional, which is shown (annotated) immediately below Figure 15A in Zelst. EX1005, ¶ 91.

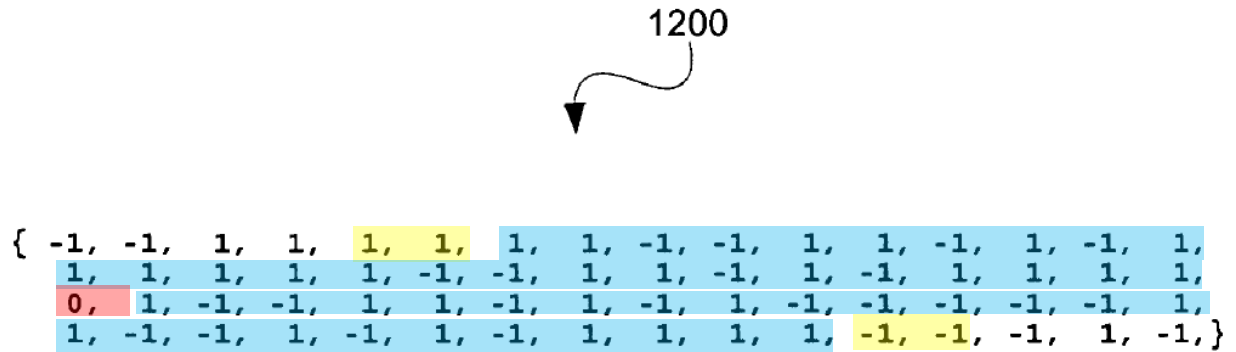


FIG. 15A

E1010, FIG. 15A. The identical sequence is disclosed in the Zelst Provisional as shown below.

20 MHz & 40 MHz Extended Long Training (ELT)

- ELT for 20 MHz:

$$L_{-32,31} = \{-1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, \\ 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, \\ 0, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, 1, \\ 1, -1, -1, 1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, 1, -1\}$$

EX1011, 4. EX1005, ¶ 91.

These highlighted sequences in Zelst and the Zelst Provisional are identical to the 56 values disclosed and claimed in the '629 patent (and Jones) for the same subcarriers. EX1005, ¶ 92.

The table of encodings in [1f] is difficult to read because the index zero subcarrier has been removed and is referenced in the language before the table, but

as shown below, the encoding sequence in 1[f] is identical to that of Zelst and the Zelst Provisional, with the legacy 52 subcarriers -26 to +26 highlighted in blue and the four additional subcarriers (-28, -27, +27, +28) highlighted in yellow. EX1005, ¶ 92. For comparison, Figure 4 of the '629 patent is shown below showing the same highlighting of the legacy, new and zero subcarriers..

Sub-carrier	-28	-27	-26	-25	-24	-23	-22
Encoding	+1	+1	+1	+1	-1	-1	+1
Sub-carrier	-14	-13	-12	-11	-10	-9	-8
Encoding	+1	+1	+1	-1	-1	+1	+1
Sub-carrier	1	2	3	4	5	6	7
Encoding	+1	-1	-1	+1	+1	-1	+1
Sub-carrier	15	16	17	18	19	20	21
Encoding	+1	+1	-1	-1	+1	-1	+1
Sub-carrier	-21	-20	-19	-18	-17	-16	-15
Encoding	+1	-1	+1	-1	+1	+1	+1
Sub-carrier	-7	-6	-5	-4	-3	-2	-1
Encoding	-1	+1	-1	+1	+1	+1	+1
Sub-carrier	8	9	10	11	12	13	14
Encoding	-1	+1	-1	-1	-1	-1	-1
Sub-carrier	22	23	24	25	26	27	28
Encoding	-1	+1	+1	+1	+1	-1	-1

+1	+1	1	1	-1	-1	1	1	-1	1	-1	1	1	1
-28	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15

Sub-carrier index

1	1	1	-1	-1	1	1	-1	1	-1	1	1	1	1	0
-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

Sub-carrier index

+1	-1	-1	1	1	-1	1	-1	1	-1	-1	-1	-1	-1
1	2	3	4	5	6	7	8	9	10	11	12	13	14

Sub-carrier index

1	1	-1	-1	1	-1	1	-1	1	1	1	1	-1	-1
15	16	17	18	19	20	21	22	23	24	25	26	27	28

Sub-carrier index

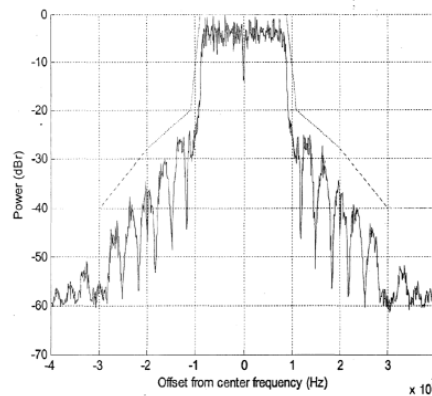
LONG TRAINING SEQUENCE FOR 56 ACTIVE
FIGURE 4

EX1001, FIG. 4, limitation 1[f]. EX1005, ¶ 92.

Although the above sequences in Zelst and the Zelst Provisional disclose 64 subcarriers, the Zelst Provisional also discloses the use of exactly 56 subcarriers for the extended long training sequence. Figure 3 of the Zelst Provisional (annotated below), recommends 56 subcarriers “Including the Extended Long Training Sequence.” EX1005, ¶ 93.

Example PSD of TX Signal

- 20 MHz mode
- Realistic filtering
- 1000 byte packet
- 56 subcarriers
- Including the Extended Long Training Sequence



EX1011, FIG. 3. Zelst Provisional explains the reason for the extended long training sequence is “to prevent interpolation issues.” *Id.*, 2, 9, 13. The same rationale for extending the number of subcarriers to 56 is disclosed in Boer. EX1012, 4:1-59; EX1005, ¶ 94.

To arrive at the '629 patent's encoding sequence for 56 subcarriers, a POSITA would simply truncate the 63-subcarrier sequence taught by Jones and Zelst so as not to use the seven sub-carriers at the highest and lowest frequencies; *i.e.*, sub-carriers -32, -31, -30, -29, +29, +30 and +31. As taught by Jones, those subcarriers would be set to zero by the signal generator. Put another way, only the middle 56 subcarriers from -28 to +28 would be used. EX1005, ¶ 95.

It would have been obvious for a POSITA to only use the middle 56 subcarriers from the Jones and Zelst sequence because, as the title of Zelst explains, the goal is “to allow for coexistence and interoperability [aka backwards

compatibility] between 802.11a devices and higher data rate ... devices.” EX1010, Title. Jones explains the same goal. EX1014, 8:37-40. Zelst explains to achieve this, “[i]n some embodiments, the modified preamble includes both legacy 802.11a Sequences as well as modified preamble Sequences.” *Id.*, 3:3-5. In other words, maintain the same encoding sequence as the legacy 802.11a standard for the center 52 subcarriers. EX1005, ¶ 96.

Boer also confirms that the particular encoding of the Zelst 56-subcarrier ELTS would have been obvious. The Boer Provisional discloses 56 subcarriers should be used to enhance channel estimation, and that there are only 16 possible encoding schemes when adding four subcarriers to the 52 subcarriers already present in 802.11a. That is, since each subcarrier can be encoded using either a +1 or -1, there are only two possibilities per subcarrier, and $2^4=16$. All 16 possibilities are disclosed in the Boer Provisional, one of which (highlighted below) is the same encoding disclosed in Zelst and claimed in the '629 patent.

Diagonal-4	1111	1	2.9337	1.0179	2.8822
		2	4.3393	1.0179	4.2632
		3	2.7409	0.9643	2.8424
	111-1	1	2.9337	1.0179	2.8822
		2	4.3393	1.0179	4.2632
		3	2.7409	0.9643	2.8424
	11-11	1	3.0600	1.0179	3.0063
		2	4.3393	1.0179	4.2632
		3	2.7409	0.9643	2.8424
	11-1-1	1	3.0600	1.0179	3.0063
		2	4.3393	1.0179	4.2632
		3	2.7409	0.9643	2.8424
	1-111	1	2.9337	1.0179	2.8822
		2	3.0265	1.0179	2.9734
		3	2.7409	0.9643	2.8424
	1-11-1	1	2.9337	1.0179	2.8822
		2	2.7592	1.0179	2.7108
		3	2.7409	0.9643	2.8424
	1-1-11	1	3.0600	1.0179	3.0063
		2	3.0265	1.0179	2.9734
		3	2.7409	0.9643	2.8424
	1-1-1-1	1	3.0600	1.0179	3.0063
		2	2.7592	1.0179	2.7108
		3	2.7409	0.9643	2.8424
	-1111	1	2.6520	1.0179	2.6055
		2	4.3393	1.0179	4.2632
		3	2.7409	0.9643	2.8424
	-111-1	1	2.6520	1.0179	2.6055
		2	4.3393	1.0179	4.2632

EX1013, 45; EX1005, ¶ 97.

The legacy 802.11a LTS encoding, which the Boer Provisional improves upon, is shown below with active subcarriers -26 to -1 and 1 to +26 highlighted in blue, and the indexed subcarrier 0 which is set to zero highlighted in red.

A long OFDM training symbol consists of 53 subcarriers (including a zero value at dc), which are modulated by the elements of the sequence L, given by

$$L_{-26, 26} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, -1, 1, 1, 1\} \quad (8)$$

EX1008, 13; EX1005, ¶ 98.

A POSITA would have understood based on the teachings of Zelst and Boer that 56 subcarriers could be used to carry the ELTS based on the room available in the 802.11a spectral mask (shown below).

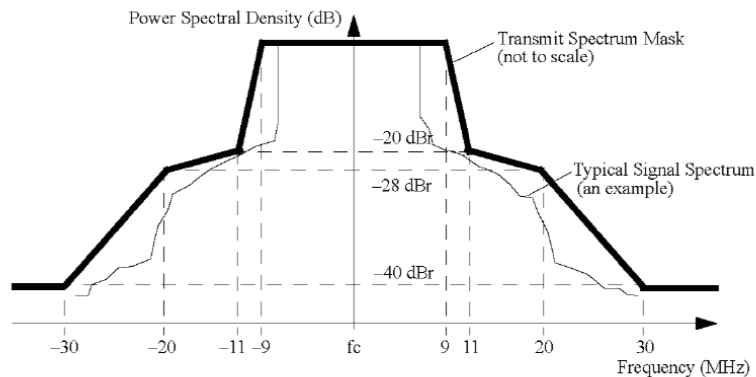


Figure 120—Transmit spectrum mask

EX1008, FIG. 120. EX1005, ¶ 99.

802.11a states the “[t]he transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz” and that “[t]he transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 120.” EX1008, 28. 802.11a further states that the subcarrier frequency spacing is “0.3125 MHz (=20 MHz/64).” *Id.*, 9. A POSITA would have understood the spectral mask’s 0dBr bandwidth of 18 MHz could fit up to 57.6 subcarriers, because $18 \text{ MHz} / 0.3125 \text{ MHz} = 57.6$. EX1005, ¶ 100.

Boer discloses an extended long training sequence, stating: “since the training technique defined by the IEEE 802.11a/g standard only modulates 52 out

of the 64 subcarriers, additional spectrum is available to specify additional subcarriers. For example, it can be shown that ***the addition of four extra training subcarriers***, two at each side of the spectrum, conforms with the IEEE 802.11a/g transmit mask defined in the IEEE 11a/g standard.” EX1012, 4:40-48; EX1005, ¶ 101.

Boer’s 56-subcarrier long training sequence also maintains the same 52 subcarriers from 802.11a and adds four more. The Boer long training sequence is “extended” because it is 4 subcarriers longer than the 802.11a long training sequence of 52 subcarriers, as shown below.

A long OFDM training symbol consists of 53 subcarriers (including a zero value at dc), which are modulated by the elements of the sequence L, given by

$$L_{-26, 26} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 0, \\ 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1\} \quad (8)$$

EX1008, 13; EX1005, ¶ 102.

The Boer Provisional also teaches that adding four subcarriers to 802.11a still complies with 802.11a’s spectral mask: “As can be seen from Figure 5 [below], the PSDs of the training sequences still fulfill the transmit spectral mask requirements, when extended with four additional subcarriers. From this it can be concluded that the extension with extra subcarriers at the edge is allowed and is in line with the IEEE 802.11a specifications.”

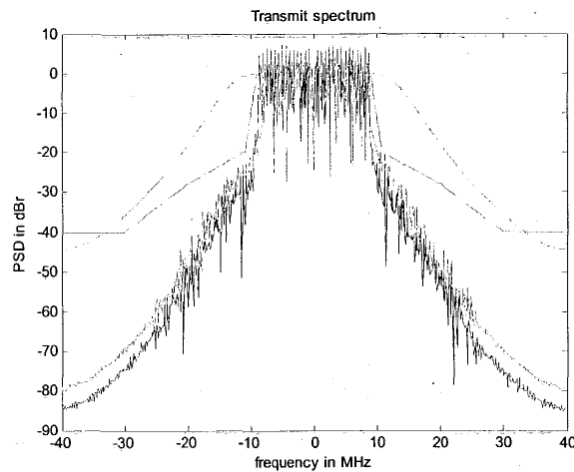


Figure 5: Transmit spectrum of the filtered and PA distorted training sequences

EX1013, 24-25; EX1005, ¶ 103.

A POSITA also would have realized that increasing the number of subcarriers from 52 to 56 could be achieved using reasonable transmit filters to attenuate out-of-band subcarriers to conform with the transmit spectral mask based on the teachings of Zelst. EX1010, 15:64-16:2; EX1011, 5; EX1005, ¶ 104.

Boer also discloses that the 56 subcarriers could be distributed amongst three transmit antennas, but that does not detract from Boer's teaching that all 56 subcarriers could be transmitted without violating the spectral mask requirements of 802.11a. Specifically, the disclosure is based on the largest (i.e., furthest from DC) subcarriers used, regardless of the number of antennas. Thus, the teaching does not depend specifically on the number of transmit or receive antennas. EX1005, ¶ 105.

Zelst and Jones expressly teach a POSITA that the combination should provide for enhanced modes by extending the long training sequence provided by 802.11a while maintaining backward compatibility with 802.11a legacy devices. EX1010, Abstract; EX1014, 20:21-25. EX1005, ¶ 106.

Further, a POSITA would have been motivated to make the combination because adding four subcarriers to 802.11a data and training fields increases data rate throughput as taught in Zelst and Jones. EX1010, 2:38-45; EX1014, 2:62-3:11; EX1005, ¶ 107.

Further, a POSITA would have been motivated to make the combination because adding additional side carriers allows for improved channel estimation by allowing for interpolation instead of extrapolation of edge subcarriers as taught by Boer. EX1012, 4:45-59; EX1005, ¶ 109.

This combination would combine known elements to yield a predictable result – a system that utilized an extended long training sequence of 56 non-zero subcarriers for the advantages taught by Zelst, Boer and Jones while remaining backwards-compatible with 802.11a as taught by Zelst and Jones. EX1005, ¶ 108.

The combination would involve the application of a known technique (*e.g.*, generating a training sequence) to a known system (802.11a's functional blocks as described by Jones) ready for improvement to yield predictable results. For example, 802.11a discloses a 64-point Inverse Fast Fourier Transform that operates

on 64 subcarrier values. A POSITA would have understood that a 64-point Inverse Fast Fourier Transform could operate on an ELTS of up to 64 values, which is greater than 52. EX1008, 12. Similarly, Jones teaches that in 802.11a systems, the signal generator populates unused subcarriers with zero before providing the training sequence to the IFFT. EX1014, 2:14-30. A POSITA would have understood that they could simply use the four additional subcarriers (as taught by Jones and very specifically taught by Zelst and Boer), using the encodings of Jones, Zelst and Boer, to achieve the benefits taught by Jones, Zelst, and Boer. EX1005, ¶ 110.

The reasoning above also shows that a POSITA would have had a reasonable expectation of success in making the combination to implement Zelst's 56-subcarrier ELTS. Notably, the '629 patent itself does not describe any problems or provide any other implementation details to overcome any such problems. To the contrary, the '629 patent admits that 56-subcarrier ELTS's were under consideration for 802.11n, and the '629 merely states that one of the 16 possible sequences should be used, when that one was previously disclosed by Jones, Zelst and Boer. EX1005, ¶ 111.

In sum, the claimed ELTS—the number of subcarriers and the particular encodings—would have been obvious. A POSITA looking to extend 802.11a and maintain backwards compatibility with legacy 802.11a devices (as taught by Zelst

and Jones) would have used an ELTS of either 56 or 63 subcarriers as taught by Zelst, Jones and Boer. Extending to 63 would have been an obvious number because that is the maximum that can be used in a 20MHz channel and 64-value IFFT as defined by 802.11a as taught by Zelst and Jones. Extending to 56 also would have been obvious because that is the maximum number that can be used within the spectral mask defined by 802.11a with reasonable filtering as taught by Zelst and Boer. Thus, to accomplish the known goals of increasing the number of subcarriers to increase bandwidth (as taught by Zelst and Jones) and enhance channel estimation (as taught by Boer), the two most obvious choices are to use either 56 or 63 subcarriers (the two choices that the APAA admits were being considered). EX1005, ¶ 112.

A POSITA extending an LTS to 56 would want to use the same 52 center subcarriers to maintain backwards compatibility as taught by Zelst, Jones and Boer. Thus, a POSITA would only have to choose the encoding (1 or -1) for the 4 extra subcarriers. There are only 16 choices, none of which is patentable because of the predictability of this art. More importantly, Zelst, Jones and Boer each disclose the precise encodings of those extra subcarriers (1,1,-1,-1). EX1005, ¶ 113.

2. It would have been obvious in the combination to use the claimed functional blocks disclosed in Jones

Jones also teaches the claimed functional blocks (e.g., a symbol mapper (Encoder 312)) coupled to a signal generator (Packet Formation block 314) coupled to an Inverse Fourier Transformer (IFFT 316), which could each be implemented as a processor) and it would have been obvious to use those functional blocks in the combination. A POSITA would have been motivated to use the hardware implementation details in Jones based on the express teachings in Jones that those implementation details should be used to support 802.11a legacy devices while simultaneously supporting an improvement to 802.11a that utilized extended long training sequences between 53 and 64 subcarriers. A POSITA also would have been motivated by the lack of any conflicting implementation details in Zelst, 802.11a and Boer to use the functional blocks in Jones. EX1005, ¶ 114.

It would also have been obvious in the combination to include an IFFT operatively coupled to the signal generator as taught by Jones because each of Zelst, 802.11a, and Boer teach an IFT (e.g., IFFT) should be operatively coupled to the source of the training signal (e.g., Packet Formation block 314) in order to perform an IFT operation (e.g., IFFT). EX1005, ¶ 115.

A POSITA would have had a reasonable expectation of success in making the combination as Jones expressly teaches that its functional blocks can support

both legacy and improved 802.11a devices with extended long training sequences. Jones incorporates by reference 802.11a (EX1014, 5:33-38) and Jones, Zelst, and Boer each purport to improve 802.11a using an ELTS. Jones's functional blocks are known components used for their known purposes and, therefore, would produce predictable results. Jones teaches a POSITA all they would need to make the combination. EX1005, ¶ 116.

B. Claim 1¹

1. [1pre]

The combination discloses “A wireless communications device (transmitter system 302),² comprising (*see* 1[a]-1[f]).” EX1005, ¶ 117.

Jones discloses a wireless communication device. EX1014, Fig. 3 (devices 302, 304), 8:1 (“two transmitter MIMO device.”); EX1005, ¶ 118.

¹ Claim language is usually quoted in the introductory sentence of each section.

² In the introductory sentence, parentheticals within the claim limitation are included to help orient the reader to exemplary arguments and evidence. These cites are just exemplary, and Petitioner relies on all of the arguments and evidence included in the Petition.

Zelst also discloses extensions to 802.11a communications protocol for wireless communications devices. EX1010, Fig. 3, (wireless communications devices 102(1), 102(2) and 104); 4:24-26; EX1005, ¶ 119.

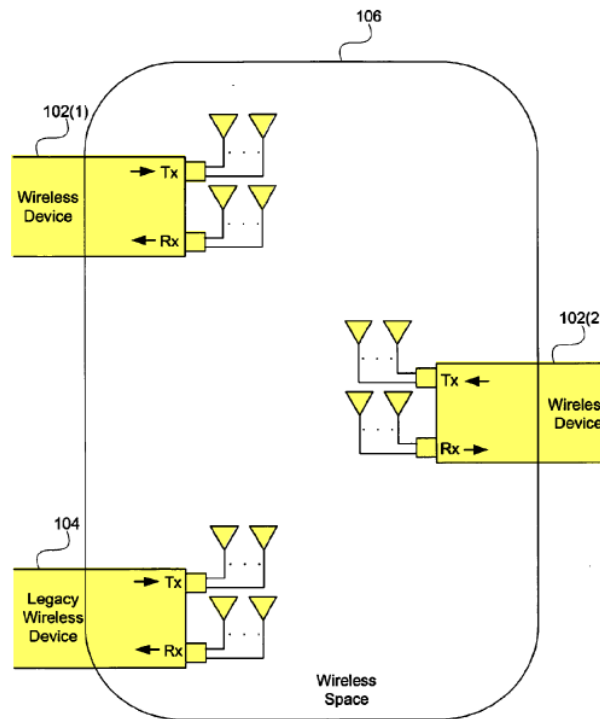
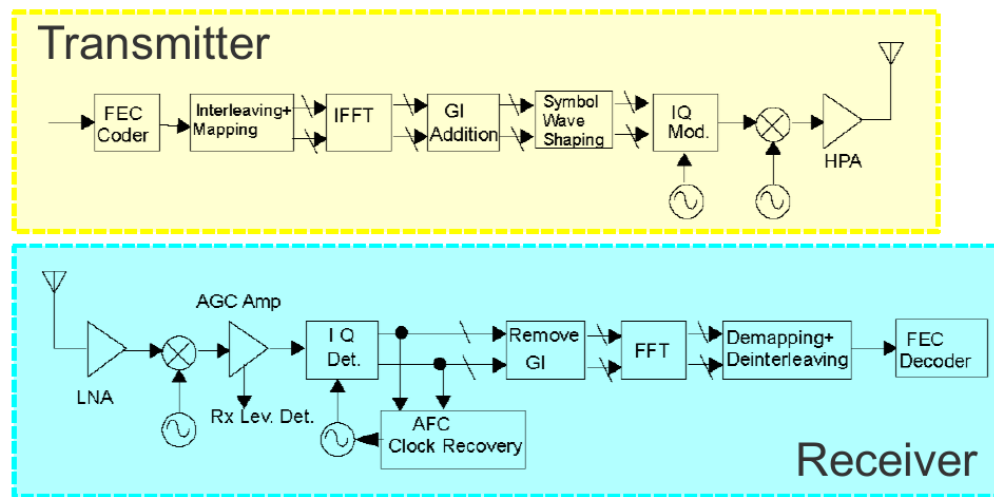


Fig. 3

The Zelst Provisional also discloses extensions to the 802.11a wireless protocol for wireless communication devices. EX1011, 3 (“packets sent over a wireless network, such as an 802.11a compliant wireless network. . . may be received by legacy receivers”). EX1005, ¶ 120.

802.11a also discloses a wireless communications device. EX1008, Fig. 118 (disclosing transmitter and a receiver, both of which are wireless communication devices). EX1005, ¶ 121.



Thus, it would have been obvious in the combination to have a wireless communication device implementing an extension to 802.11a. EX1005, ¶ 122.

2. 1[a]

The combination discloses “a signal generator (Packet Formation block 314) that generates an extended long training sequence (Zelst 56-subcarrier ELTS).” EX1005, ¶ 123.

Jones discloses a signal generator (Packet Formation block 314) (highlighted below) “advantageously pre-pends a preamble to each transmitted packet,” which may include “a preamble suitable for extended-rate 802.11a communication systems.” EX1014, 7:38-42. Jones states that in “an extended mode long training sequence,” $L[k]$ may “contain more than 52 non-zero subcarriers” such as sequence L2 in FIG. 4. *Id.*, 8:22-27. Jones discloses the same 63-value encoding sequence (shown below) taught in Zelst Figure 15A and disclosed in the ’629

patent. Jones also teaches that the extended LTS could use more than 52 but fewer than all 63 subcarriers. EX1014, 6:11-23, 8:22-41; EX1005, ¶ 124.

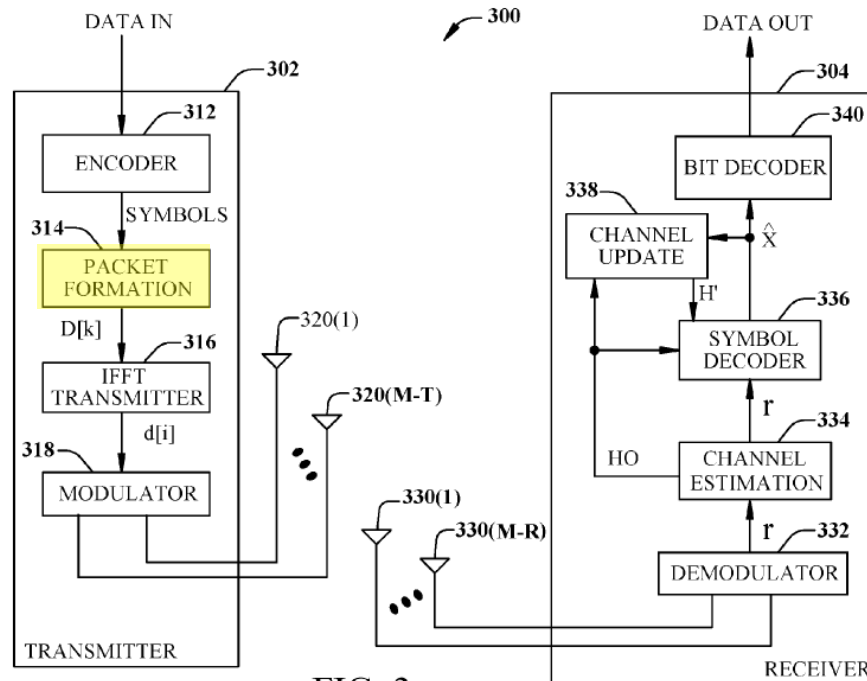
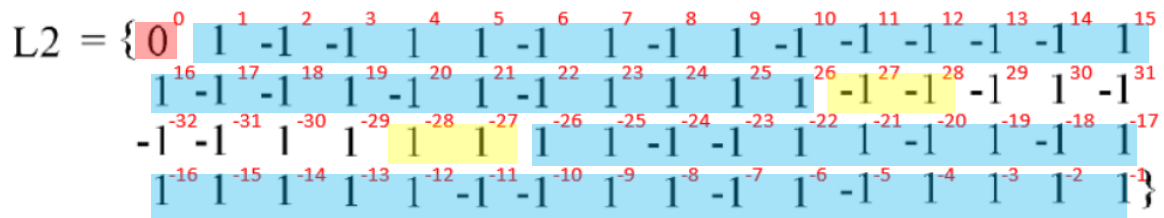


FIG. 3

Jones teaches the same 63-subcarrier ELTS as Zelst and, like Zelst, explicitly teaches that fewer than all of the extra subcarriers could be used. EX1014, FIG. 4 (L2), 6:11-23. As illustrated in the annotated L2 sequence below, Jones lists the sequence from index 0 to 31 followed by index -32 to -1. EX1014, 2:14-30, 8:24-28. Zelst and the '629 patent use a different convention, listing the sequence from index -32 to +31. EX1010, FIG. 15A; EX1001, FIG. 5. For ease of reference, an annotated version of L2 in Jones is included below, with the subcarrier indexes added in red. EX1005, ¶ 125.



Zelst discloses the same ELTS as Jones in Figure 4 (L2), and reformats it in Figure 15A, shown below.

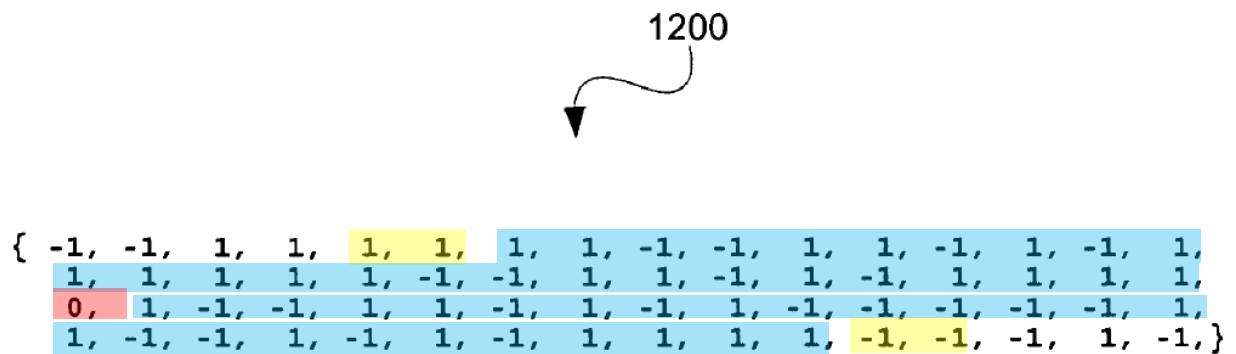


FIG. 15A

EX1010, FIG. 15A; EX1005, ¶ 126. Zelst states “FIG. 15A . . . shows the 64 tones of an ELT sequence 1200 adapted for a 20 MHz channel.” EX1010, 15:34-37.

EX1005, ¶ 126.

The incorporated Zelst Provisional discloses the same “Extended Long Training (ELT)” sequence.

20 MHz & 40 MHz Extended Long Training (ELT)

- ELT for 20 MHz:

$$L_{-32,31} = \{-1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, -1, 1, 1, -1\}$$

EX1011, 4. EX1005, ¶ 127.

The incorporated Zelst Provisional goes on to teach that exactly 56 subcarriers can be used for the ELT sequence. EX1011, FIG. 3. This is the Zelst 56-subcarrier ELTS, and it would have been obvious to use that ELTS in the combination. *See* Section VII.A (Combination Rationale); EX1005, ¶ 128.

Boer similarly teaches that exactly 56 subcarriers can be used for the ELTS, discloses the same encodings for the four additional subcarriers as Zelst and Jones, and it would have been obvious to use that (same) ELTS in the combination. *See* Section VII.A (Combination Rationale); EX1005, ¶ 129.

The ELTS is “extended” since it is longer than a “long training sequence” from a legacy standard, such as 802.11a, which has 52 active sub-carriers (below). EX1005, ¶ 130.

A long OFDM training symbol consists of 53 subcarriers (including a zero value at dc), which are modulated by the elements of the sequence L , given by

$$L_{-26,26} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1\} \quad (8)$$

EX1008, 13.

Moreover, 802.11a itself repeatedly states that the long training sequence is “generated.” EX1008, 13 (“A long OFDM training symbol shall be generated according to the following equation.... An illustration of the long training sequence generation is given in Annex G.”), 59 (“G.3.2 Generation of the long sequences”). 802.11a’s teaching that the LTS is “generated” renders obvious a “signal generator” to a POSITA because using a “signal generator” would have been an obvious way to perform the disclosed function of generating. Jones teaches its Packet Formation block 314 can generate 802.11a compliant long training sequences. EX1014, 6:11-22. Zelst and Jones emphasize the need to support legacy 802.11a devices, so it would have been obvious to use the same Packet Formation block 314 (signal generator) that generates the 802.11a LTS to generate the improved Zelst 56-subcarrier ELTS. EX1005, ¶ 131.

In the combination, it would have been obvious for Jones’s Packet Formation block 314 (signal generator) to generate the Zelst 56-subcarrier ELTS as taught by Zelst and Boer and zeros for the unused subcarriers. Jones expressly teaches that the extended sequence could use fewer than all of the subcarriers, and the Packet Formation Block 314 (signal generator) would insert zeros for unused carriers “as is known in the art.” EX1014, 6:11-23. Furthermore, a POSITA would have understood there would have been no reason to generate all 63 values just to

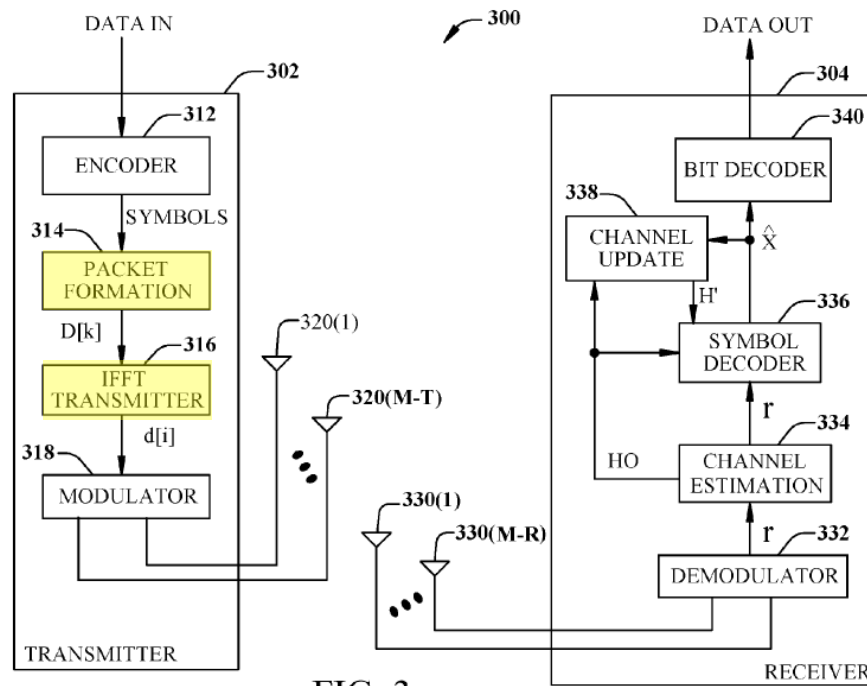
discard unused values. Thus, it would have been obvious to a POSITA that in the combination the signal generator would generate the Zelst 56-subcarrier ELTS that would be used, and zeros for the other subcarriers. EX1005, ¶ 132.

Lastly, it should be noted that in the related ITC Investigation, PO asserted claim 1 (and other claims) of the '629 patent were “essential” to practicing the 802.11n standard because using the ELTS defined by the 802.11n standard necessarily required the use of the claimed “signal generator.” EX1022, 6-8. Thus, according to PO’s contentions on which it sought to exclude Petitioner’s products from the United States, the definition of a training sequence by a standard inherently requires the claimed “signal generator.” *Id.* In light of PO’s inherency arguments before the ITC, the Board should be skeptical of any argument by PO in this IPR that the definitions of training sequences by Zelst and 802.11a do not (at least) render obvious the claimed “signal generator.” EX1005, ¶ 133.

3. 1[b]

The combination discloses “an Inverse Fourier Transformer (IFFT) operatively coupled to the signal generator (Packet Formation block 314).” EX1005, ¶ 134.

Jones discloses an Inverse Fourier Transformer (IFFT block 316) operatively coupled to the signal generator (Packet Formation block 314). EX1014, 5:5-20, 5:65-6:10.



EX1014, FIG. 3 (annotated). Jones discloses that IFFT would process the legacy and any extended long training sequence from the signal generator, Packet Formation block 314, with zeros for any unused subcarriers. EX1014, 5:65-6:10, 9:21-29; EX1005, ¶ 135.

Zelst also discloses this limitation, stating “The samples are obtained by taking a 64-point IFFT (inverse fast-Fourier transform) of the long training sequence, L1 in this example.” EX1010, 2:28-34. A POSITA would have understood that “in this example” means Zelst’s teaching of using an IFFT applied to the other long training sequences (in fact any long training sequence that uses 64 or fewer sub-carriers), including the Zelst 56-subcarrier ELTS. EX1005, ¶ 136.

The incorporated Zelst Provisional also discloses this limitation, stating that on the receiver side, one would “perform an FFT on the received samples corresponding to the transmitted long training symbol(s).” EX1011, 18. This disclosure conveys to a POSITA that because the receiver includes a FFT, the transmitter must include an IFT (i.e., the inverse of the FFT) that is processing the long training symbols. EX1005, ¶ 137.

802.11a also discloses an IFFT as part of the transmitter in Figure 118, annotated below.

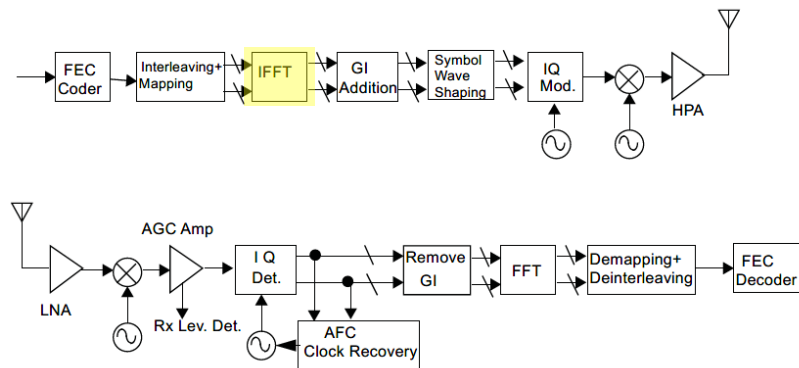


Figure 118—Transmitter and receiver block diagram for the OFDM PHY

EX1008, FIG. 118. And 802.11a also discloses that an IFFT is performed on the long training sequence (in Table G.5).

Table G.5—Frequency domain representation of the long sequences

##	Re	Im	##	Re	Im	##	Re	Im	##	Re	Im
-32	0.000	0.000	-16	1.000	0.000	0	0.000	0.000	16	1.000	0.000
-31	0.000	0.000	-15	1.000	0.000	1	1.000	0.000	17	-1.000	0.000
-30	0.000	0.000	-14	1.000	0.000	2	-1.000	0.000	18	-1.000	0.000
-29	0.000	0.000	-13	1.000	0.000	3	-1.000	0.000	19	1.000	0.000
-28	0.000	0.000	-12	1.000	0.000	4	1.000	0.000	20	-1.000	0.000
-27	0.000	0.000	-11	-1.000	0.000	5	1.000	0.000	21	1.000	0.000
-26	1.000	0.000	-10	-1.000	0.000	6	-1.000	0.000	22	-1.000	0.000
-25	1.000	0.000	-9	1.000	0.000	7	1.000	0.000	23	1.000	0.000
-24	-1.000	0.000	-8	1.000	0.000	8	-1.000	0.000	24	1.000	0.000
-23	-1.000	0.000	-7	-1.000	0.000	9	1.000	0.000	25	1.000	0.000
-22	1.000	0.000	-6	1.000	0.000	10	-1.000	0.000	26	1.000	0.000
-21	1.000	0.000	-5	-1.000	0.000	11	-1.000	0.000	27	0.000	0.000
-20	-1.000	0.000	-4	1.000	0.000	12	-1.000	0.000	28	0.000	0.000
-19	1.000	0.000	-3	1.000	0.000	13	-1.000	0.000	29	0.000	0.000
-18	-1.000	0.000	-2	1.000	0.000	14	-1.000	0.000	30	0.000	0.000
-17	1.000	0.000	-1	1.000	0.000	15	1.000	0.000	31	0.000	0.000

The time domain representation is derived by performing IFFT on the contents of Table G.5, cyclically extending the result to get the cyclic prefix, and then multiplying with the window function given in G.3.1. The resulting 161 points vector is shown in Table G.6. The samples are appended to the short sequence section by overlapping and adding element 160 of Table G.4 to element 0 of Table G.6.

EX1008, Table G.5 (“The time domain representation is derived by performing IFFT on the contents of Table G.5.”). Because the IFFT is receiving the long training sequence in Table G5, this disclosure teaches the limitation “an Inverse Fourier Transformer operatively coupled to the signal generator.” EX1005, ¶ 138.

Boer also discloses “a conventional long training symbol according to the IEEE 802.11a/g standard consisting of 64 subcarriers, seen at the input of the Inverse Fast Fourier Transform (IFFT).” EX1012, 2:49-52; EX1005, ¶ 139.

4. 1[c]

The combination discloses “wherein the Inverse Fourier Transformer (IFFT) processes the extended long training sequence (Zelst 56-subcarrier ELTS) from the

signal generator (Packet Formation block 314), and provides an optimal extended long training sequence with a minimal peak-to-average ratio (Zelst 56-subcarrier ELTS processed by the IFFT).” EX1005, ¶ 140.

As explained for limitation 1[b], in the combination, the IFFT processes Zelst’s 56-subcarrier ELTS from the Packet Formation block 314. *See* [1a]. Thus, the only remaining issue for this limitation is whether the output of the IFFT is “an optimal extended long training sequence with a minimal peak-to-average ratio.” It is. Zelst’s 56-subcarrier ELTS is identical to the disclosed and claimed sequence and, therefore, the output of the IFFT for each sequence is identical. As discussed above for claim construction, the patent admits (and requires in the claim) that this is “optimal” and has a minimal PAPR. *See* Section III.C.1 (claim construction). Nothing else is required. EX1005, ¶ 141.

Notably, dependent claim 4 depends from this claim and adds the limitation that “the optimal extended long training sequence has a minimum peak-to-average power ratio of 3.6 dB.” EX1001, Claim 4. Thus, independent claim 1 must at least encompass a sequence with a PAPR of 3.6 dB. The ’629 patent admits the claimed sequence (which is the Zelst 56-subcarrier ELTS) results in a PAPR of 3.6 dB and Dr. Buehrer confirmed the same. *See* claim 4; EX1005, ¶ 142.

Zelst’s 56-subcarrier ELTS is optimal for the additional reason that the middle 52 subcarriers are identical to the long training sequence in 802.11a.

Compare EX1010, FIG. 15A with EX1008, 13. Thus, a device that uses the Zelst 56-subcarrier ELTS can coexist with a legacy 802.11a device that uses only the 52 subcarriers from 802.11a. Zelst explicitly teaches this advantage. EX1010, 8:54-58; EX1011, 3 (“[p]ackets containing preambles of the present invention may be received by legacy receivers that are not configured to receive and interpret these preambles”). Similarly, Jones teaches the same advantage. EX1014, 20:21-25. The ’629 patent also teaches this is a desirable feature of the same ELTS. EX1001, 4:21-25; EX1005, ¶ 143.

Finally, in the related ITC Investigation No. 1367, PO accused asserted claim 1 was essential to the 802.11n standard merely because that standard used the recited sequence. PO should not be heard to argue otherwise now. EX1022, 10-12.

5. 1[d]

The combination discloses “wherein at least the optimal extended long training sequence (Zelst 56-subcarrier ELTS processed by an IFFT) is carried by a greater number of subcarriers (56 subcarriers) than a standard wireless networking configuration (56 subcarriers) for an [OFDM] scheme (802.11a).” EX1005, ¶ 144.

As explained in Section VII.A (Combination Rationale) and above for limitations [1a]-[1c], it would have been obvious in the combination to use the Zelst 56-subcarrier ELTS. Zelst and Boer disclose increasing the number of

OFDM subcarriers used to carry the ELTS to 56, up from the 52 in 802.11a, and Jones discloses increasing the number above the 52 in 802.11a and up to 63. 802.11a is an OFDM scheme. EX1008, Cover. Thus, Zelst, Boer and Jones each disclose this limitation. EX1005, ¶ 145.

6. 1[e]

The combination discloses “wherein the optimal extended long training sequence (Zelst 56-subcarrier ELTS processed by IFFT) is carried by exactly 56 active sub-carriers.” As shown above, it would have been obvious in light of Jones, Zelst and Boer to use the Zelst 56-subcarrier ELTS, which is carried by exactly 56 active subcarriers. See Section VII.A (Combination Rationale); [1a]-[1d]; EX1005, ¶ 146.

7. 1[f]

The combination discloses “wherein the optimal extended long training sequence (Zelst 56-subcarrier ELTS processed by IFFT) is represented by encodings for indexed sub-carriers -28 to +28, **excluding indexed sub-carrier 0 which is set to zero**, as follows:

<i>Sub-carrier</i>	-28	-27	-26	-25	-24	-23	-22
<i>Encoding</i>	+1	+1	+1	+1	-1	-1	+1
<i>Sub-carrier</i>	-14	-13	-12	-11	-10	-9	-8
<i>Encoding</i>	+1	+1	+1	-1	-1	+1	+1
<i>Sub-carrier</i>	1	2	3	4	5	6	7
<i>Encoding</i>	+1	-1	-1	+1	+1	-1	+1
<i>Sub-carrier</i>	15	16	17	18	19	20	21
<i>Encoding</i>	+1	+1	-1	-1	+1	-1	+1
<i>Sub-carrier</i>	-21	-20	-19	-18	-17	-16	-15
<i>Encoding</i>	+1	-1	+1	-1	+1	+1	+1
<i>Sub-carrier</i>	-7	-6	-5	-4	-3	-2	-1
<i>Encoding</i>	-1	+1	-1	+1	+1	+1	+1
<i>Sub-carrier</i>	8	9	10	11	12	13	14
<i>Encoding</i>	-1	+1	-1	-1	-1	-1	-1
<i>Sub-carrier</i>	22	23	24	25	26	27	28
<i>Encoding</i>	-1	+1	+1	+1	+1	-1	-1

EX1001, [1f]; EX1005, ¶ 147.

As shown above, in the combination it would have been obvious to use the Zelst 56-subcarrier ELTS which has this sequence. See Section VII.A (Combination Rationale). Petitioner has annotated [1f] above by highlighting “indexed sub-carrier 0 which is set to zero” in red, highlighting the 52-subcarriers that comprise the legacy 802.11a LTS in blue, and highlighted the four extra subcarriers that define the 56-subcarrier ELTS in yellow. The table in [1f] is difficult to read. Figure 4 of the ’629 patent contains the same sequence in much better format, and is reproduced below and annotated in the same way.

+1	+1	1	1	-1	-1	1	1	-1	1	-1	1	1	1
-28	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15

Sub-carrier index

1	1	1	-1	-1	1	1	-1	1	-1	1	1	1	1	0
-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

Sub-carrier index

+1	-1	-1	1	1	-1	1	-1	1	-1	-1	-1	-1	-1
1	2	3	4	5	6	7	8	9	10	11	12	13	14

Sub-carrier index

1	1	-1	-1	1	-1	1	-1	1	1	1	1	-1	-1
15	16	17	18	19	20	21	22	23	24	25	26	27	28

Sub-carrier index

LONG TRAINING SEQUENCE FOR 56 ACTIVE
FIGURE 4

EX1001, FIG. 4. EX1005, ¶ 148. Jones at Figure 4 discloses the claimed sequence as part of L2, which is annotated below to highlight sub-carrier 0 in red (set to zero), highlight the 52-subcarriers of the legacy 802.11a LTS in blue, and highlight the four extra subcarriers for the claimed 56-subcarrier ELTS in yellow.

$$L2 = \{ \begin{matrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 \\ 16 & 17 & 18 & 19 & 20 & 21 & 22 & 23 & 24 & 25 & 26 & 27 & 28 & 29 & 30 & 31 \\ -32 & -31 & -30 & -29 & -28 & -27 & -26 & -25 & -24 & -23 & -22 & -21 & -20 & -19 & -18 & -17 \\ -16 & -15 & -14 & -13 & -12 & -11 & -10 & -9 & -8 & -7 & -6 & -5 & -4 & -3 & -2 & -1 \end{matrix} \}$$

EX1014, Fig.4, 2:14-30 (explaining subcarrier numbering convention). The Jones Provisional discloses the same L2 sequence. EX1030, Fig. 2 (L2). EX1005, ¶ 149.

Zelst at Figure 15A reformats the claimed sequence as explained at 15:34-40 to show it in a different format. The reformatted sequence is shown below and highlighted in the same manner.

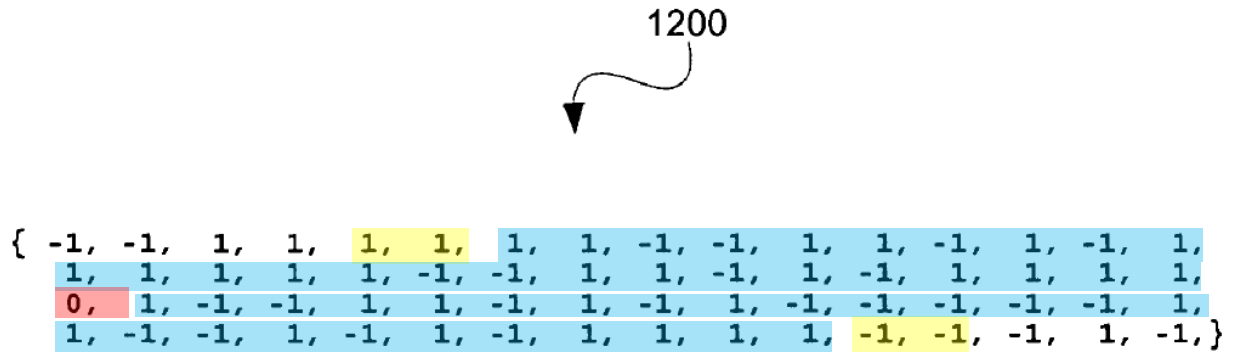


FIG. 15A

EX1010, Fig. 15A; EX1005, ¶ 150. The Zelst Provisional discloses the same sequence in the same format as Zelst Fig. 15A. EX1011, 4 (ELT for 20 MHz). EX1005, ¶ 150.

The Boer Provisional (incorporated into Boer) discloses the same sequence by disclosing the 802.11a 52-subcarrier LTS and stating it could be expanded by adding the same four extra subcarriers (highlighted in yellow) to create the claimed sequence.

Diagonal-4	1111	1	2.9337	1.0179	2.8822
		2	4.3393	1.0179	4.2632
		3	2.7409	0.9643	2.8424
	111-1	1	2.9337	1.0179	2.8822
		2	4.3393	1.0179	4.2632
		3	2.7409	0.9643	2.8424
	11-11	1	3.0600	1.0179	3.0063
		2	4.3393	1.0179	4.2632
		3	2.7409	0.9643	2.8424
	11-1-1	1	3.0600	1.0179	3.0063
		2	4.3393	1.0179	4.2632
		3	2.7409	0.9643	2.8424
	1-111	1	2.9337	1.0179	2.8822
		2	3.0265	1.0179	2.9734
		3	2.7409	0.9643	2.8424
	1-11-1	1	2.9337	1.0179	2.8822
		2	2.7592	1.0179	2.7108
		3	2.7409	0.9643	2.8424
	1-1-11	1	3.0600	1.0179	3.0063
		2	3.0265	1.0179	2.9734
		3	2.7409	0.9643	2.8424
	1-1-1-1	1	3.0600	1.0179	3.0063
		2	2.7592	1.0179	2.7108
		3	2.7409	0.9643	2.8424
	-1111	1	2.6520	1.0179	2.6055
		2	4.3393	1.0179	4.2632
		3	2.7409	0.9643	2.8424
	-111-1	1	2.6520	1.0179	2.6055
		2	4.3393	1.0179	4.2632

EX1013, 45; EX1005, ¶ 151.

The legacy 802.11a LTS encoding, which the Boer Provisional improves upon, is shown below with active subcarriers -26 to -1 and 1 to +26 highlighted in blue, and the indexed subcarrier 0 which is set to zero highlighted in red.

A long OFDM training symbol consists of 53 subcarriers (including a zero value at dc), which are modulated by the elements of the sequence L, given by

$$L_{-26, 26} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, 1, -1, 1, 1, 1, 1\} \quad (8)$$

EX1008, 13; EX1005, ¶ 152.

As shown above, each of Jones, Zelst, and Boer disclose the claimed sequence. Specifically, each maintains the legacy 52-value training sequence from 802.11a and adds the same four encodings to the same four subcarriers (+1/-28, +1/-27, -1/27, -1/28) to arrive at the claimed sequence, i.e., the Zelst 56-subcarrier ELTS. As shown at length in the Combination Rationale (VII.A) and for limitations [1pre]-[1f], the encoding scheme for the Zelst 56-subcarrier ELTS used in the combination is identical to the claimed encoding scheme. EX1005, ¶ 153.

C. Claim 4

The combination (see claim 1) inherently discloses “wherein the optimal extended long training sequence (Zelst 56-subcarrier ELTS processed by IFFT) has a minimum peak-to-average power ratio of 3.6 dB.” EX1005, ¶ 154.

As explained for limitation 1[c], the Zelst 56-subcarrier ELTS is identical to the 56-subcarrier sequence disclosed and claimed in the '629 patent, which the '629 patent admits results in a 3.6 dB PAPR. EX1001, 5:30-35. Additionally, a POSITA would have known how to calculate the PAPR of an ELTS and Dr. Buehrer calculated the PAPR of the Zelst 56-subcarrier ELTS sequence using that method to confirm it is 3.6 dB as admitted in the '629 patent and claimed in this claim. EX1005, ¶ 155.

D. Claim 8

The combination (see claim 1) discloses “wherein a binary phase shift key encoding is used for each sub-carrier above the +26 indexed sub-carrier and below the -26 indexed sub-carrier.” E1005, ¶ 156.

Both Zelst and Jones expressly teach using BPSK encoding on all of the active subcarriers, including the extended subcarriers. EX1010, 16:14; EX1011, 6; EX1014, 5:49. Boer also discloses BPSK encoding is used for all 56 subcarriers (including the new 4 subcarriers) by stating: “The SIGNAL-field in a SISO-OFDM system is always modulated and encoded in the same robust way using BPSK modulation and rate $\frac{1}{2}$ convolutional encoding, which facilitates good reception.” E1012, 9:7-10; EX1005, ¶ 157.

The training sequences in each of the references are defined as a sequence of +1 or -1. As explained by Dr. Buehrer, a POSITA would have understood that defining the sequences that way teaches binary phase shift keying is used for each subcarrier, including the extended subcarriers above +26 and below -26. More specifically, bit values are 0 and 1. However, as is well-known by a POSITA, in BPSK the bit values of 0 and 1 are mapped to phase values of π and 0. Modulating the phase of a subcarrier using a value of 0 is the same as multiplying that subcarrier by 1, while modulating the phase of a subcarrier by π is the same as multiplying that subcarrier by -1. Thus, inputting values of 1 and -1 into an IFFT

is equivalent to using BPSK on each subcarrier. EX1005, ¶ 158 *See* claim 8 (BPSK used for all subcarriers).

In fact, 802.11a defines the term “BPSK” to be “binary phase shift keying.” E1008, 2. And 802.11a states that all of the 52 subcarriers are modulated using BPSK. E1008, 3. A POSITA would have been motivated to use the same BPSK encoding for any additional subcarriers so that all subcarriers would be encoded using the same scheme. This would allow for the simplest and most straightforward implementation of the additional four subcarriers. EX1005, ¶ 159.

E. Claim 9

See [1b] (the IFT in each of Jones, Zelst, Boer and 802.11a is an IFFT); EX1005, ¶ 160.

F. Claim 10

The combination discloses “wherein the wireless communication device (see claim 1) comprises ... a processor (processing device running software).” EX1005, ¶ 161.

Jones teaches that its functional blocks “may be implemented using hardware (e.g., suitable integrated circuit components), software (e.g., program instructions) executing on appropriate processing devices, or any combination thereof.” EX1014, 20:26-30. A POSITA would have understood a processing device that executes software to perform the functional blocks of Jones to

constitute a “processor” as claimed under the ordinary meaning of “processor.”

Accordingly, in the combination, it would have been obvious for the device to comprise a processor implementing one or more of Jones’s functional blocks, e.g., the Encoder, Packet Formation block, and/or IFFT. EX1005, ¶ 162.

G. Claim 11

The combination discloses “wherein the wireless communications device (see claim 1) comprises a wireless mobile communications device (portable or hand-held device).” EX1005, ¶ 163.

802.11-1999 states “The purpose of this standard is to provide wireless connectivity to automatic machinery, equipment, or stations . . . ***which may be portable or hand-held***, or which may be mounted on moving vehicles within a local area.” EX1006, 1 (emphasis added). A POSITA would have understood that portable or hand-held stations that communicate using Wi-Fi are wireless mobile communications devices, as claimed. Known examples at the time include cellular phones, processors, personal digital assistants and laptops. EX1005, ¶ 164. Jones also discloses the wireless communication device can be a “mobile” device. EX1014, 20:20 (“mobile”).

H. Claim 12

The combination discloses “wherein the wireless communications device (see claim 1) comprises one or more of the following: an access point and a base station.” EX1005, ¶ 165.

Each of Jones, Zelst, Boer and 802.11a is an improvement on 802.11-1999, which defines an infrastructure wireless system comprised of access points and base stations.

3.2 access point (AP): Any entity that has station functionality and provides access to the distribution services, via the wireless medium (WM) for associated stations.

EX1006, 3. Figure 2 of 802.11-1999 (below, annotated) shows a distribution system with mobile stations (STA 2, STA 3) acting as access points (AP).

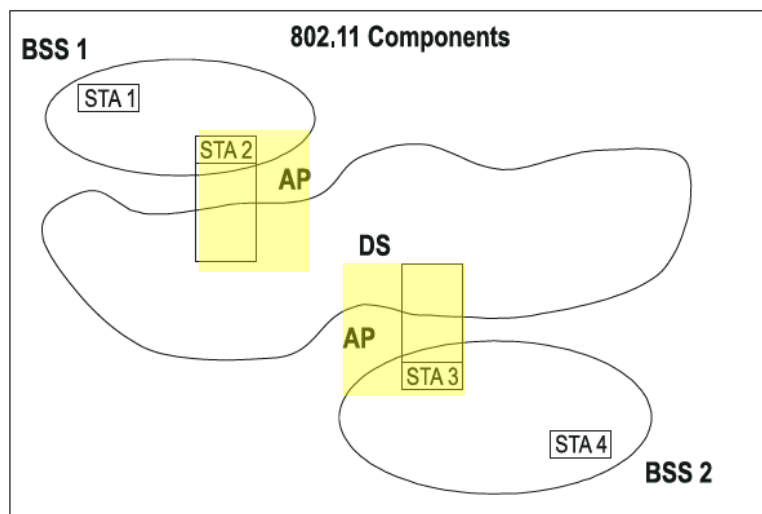


Figure 2—Distribution systems and access points

EX1006, FIG. 2; EX1005, ¶ 166.

I. Claim 13

The combination discloses “wherein the wireless communications device (see claim 1) is backwards compatible with legacy wireless local area network devices.” EX1005, ¶ 167.

The title of Zelst is “Modified Preamble Structure for IEEE 802.11a Extensions to Allow for ***Coexistence and Interoperability Between 802.11a Devices and Higher Data Rate***, MIMO or Otherwise Extended Devices.” EX1010, Cover. This alone tells a POSITA that the disclosed higher data rate devices are backwards compatible with lower-rate 802.11a devices. EX1005, ¶ 168.

Zelst also discloses “[t]he modified preamble preferably includes properties that facilitate detection of conventional and/or extended modes (“mode detection”) and provides some level of ***coexistence with legacy IEEE 802.11a devices***.” EX1010, 2:65-3:1; EX1005, ¶ 169.

The Zelst Provisional also discloses that “packets containing preambles of the present invention may be received by legacy receivers that are not configured to receive and interpret these preambles.” EX1011, 1; EX1005, ¶ 170.

The Zelst Provisional also discloses a mixed-mode preamble that is detectable by legacy devices.

- “Mixed-mode” preamble
 - Use long preamble detectable by legacy devices

EX1011, 8. In other words, the disclosed devices are backwards compatible with 802.11a legacy devices. EX1005, ¶ 171.

Jones expressly teaches a POSITA that the combination should provide for enhanced modes by extending the long training sequence provided by 802.11a while maintaining backward compatibility with 802.11a legacy devices. EX1014, 20:21-25; EX1005, ¶ 172.

Moreover, a POSITA would have been motivated to make the wireless communications device backwards compatible with legacy wireless local area network devices. Backwards compatibility ensures that both higher level devices and legacy devices could still communicate on the improved wireless communication system. In addition, it would have been obvious to try this combination because a POSITA understood legacy 802.11a devices were already successfully used, so it would make sense that the combined system of 802.11a and Zelst would be backwards-compatible with 802.11a and that any newer wireless communications devices that implement the combination would also be able to communicate with those same legacy devices. EX1005, ¶ 173.

This combination was also obvious because of the predictability of market demand for wireless communication devices operating on an improved wireless communication system with increased data throughput capabilities while maintaining accuracy and reliability. The market would desire to have still-

operational legacy devices used on the new and improved wireless communications system. Thus, consumers would not be forced to purchase new equipment each time the wireless communication system was improved. A POSITA additionally would have been motivated to combine these references in order to improve the reliability, performance, and efficiency of a wireless communication device for communicating on a wireless communication system. EX1005, ¶ 174.

J. Claim 14

The combination discloses “wherein the optimal extended long training sequence (Zelst 56 subcarrier ELTS) is longer than a long training sequence (52 subcarrier LTS) used by a legacy wireless local area network device (legacy 802.11a device) in accordance with a legacy wireless networking protocol standard (802.11a). *See* [1d]; EX1005, ¶ 175.

K. Claim 15

The combination discloses this claim because 802.11a discloses that legacy wireless devices use the training sequence for carrier frequency offset. As explained for claim 13, the combination teaches compatibility with 802.11a legacy devices so that those legacy devices can use the 52-subcarriers of the LTS and simply ignore the additional 4 subcarriers of the ELTS. *See* [13]; *see also*, e.g., EX1010, 4:51-67; EX1011, 1. Claim 15 merely recites one of the uses of the 52-

value LTS specified by 802.11a, i.e., to estimate a carrier frequency offset, as shown in Figure 110 reproduced below.

17.3.3 PLCP preamble (SYNC)

The PLCP preamble field is used for synchronization. It consists of 10 short symbols and two long symbols that are shown in Figure 110 and described in this subclause.

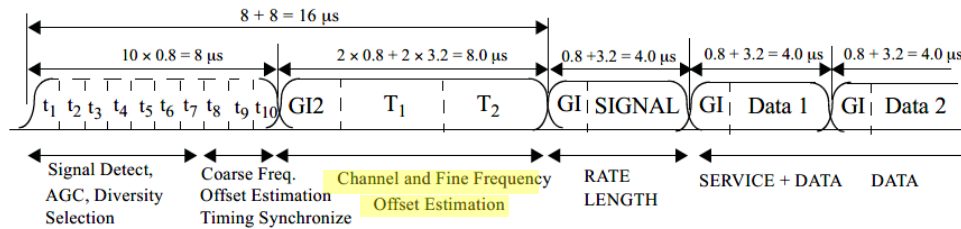


Figure 110—OFDM training structure

EX1008, FIG. 110; EX1005, ¶ 176.

L. Claim 16

As explained in VII.A and for limitation 1[c], in the combination, the LTS specified by 802.11a is maintained in the Zelst 56-subcarrier ELTS. The middle 52 subcarriers (+26 to -26) of the Zelst 56-subcarrier ELTS are identical to the LTS specified by 802.11a. Compare EX1010, FIG. 15A and EX1011, 4 with EX1008, 13. That is why it is backward compatible. See Claim 13. Thus, the long training sequence specified by the legacy standard is maintained in the extended long training sequence. EX1005, ¶ 177.

M. Claim 17

The combination discloses the device “decreases power back-off.” This claim recites a well-known property of a low PAPR; i.e., decreased power back-off. The ’629 patent admits that “The present invention provides an expanded long

training sequence of minimum peak-to-average power ratio ***and thereby decreases power back-off.***” EX1001, 4:15-17. The prior art provides the identical sequence and, therefore, identically decreases power back-off. EX1005, ¶ 178.

Boer similarly states: “the extra subcarriers at the edges are modulated in such a way that the peak-to-average power ratio (PAP) is lowest to minimize the effect of non-linearity of the power amplifiers.” EX1012, 5:1-3. A POSITA would have understood this statement to mean the expanded long training sequence, with its desirable low PAP, decreases power back-off. As a POSITA would have known, amplifiers have a non-linear region that can distort large signal values. When the PAP is high, the input signal (going into the amplifier) must be reduced (i.e., back off) to prevent the larger values from being distorted by the non-linear region of the amplifier. When the PAP is low, the input signal power can be increased (less back-off) since it is less likely to have a signal value that is impacted by the non-linear region. EX1005, ¶ 179.

N. Claim 18

As explained for claim 12, Figure 2 of 802.11-1999 discloses a wireless communications device (e.g., STA 2, STA 3) as an access point (AP). Figure 2 also discloses wireless communications devices (STA 1, STA 4, blue highlighting) registered with their respective access points (STA 2, STA 3, yellow highlighting). More specifically, 802.11-1999 describes the association process where a wireless

device (viz., a STA) associates (i.e., registers) with an access point. EX1006,109-114.

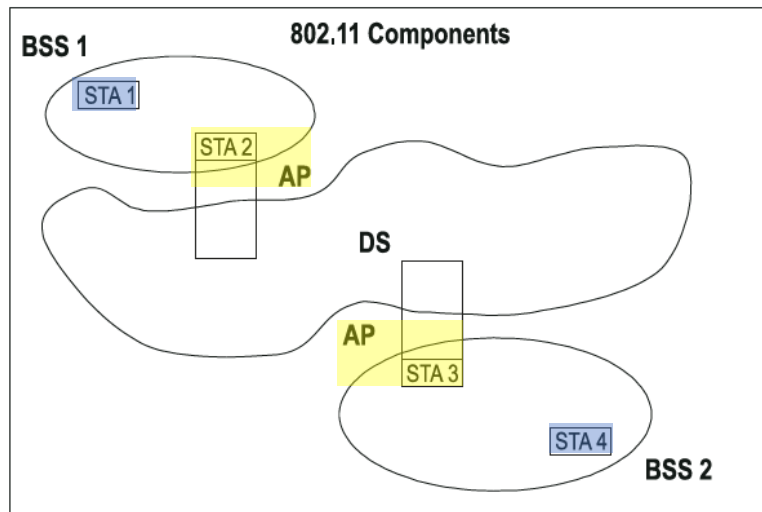


Figure 2—Distribution systems and access points

EX1006, FIG. 2; EX1005, ¶ 180.

O. Claim 19

See claim 8 (BPSK used for all subcarriers). As explained in claim 8, 802.11a defines the term “BPSK” to be “binary phase shift keying.” E1008, 2. 802.11a states that all of the 52 subcarriers can be modulated using BPSK. E1008, 3. Both Zelst and Jones also discloses BPSK encoding. EX1010, 16:14; EX1011, 6; EX1014, 5:49. In connection with Zelst’s FIG. 15A, each value of the 56 active indexed subcarriers, which includes the same 52 middle subcarriers as 802.11a (highlighted below), is either -1 or +1. The use of -1 and +1 tells a POSITA that binary phase shift key (“BPSK”) encoding is used for each sub-carrier, as required

by this claim. More specifically, as discussed above, BPSK is well-known to use one bit to determine the phase of the carrier (or sub-carrier in the case of OFDM). Those two phase values are 0 and π which correspond to multiplying the subcarriers by either 1 or -1 respectively as discussed above. Zelst also discloses the use of BPSK.

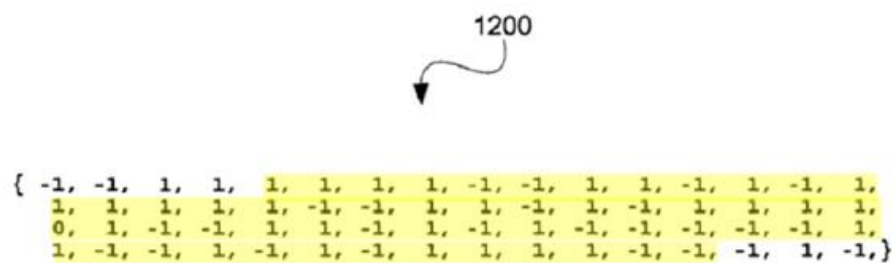


FIG. 15A

EX1010, FIG. 15A. EX1005, ¶ 181.

The Zelst Provisional also discloses using +1 and -1 for each of 56 active subcarriers (highlighted below) of an extended long training sequence.

20 MHz & 40 MHz Extended Long Training (ELT)

- ELT for 20 MHz:

$L_{-32,31} = \{-1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, -1, -1, 1, -1, \}$

EX1011, 4; EX1005, ¶ 182.

P. Claim 20

The combination discloses “a symbol mapper operatively coupled to the signal generator wherein the symbol mapper receives coded bits and generates symbols for each of 64 subcarriers of [an OFDM] sequence” EX1005, ¶ 183.

802.11a discloses an “Interleaving+Mapping” block that interacts with the IFFT.

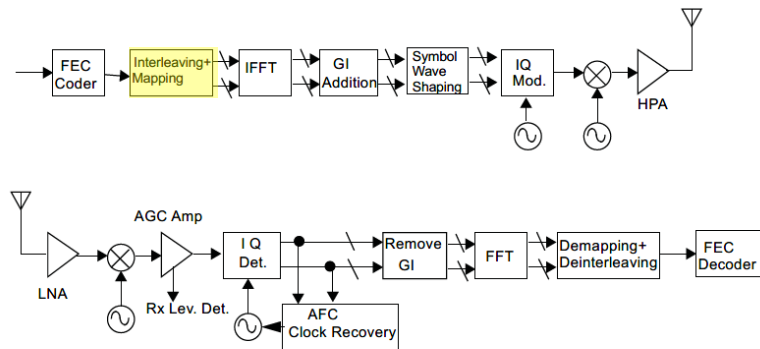


Figure 118—Transmitter and receiver block diagram for the OFDM PHY

EX1008, Figure 118 (annotated); EX1005, ¶ 184.

802.11a explains: “[t]he OFDM subcarriers shall be modulated by using BPSK, QPSK, 16-QAM, or 64-QAM modulation, depending on the RATE requested. The encoded and interleaved binary serial input data shall be divided into groups of NBPSC (1, 2, 4, or 6) bits and converted into complex numbers representing BPSK, QPSK, 16-QAM, or 64-QAM constellation points. The conversion shall be performed according to Gray-coded constellation mappings, illustrated in Figure 116, with the input bit, b0, being the earliest in the stream.”

EX1008, 19. This describes a symbol mapper that receives coded bits (the encoded and interleaved binary serial input data) and generates symbols according to BPSK or another modulation scheme. EX1005, ¶ 185.

Annex G of 802.11a provides “an example of encoding a frame for the OFDM PHY.” EX1008, 54. Section G.6.3 describes mapping coded bit into symbols: “The frequency domain symbols are generated by grouping 4 coded bits and mapping into complex 16-QAM symbols according to Table 84...The frequency domain is shown in Table G.22.” EX1008, 71-74. Table G.22 is titled “Frequency domain of the first DATA symbol” and contains real and imaginary values for 64 sub-carriers or which 52 are non-zero. EX1008, 74. This disclosure shows that the “symbol mapper receives coded bits and generates symbols for each of 64 subcarriers of an Orthogonal Frequency Division Multiplexing sequence” as required by the claim. EX1005, ¶ 186.

Further, Jones, which incorporates by reference 802.11a (EX1014, 5:32-40), discloses in connection with Figure 3, that “input data is provided (generally as a bit stream) to encoder 312 (highlighted below) which encodes the data stream into a sequence of complex numbers (symbols)” and that “encoding may include ... mapping groups of bits to symbols in a signaling constellation.” EX1014, 5:42-49, *see also* 1:29-39; EX1005, ¶ 187.

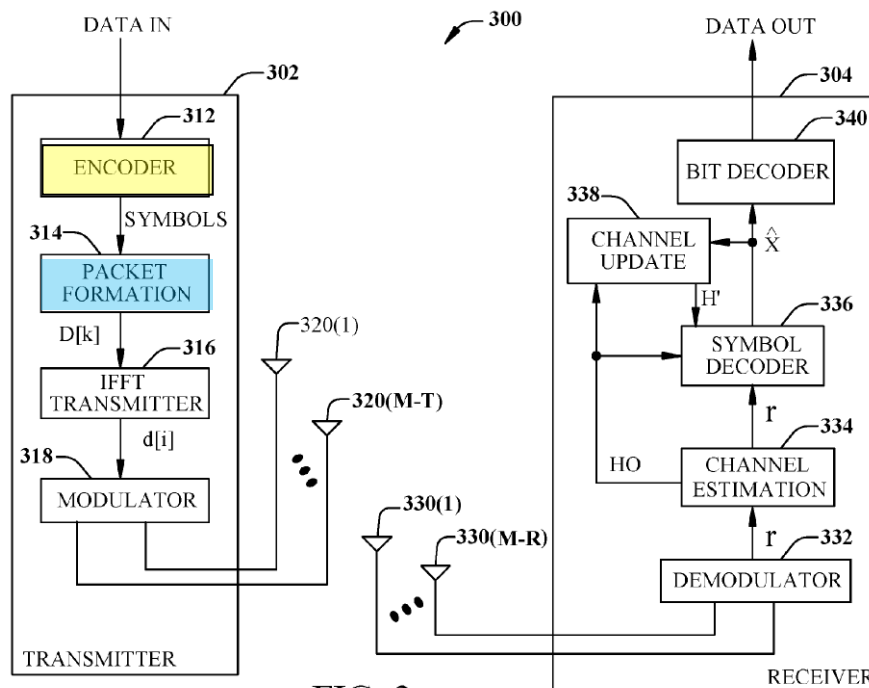


FIG. 3

Jones also discloses that “packet formation block 314 provides groups of symbols to IFFT module 316, which uses the group of symbols to modulate a group of OFDM subcarriers” and that “IFFT module 316 generates 64 time-domain samples $d[i]$ ” EX1014, 5:65-6:2; EX1005, ¶ 188.

As explained above for limitation 1[a], packet formation block 312 (highlighted above in blue) is the recited signal generator. Thus, Jones discloses a symbol mapper (encoder 312) operatively coupled to the signal generator (packet formation block 314). Jones states that the IFFT is provided 64 frequency-domain symbols at its input from encoder block 312. EX1014, 5:65-6:10. EX1005, ¶ 189.

Q. Claim 21

In the combination, “the legacy wireless networking protocol standard for the [OFDM] scheme (802.11a) corresponds to exactly 52 active subcarriers (52 subcarriers LTS).” *See* VII.A, 1[a]; EX1005, ¶ 190.

R. Claim 22

In the combination, the LTS in 802.11a is identical to the recited sequence in claim 22 because it has 52 active subcarriers (blue) with the zero index subcarrier set to zero (red). *See* [1f].

A long OFDM training symbol consists of 53 subcarriers (including a zero value at dc), which are modulated by the elements of the sequence L, given by

$$L_{-26,26} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, 1, 1, 0, \\ 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1\} \quad (8)$$

EX1008, 13; EX1005, ¶ 191.

S. Claim 23

The combination discloses claim 23, which merely aggregates the limitations in dependent claims already addressed above. EX1005, ¶ 192.

1. 23[pre]

See [1pre]; EX1005, ¶ 193.

2. 23[a]

See claim 9; EX1005, ¶ 194.

3. 23[b]

See claim 10; EX1005, ¶ 195.

4. 23[c]

See claim 13; EX1005, ¶ 196.

5. 23[d]

See claim 15; EX1005, ¶ 197.

6. 23[e]

See claim 17; EX1005, ¶ 198.

7. 23[f]

See claim 19; EX1005, ¶ 199.

8. 23[g]

See claim 20; EX1005, ¶ 200.

T. Claim 27

The combination discloses “wherein, an output of the Inverse Fourier Transformer is operatively coupled to a time-domain windower.” EX1005, ¶ 201.

Zelst, Boer and Jones are improvements on 802.11a, which states “[t]he time domain representation is derived by performing IFFT on the contents of Table G.5, cyclically extending the result to get the cyclic prefix, and then multiplying with the window function given in G.3.1.” E1008, 59. The window function in G.3.1 is:

$$W(k) = \begin{bmatrix} 0.5 & k = 0 \\ 1 & 1 \leq k \leq 16 \\ 0.5 & k = 60 \end{bmatrix}$$

E1008, 57. The functional block applying the window function in G.3.1 is a time-domain windower. EX1005, ¶ 202.

A POSITA would have understood that the combination would have to operatively couple the output of the IFFT to a time-domain windower, as claimed, because that was required by 802.11a in order to ensure backwards compatibility, which Zelst, Boer and Jones state is desirable and achieved. Moreover, a POSITA would have understood that the above-described improvements to 802.11a disclosed in Zelst in connection with, e.g., Sections VII.A and B, increasing the number of subcarriers from 52 to 56 and 63, also require a time-domain windower operatively coupled to the output of the IFFT because a time-domain windower provides spectral shaping which is required regardless of the number of subcarriers used by the data and/or training sequences. Time-domain windowing is used to help ensure the spectral mask is met, which is a requirement regardless of the number of subcarriers used. EX1005, ¶ 203.

VIII. GROUND 2: JONES, 802.11A, 802.11-1999 AND BOER

Ground 2 is duplicative of Ground 1 with one exception—Zelst is not included in Ground 2. PO asserted in the related litigation that Zelst (EX1010) is not prior art because it is not entitled to the filing date of the Zelst Provisional (EX1011). But as demonstrated above in IV.D and Ground 1, Zelst is entitled to the filing date of the Zelst Provisional and, therefore, is prior art to the '629 patent.

But out of an abundance of caution, Petitioner includes this separate Ground 2 which relies on all of the arguments and evidence in Ground 1, except the evidence from Zelst. EX1005, ¶ 204.

A. Combination Rationale

Jones, 802.11a and 802.11-1999 set the same foundation for Ground 2 as the do for Ground 1, which is incorporated by reference. Specifically, Jones teaches an ELTS could use any of 53-63 subcarriers (including exactly 56 subcarriers) as required by [1e], and teaches the precise encodings required by [1f]. EX1005, ¶ 205.

1. It would have been obvious in the combination to use the Boer 56-Subcarrier ELTS

In Ground 1, Petitioner relied on Zelst and Boer's teaching that exactly 56 subcarriers should be used as required by [1e] and Zelst and Boer's teaching (with Jones) of the precise encodings required by [1f]. Petitioner referred to this ELTS as the "Zelst 56-Subcarrier ELTS" to distinguish Grounds 1 and 2. Here, in Ground 2, Petitioner relies on Boer's teachings (in addition to Jones) and so Petitioner refers to the ELTS as the "Boer 56-Subcarrier ELTS" to distinguish from Ground 1. EX1005, ¶ 206.

It would have been obvious for a POSITA to use the Boer 56-Subcarrier ELTS in view of the same teachings and opinions explained in Ground 1 for Jones,

Boer, 802.11a and 802.11-1999. In short, Boer’s express teaching (including the teachings incorporated from the Boer Provisional) that 56 subcarriers would fit within the 802.11a spectral mask would have rendered obvious to a POSITA to implement Jones’s ELTS using exactly 56-subcarriers. The arguments and evidence from Ground 1 (*see* XI.A.1) are incorporated by reference here in Ground 2. EX1005, ¶ 207.

2. It would have been obvious in the combination to use the functional blocks disclosed in Jones

See Section VII.A.2, incorporated here by reference. EX1005, ¶ 208.

B. Claims 1, 4, 8-23, 27

Petitioner incorporates the arguments and evidence from the corresponding limitations of these claims in Ground 1, excluding the citations to Zelst. References to “Zelst 56-Subcarrier ELTS” in the incorporated arguments should be replaced with “Boer 56-Subcarrier ELTS” for this ground, to reflect that only the teachings of Boer and Jones (along with 802.11a and 802.11-1999) are being relied on to teach 56-subcarriers in this ground. EX1005, ¶ 209.

IX. DISCRETIONARY DENIAL IS NOT WARRANTED

A. 35 U.S.C. § 325(b) Analysis

Applying the two-part framework discussed in *Advanced Bionics, LLC v. Med-El Elektromedizinische Gerate GMBH*, IPR2019-01469, Pap. 6, *8-9, the Board should not exercise its §325(d) discretion to deny institution.

Neither 802.11a nor 802.11-1999 were made of record during reissue.

Accordingly, none of the combinations presented herein were considered.

It was clear error for the examiner to allow the claims during reissue based on certain prior art of record. Jones was made of record during reissue (EX1001, page 2) but was not discussed. It was clear error for the examiner to allow the amended claims in light of Jones's teaching of the claimed encoding sequence (EX1014, Fig. 4 (L2)) and that any of 53-64 subcarriers could be used. EX1014, 6:11-23. This literally discloses 56 subcarriers could be used or, at the very least, renders 56 subcarriers obvious by disclosing such a limited range (53-64) in a predictable art. Nevertheless, Jones is presented in Ground 1 herein in combination with the more specific 56-subcarrier ELTS of Zelst and Boer, along with details from 802.11a and 802.11-1999.

Zelst was made of record during reissue but was not discussed. EX1001, page 2. However, the Zelst Provisional was not of record, and it is the teaching of using exactly 56-subcarriers in the Zelst Provisional (incorporated into Zelst by reference) that is material to this Petition.

Neither Boer nor the Boer Provisional were made of record. But Boer is similar to US2007/0060073, which was made of record but not discussed. EX1001, page 2. The particularly strong teachings related to 56 subcarriers in the Boer Provisional (incorporated by reference into Boer) were not considered. It was clear

error for the examiner to allow the claims over Jones and US2007/0060073 as shown in Ground 2.

Additional evidence of the examiner's clear error includes the failure of the examiner to substantively address any prior art during reissue, much less the prior art relied on in this Petition. Additional evidence includes the examiner's statement on reasons for notice of allowance dated 5/17/2021, wherein the examiner erred by relying on the reasons for allowance as stated in an action mailed 6/22/2009 in parent application 11/188,771. EX1004, 27-35. None of the prior art asserted herein was considered during the prosecution of parent application 11/188,771. EX1031, cover. Notably, PO submitted comments on 5/21/2021 admitting that the examiner's statement "does not accurately characterize independent claim 1." EX1004, 21.

Accordingly, based on the indisputably new combination presented in Ground 1, the evidence of clear error related to the individual references that were of record and not discussed, and the showing of compelling merits contained in this Petition, the Board should not exercise its discretion to deny institution under §325(d).

X. COMPLIANCE WITH FORMAL REQUIREMENTS

A. Mandatory Notices Under 37 C.F.R. §§ 42.8(b)(1)-(4)

1. Real Party-In-Interest

NXP USA, Inc. and NXP Semiconductors, N.V. are real parties-in-interest.

2. Related Matters

The '629 patent is subject to the following actions: *Bell Northern Research, LLC v. T-Mobile USA, Inc.*, 4-23-cv-00910 (EDTX); *Bell Northern Research, LLC v. AT&T Inc. et al*, 4-23-cv-00789 (EDTX); *Bell Northern Research, LLC v. Shenzhen Tinno Mobile Technology Corp. et al*, 1-23-cv-07583 (SDNY); *Electronic Devices and Semiconductor Devices Having Wireless Communications Capabilities and Components Thereof*, Inv. No. 337-TA-1367 (ITC); *Bell Northern Research, LLC v. ASUSTek Computer, Inc. et al*, 4-23-cv-00573 (EDTX); *Bell Northern Research, LLC v. Qualcomm Inc. et al*, 8-23-cv-01065 (CDCA); *Bell Northern Research, LLC v. NXP Semiconductors, N.V. et al*, 1:23-cv-633 (WDTX); *Bell Northern Research, LLC v. Huaquin Co., Ltd.*, 1-22-cv-24026 (SDFL); *Bell Northern Research, LLC v. HMD America, Inc. et al*, 1-22-cv-22706 (SDFL); *Bell Northern Research, LLC v. HMD America, Inc. et al*, 1-22-cv-21035 (SDFL); *Bell Northern Research, LLC v. BLU Products Inc.*, 1-21-cv-23484 (SDFL); *Bell Northern Research, LLC v. OnePlus Technology (Shenzhen) Co. Ltd. et al*, 3-21-cv-02293 (NDTX); Certain Electronic Devices Having Wireless

Communications Capabilities and Components Thereof, Inv. No. 337-TA-1284 (ITC); *Bell Northern Research, LLC v. TTE Technology Inc., et al*, 2-21-cv-07323 (CDCA); *TCL Industries Holdings Company Ltd. et al v. Bell Northern Research, LLC*, 3-21-cv-01598 (CDCA); *Bell Northern Research, LLC v. HP Inc.*, 6-21-cv-00939 (WDTX); *Bell Northern Research, LLC v. CommScope Holding Company, Inc., et al*, 6-21-cv-00941 (WDTX); *Bell Northern Research, LLC v. Dell Technologies, Inc. et al*, 6-21-cv-00909 (WDTX); *Bell Northern Research, LLC v. Lenovo Group Ltd. et al*, 6-21-cv-00847 (WDTX); *Bell Northern Research, LLC v. Apple Inc.*, 6-21-00833 (WDTX).

3. Lead and Backup Counsel

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4. Service Information

Service information for lead and backup counsel is provided in the designation of lead and backup counsel above.

B. Proof of Service on the Patent Owner

In accordance with 37 C.F.R. §§42.6(e) and 42.105, as identified in the attached Certificate of Service, a copy of this Petition in its entirety is being served electronically to the Patent Owner's attorney of record, as well as on counsel for Patent Owner in the District Court Litigation.

C. Power of Attorney

Powers of attorney are being filed with designation of counsel in accordance with 37 C.F.R. § 41.10(b).

D. Standing

In accordance with 37 C.F.R. §42.104(a), Petitioner certifies that the '629 patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting an *inter partes* review challenging the patent claims on the grounds identified in this Petition.

E. Fees

The undersigned authorizes the Director to charge the fee specified by 37 C.F.R. § 42.15(a) and any additional fees that might be due in connection with this Petition to Deposit Account No. 50-3266.

XI. CONCLUSION

All Challenged Claims of the '629 patent should be found unpatentable for the reasons discussed in this Petition.

Date: June 21, 2024

Respectfully submitted,

/s/ Brian Erickson

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CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(d), Petitioner certifies that this petition includes 12,239 words, as measured by Microsoft Word, exclusive of the table of contents, mandatory notices under § 42.8, certificates of service, word count, claim listing, and exhibits.

Date: June 21, 2024

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CERTIFICATE OF SERVICE

The undersigned certifies pursuant to 37 C.F.R. §§ 42.6(e) and 42.105 that on June 21, 2024, a true and correct copy of the Petition for *Inter Partes* Review of U.S. Patent No. RE48,629 was served by emailing a copy of same (by agreement) to the following attorneys for the Patent Owner:

Jason Shaprio (jshapiro@devlinlawfirm.com)

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A courtesy copy was sent to the below counsel via electronic mail:

(dlflitparas@devlinlawfirm.com)

Date: June 21, 2024

/s/ Brian Erickson

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