

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMERICAN AIRLINES, INC. AND SOUTHWEST AIRLINES CO.,

Petitioners

v.

INTELLECTUAL VENTURES I LLC,

Patent Owner.

IPR2025-01055

U.S. Patent No. 8,027,326 B2

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 8,027,326**

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EXHIBIT LIST

Exhibit No.	Description of Document
1001	U.S. Patent No. 8,027,326 B2 (the '326 Patent) to Shearer, III (filed January 12, 2005; issued September 27, 2011)
1002	File history for the '326 Patent
1003	File history for U.S. Provisional Patent Application No. 60/535,540
1004	Expert Declaration of Dr. Chuck Easttom, Ph.D., D.Sc.
1005	Dr. Chuck Easttom, Ph.D., D.Sc. Curriculum Vitae
1006	U.S. Patent No. 7,418,050B1 ("Gardner")
1007	Japanese Laid Open Patent Application No. 2002-319917 ("Mori")
1008	English translation of Japanese Laid Open Patent Application No. 2002-319917 ("Mori")
1009	U.S. Patent Application Publication No. 2005/0259628A1 ("Bolinth")
1010	U.S. Patent Application Publication No. 2005/0138194A1 ("Lu")
1011	U.S. Patent Application Publication No. 2003/0048462A1 ("Williams")
1012	Claims Listing
1013	Complaint, <i>Intellectual Ventures I LLC et al. v. Southwest Airlines Co.</i> , No. 7:24-cv-277 (W.D. Tex. Nov. 2, 2024)
1014	Claim Charts for '326 Patent, <i>Intellectual Ventures I LLC et al. v. Southwest Airlines Co.</i> , No. 7:24-cv-277 (W.D. Tex. Nov. 2, 2024) (Dkt. 1-14)
1015	Complaint, <i>Intellectual Ventures I LLC et al. v. American Airlines Inc.</i> , No. 4:24-cv-980 (E.D. Tex. Nov. 2, 2024)

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Exhibit No.	Description of Document
1016	Claim Charts for '326 Patent, <i>Intellectual Ventures I LLC et al. v. American Airlines Inc.</i> , No. 4:24-cv-980 (E.D. Tex. Nov. 2, 2024) (Dkt. 1-12)
1017	Complaint, <i>Viasat, Inc. v. Intellectual Ventures I LLC et al.</i> , No. 1:25-cv-056 (D. Del. Jan. 14, 2025)
1018	Complaint, <i>Anuvu Corp. v. Intellectual Ventures I LLC et al.</i> , No. 1:25-cv-124 (D. Del. Jan. 30, 2025)

Petitioners American Airlines, Inc. (“American”) and Southwest Airlines Co. (“Southwest”) (collectively “Petitioners”) petition for *inter partes* review (“IPR”) of claims 1-18 of U.S. Patent No. 8,027,326 (“’326 Patent”) owned by Intellectual Ventures I LLC (“Patent Owner”).

I. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8

A. Real Parties-in-Interest Under § 42.8(b)(1)

American is a real party in interest to this petition. American is a wholly owned subsidiary of American Airlines Group, Inc., which is not a real party in interest to this petition. No unnamed entity is funding, controlling, or otherwise has an opportunity to control or direct this petition or American’s participation in any resulting IPR.

Southwest is also a real party in interest to this petition. No unnamed entity is funding, controlling, or otherwise has an opportunity to control or direct this petition or Southwest’s participation in any resulting IPR.

B. Related Matters Under § 42.8(b)(2)

To the best of Petitioners’ knowledge, the ’326 Patent is or has been involved in these matters:

Name	No.	Court	Filed	Status
<i>Intellectual Ventures I LLC et al. v. Southwest Airlines Co.</i>	7:24-cv-277	WDTX	Nov. 2, 2024 See EX.1013	Active

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Name	No.	Court	Filed	Status
<i>Intellectual Ventures I LLC et al. v. American Airlines, Inc.</i>	4:24-cv-980	EDTX	Nov. 2, 2024 See EX.1015	Active
<i>Viasat, Inc. v. Intellectual Ventures I LLC et al.</i>	1:25-cv-056	D.Del.	Jan. 14, 2025 See EX.1017	Active
<i>Anuvu Corp. v. Intellectual Ventures I LLC et al.</i>	1:25-cv-124	D.Del.	Jan. 30, 2025 See EX.1018	Active

C. Lead and Backup Counsel Under § 42.8(b)(3)

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An executed power of attorney under 37 C.F.R. § 42.10(b) accompanies this
Petition.

D. Service Information Under § 42.8(b)(4)

Petitioners consent to electronic service at the above designated Counsel email addresses and at the following email address:

SWA-IV@munckwilson.com.

Service of any documents via post or hand-delivery may be made at: Munck Wilson Mandala LLP, 2000 McKinney Ave., Ste. 1900, Dallas, TX 75201; Telephone: (972) 628-3600; Facsimile: (972) 628-3616.

II. GROUNDS FOR STANDING

Pursuant to 37 C.F.R. § 42.104(a), Petitioners certify the '326 Patent is available for IPR and Petitioners are not barred or estopped from requesting an IPR challenging the claims on the grounds identified in this petition. This Petition is filed within one year of service of the Complaints. EX.1013; EX.1015.

III. IDENTIFICATION OF CHALLENGES AND RELIEF REQUESTED

Petitioners respectfully request review and cancellation of claims 1-18 on the following prior art and statutory grounds:

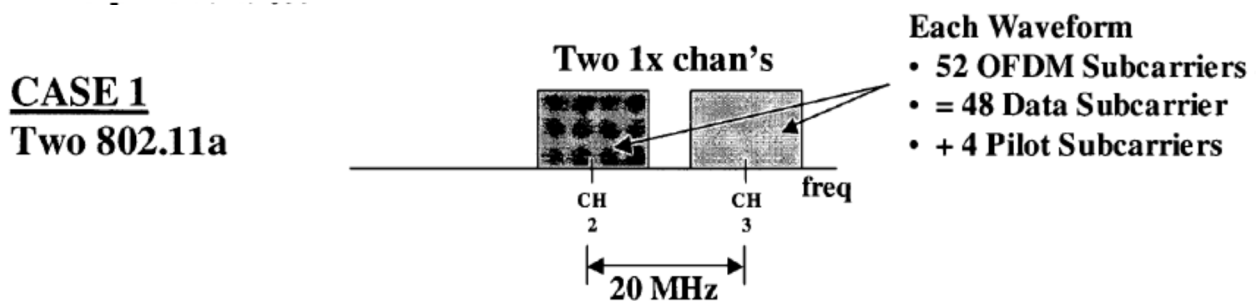
Prior Art
U.S. Patent No. 7,418,050B1 (“Gardner”) (EX.1006) Pre-AIA 35 U.S.C. § 102(e)
Japanese Laid Open Patent Application No. 2002-319917 (“Mori”) (EX.1007, EX.1008) Pre-AIA 35 U.S.C. § 102(b)
U.S. Patent Application Publication No. 2005/0259628A1 (“Bolinth”) (EX.1009) Pre-AIA 35 U.S.C. § 102(e)
U.S. Patent Application Publication No. 2005/0138194A1 (“Lu”) (EX.1010) Pre-AIA 35 U.S.C. § 102(e)
U.S. Patent Application Publication No. 2003/0048462A1 (“Williams”) (EX.1011) Pre-AIA 35 U.S.C. § 102(e)

Ground	Challenged Claims	Basis
1	1-18	§ 103: Gardner and Mori
2	12-13	§ 103: Gardner, Mori, and either of Bolinth or Williams
3	1-18	§ 103: Mori, Lu, and Williams

IV. THE '326 PATENT

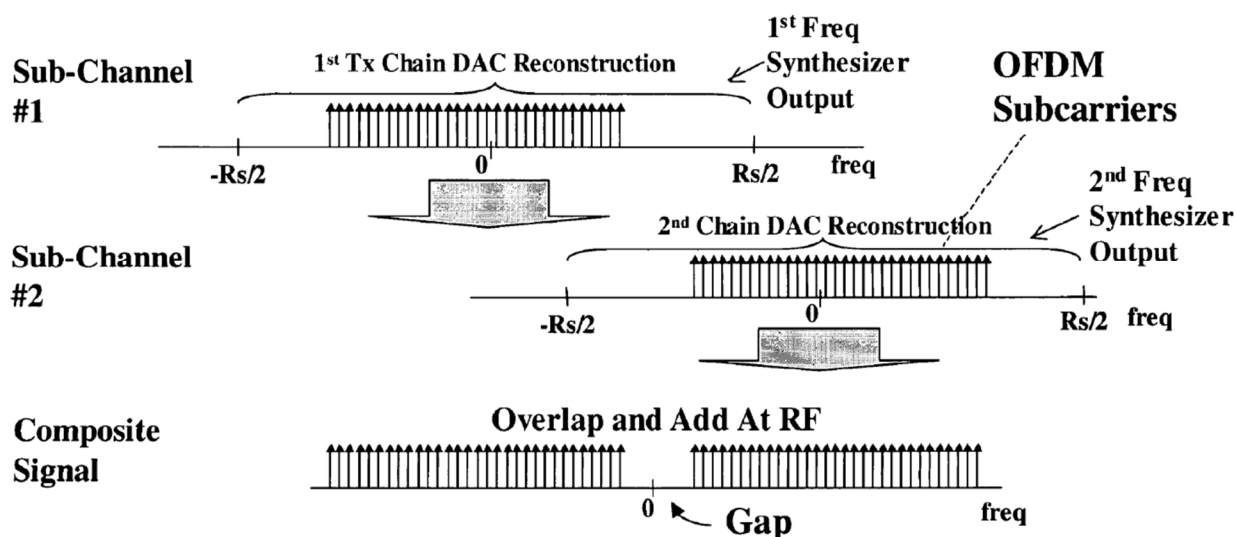
A. Overview

The '326 Patent relates to well-known grouping of subcarriers to form a “channel.” As conceded in the '326 Patent, IEEE 802.11a teaches grouping 64 equally spaced (in the frequency domain) subcarriers as one channel, with each channel occupying 20 MHz of bandwidth (measured center-to-center):



EX.1001, Fig.4, 10:30-31. Since each channel's edge subcarriers are left unused, forming guard bands to reduce inter-channel interference (ICI) (a/k/a inter-symbol interference or “ISI”), only the center 52 of the 64 channel subcarriers are used: 48 data subcarriers and 4 pilot signals. EX.1001, Fig. 4. EX.1004, ¶41. Application of a 64-point inverse Fast Fourier Transform (IFFT) converts the frequency-domain subcarriers into a time-domain Orthogonal Frequency Division Multiplexing (OFDM) symbol for wireless transmission. EX.1004, ¶34. The frequency-domain guard bands convert into time-domain guard intervals between consecutive OFDM symbols. EX.1004, ¶112.

Prior to the '326 Patent's earliest filing date, extension of IEEE 802.11a/g to "802.11n" to increase data rates was being discussed. EX.1001, 4:66-67; EX.1006, 2:15-62). Options included "channel bonding," "us[ing] multiple channels to transmit...data...multiplexed between two...streams occupying two contiguous 20 MHz channels." EX.1006, 2:15-20; see also EX.1010, ¶[0026] ("one such channel bonding mechanism may simultaneously transmit data frames over two adjacent channels as if it were a single channel with twice the bandwidth"). Such channel bonding ("dual channel") operation is depicted in the '326 Patent:



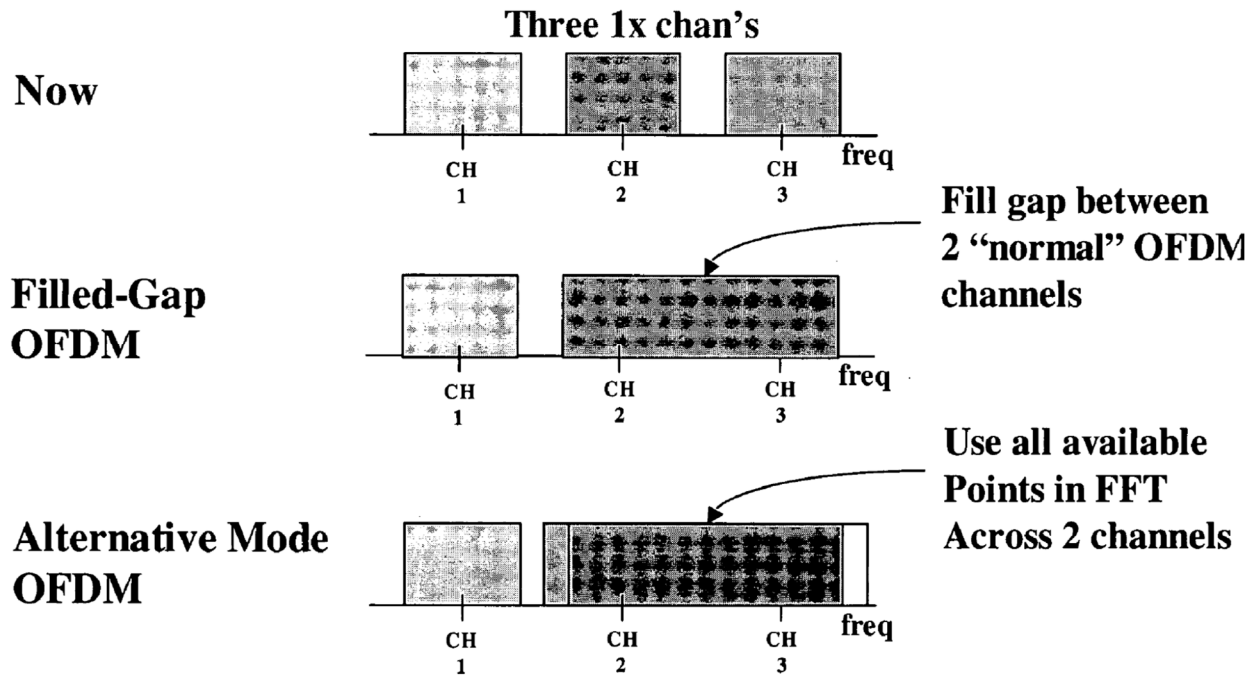
EX.1001, Fig.19

See EX.1004, ¶27.

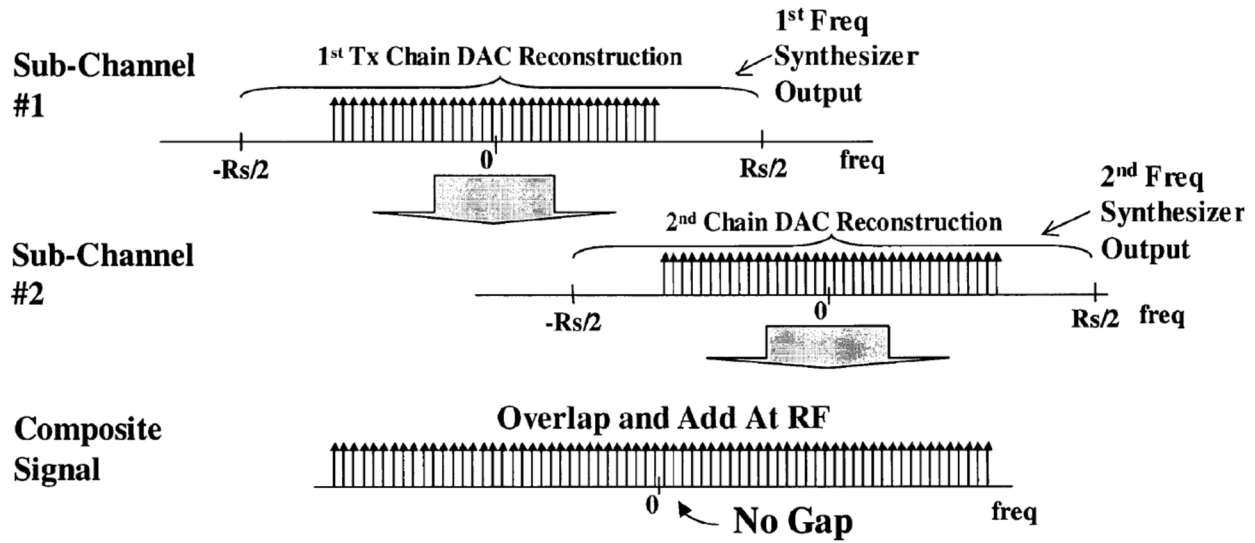
Other proposed 802.11a/g extension options involved:

- “us[ing] multiple input, multiple output (MIMO) systems to increase the data rate and the operating range without increasing bandwidth.” EX.1006, 2:49-51; see also EX.1010, ¶[0026]; EX.1004, ¶¶120-122; and
- guard band (guard interval) reduction—using more channel subcarriers for data. EX.1010, ¶[0026]; EX.1009, ¶[0014]; EX.1004, ¶¶64,71.

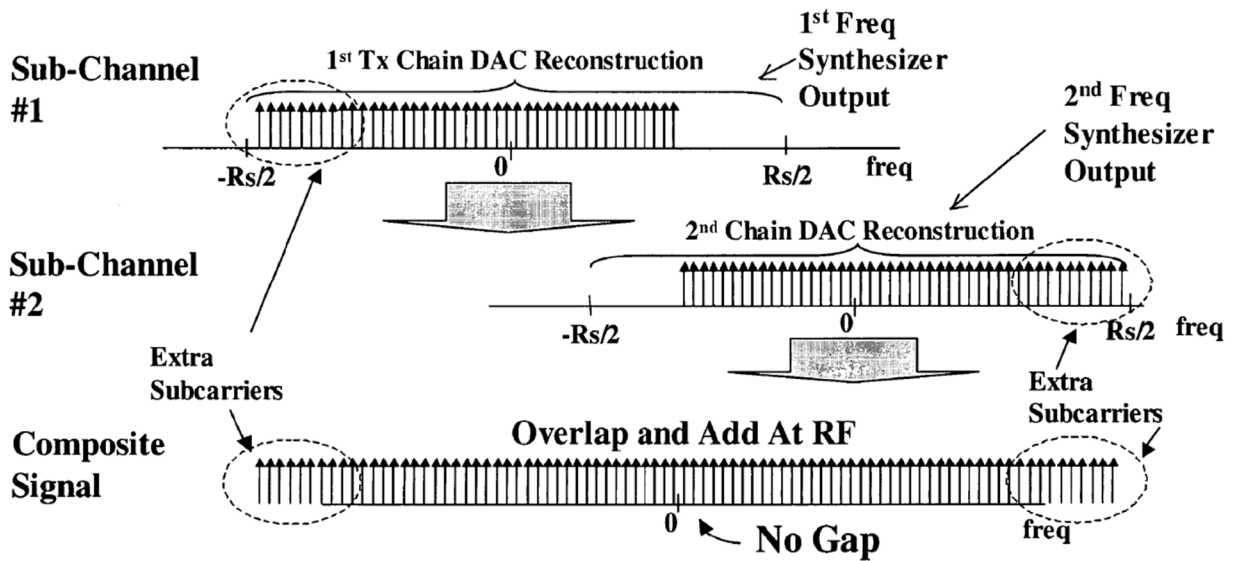
The '326 Patent describes channel bonding coupled with “filling the gap” (guard band) between two adjacent channels with data subcarriers (middle diagram in Fig. 6 below and Fig. 20), and optionally also filling guard band regions at opposite ends of those adjacent channels (bottom diagram in Fig. 6 and Fig. 21):



EX.1001, Fig.6



EX.1001, Fig.20



EX.1001, Fig.21

See also EX.1001, Figs. 4-5; EX.1004, ¶¶26-29.

B. Effective Filing Date

For purposes of this IPR,¹ Petitioners assume the earliest effective filing date the '326 Patent can claim is January 12, 2004. Application No. 11/033,524 was filed on January 12, 2005, claiming priority to Provisional Application No. 60/535,540 filed January 12, 2004. Therefore, the earliest effective filing date to which asserted claims of the '326 Patent could be entitled is January 12, 2004.

C. Level of Ordinary Skill

A POSITA, on or before January 12, 2004, would have had a bachelor's degree in an academic area emphasizing computer networking (i.e. computer science, computer information systems, computer engineering, etc.), and approximately two years of experience working with wireless network traffic. Additional experience might substitute for less education and vice versa. EX.1004, ¶¶22-23.

V. CLAIM CONSTRUCTION

Claim terms are construed according to the *Phillips* standard in an IPR. *Phillips v. AWH Corp.*, 415 F.3d 1303; 37 C.F.R. §42.100. The analysis in Sections VII-IX establishes the challenged claims are obvious under any reasonable

¹ Petitioners reserve the right to argue in this and any other proceeding that the effective filing date of the '326 Patent is September 29, 2009, the date on which the concept of “partially filling the frequency gap” (recited in every claim) was first disclosed, during prosecution of the claims.

interpretation under the *Phillips* standard, and thus Petitioners submit the Board need not resolve any express constructions. *See, e.g., Toyota Motor Corp. v. Cellport Systems, Inc.*, IPR2015-00633, Paper 11 at 16 (Aug. 14, 2015) (citing *Wellman, Inc. v. Eastman Chemical Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011)). Petitioners propose the following claim constructions.

A. Claim 16: “means for”; Claim 18: “instructions to”

Claim 16 and Claim 18 respectively recite “means for”/“instructions to” perform[ing] certain functions. “Instructions”² is a nonce word that substitutes for “means” for purposes of §112, ¶6. *See Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1350 (Fed. Cir. 2015) (en banc) (terms “connoting a generic ‘black box’ for performing the recited computer-implemented functions”).

Claim 16 uses “means for,” and Claim 18 uses “instructions to,” before each step of method Claim 1. In light of the Patent Owner’s Infringement Contentions (EX.1014, EX.1016), a POSITA would understand Patent Owner to assert “means for” and “instructions to” are not limited to any specific structure(s), reading any

² The ’326 Patent specification does not describe any “non-transitory computer-readable medium having instructions stored thereon.” Instead, the ’326 Patent merely states that IEEE 802.11 networks include “mobile stations comprising a basic service set (BSS)” that could be “*computing stations*, such as notebook computers, PDAs,” and references one embodiment of “a single chain [transmitter] with *programmable* bandwidth (BW) expansion.” EX.1001, 2:49-53, 8:56-60, 12:19-22.

structure(s) that perform the recited function(s) as at least an equivalent to the corresponding structure(s) within the '326 Patent.

Claims	Function	Structure in '326 Specification
16.1	“selecting at least a first channel and a second channel”	The specification does not link any specific structure to “selecting” channels. The radios depicted merely receive (pre-selected) channels CH2 and CH3. A POSITA would understand the corresponding structure to “selecting at least a first channel and a second channel” to be a signal processing chain receiving two channels. A POSITA would understand “instructions to select at least a first channel and a second channel” to require a signal processing chain receiving two channels receiving two channels and having at least one programmable element relating to processing the two channels. EX.1004, ¶44.
18.1	“select at least a first channel and a second channel”	
16.2	“partially filling the frequency gap with at least one additional subcarrier ... using full spectral synthesis capability of a fast fourier transform or an inverse fast fourier transform”	The specification does not link any specific structure to “filling the frequency gap” (guard band) between adjacent channels with “data subcarrier[s].” Instead, the subcarriers for the guard band(s) are merely described as being used for data. A POSITA would understand the corresponding structure to “filling the frequency gap with” “data subcarrier[s]” to be at least one IFFT calculator receiving data on subcarriers between two channels that correspond to guard band region(s). A POSITA would understand “instructions to select at least a first channel and a second channel” to require a signal processing chain receiving two channels receiving two channels and having at least one programmable element relating to processing the two channels. A POSITA would understand “instructions to fill the frequency
18.2	“partially fill the frequency gap between the first channel and the second channel by adding one or more data subcarriers into the frequency gap...	

Claims	Function	Structure in '326 Specification
	using full spectral synthesis capability of a fast fourier transform or an inverse fast fourier transform”	gap with” “data subcarrier[s]” to require at least one IFFT calculator that can be programmed to receive data on subcarriers between two channels that correspond to a guard band region between the channels. EX.1004, ¶44.
16.3	“combining the first channel and the second channel using channel bonding with orthogonal frequency division multiplexing (OFDM)”	The specification does not link any specific structure to “combining” adjacent channels “using channel bonding with orthogonal frequency division multiplexing (OFDM).” Instead, the radios are merely shown and described as performing “2-64-point [I]FFTs” or “1-128-point [I]FFT.” A POSITA would understand the corresponding structure to “combining” adjacent channels “using channel bonding with orthogonal frequency division multiplexing (OFDM)” to be one or more IFFT calculators generating OFDM symbols for the two channels using all 64 subcarriers for each channel. A POSITA would understand “instructions to “combine” adjacent channels “using channel bonding with orthogonal frequency division multiplexing (OFDM)” to require one or more IFFT calculators generating OFDM symbols for the two channels using all 64 subcarriers for each channel. EX.1004, ¶44.
18.3	“combine the first channel and the second channel using channel bonding with orthogonal frequency division multiplexing (OFDM)”	
16.4	“transmitting the first plurality of subcarriers, the second plurality of subcarriers, and the at least one additional subcarrier in parallel” “transmit data	The specification depicts and describes various radios as having signal outputs and either none, one, or two antennas. A POSITA would understand the corresponding structure to “transmitting the first plurality of subcarriers, the second plurality of subcarriers, and the at least one additional subcarrier in parallel” to be two signal outputs suitable for coupling with

Claims	Function	Structure in '326 Specification
18.4	subcarriers occupying the first channel, the second channel, and the frequency gap in parallel”	one or more antennas. A POSITA would understand “instructions to transmit the first plurality of subcarriers, the second plurality of subcarriers, and the at least one additional subcarrier in parallel” to require two signal outputs can be programmed for coupling with one or more antennas. EX.1004, ¶44.

See EX.1004 ¶¶43-44. Should any subsequent claim interpretation discussion arise here or in related proceeding(s), Petitioners reserve the right to propose constructions and/or respond to any construction advanced by the Patent Owner, Board, or Court.

VI. OVERVIEW OF THE ART

Prior art IEEE 802.11a/g standards for wireless local area networking (WLANs) employ orthogonal frequency division multiplexing (OFDM), in which “channels” of multiple subcarriers (frequencies) are used to generate symbols by an inverse Fast Fourier Transform (IFFT). EX.1001, Figs. 5-6, 1:42-2:18. The standard allowed for 48 data and 4 pilot (known) signal subcarriers. EX.1001, Fig. 4, 10:29-31. Guard band (unused) subcarriers at channel edges account for 20% of channel bandwidth. EX.1001, Fig. 4, 10:29-31, 10:43-47; see also EX.1011, ¶[0007]. EX.1004, ¶¶24-26, 74.

A. Gardner (EX.1006)

Gardner summarizes “options for IEEE 802.11a extensions that would support higher data rates,” including: “us[ing] multiple channels to transmit the data

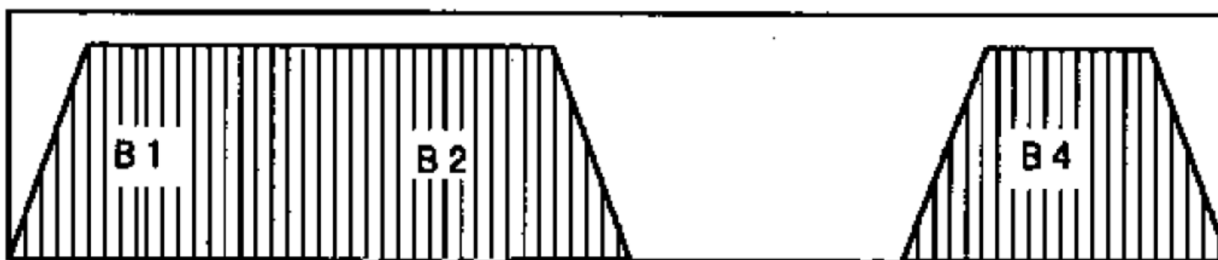
stream; for example, data could be multiplexed between two 54 Mbps streams occupying two contiguous 20 MHz channels to obtain a rate of 108 Mbps” (channel bonding); and “us[ing] multiple input, multiple output (MIMO) systems to increase the data rate and the operating range without increasing bandwidth.” EX.1006, 2:15-62.

Gardner describes “non-degenerate” MIMO systems in which “MIMO transmitter 100 send[s] signals to...MIMO receiver 150” “via each of a plurality of antennas.” EX.1006, Fig. 1A, 5:57-65. “Data provided to transmitter 100 is split into two streams” with “a first stream...sent via antenna 110a, while the second stream is sent via antenna 110b.” EX.1006, 6:1-4. “Receiver 150 receives a first signal via antenna 160a and a second signal via antenna 160b” and “decombines the two signals in order to estimate the transmitted data sequence.” EX.1006, 6:9-24.

A POSITA would understand channel bonding and MIMO to be distinct but compatible technologies. EX.1004, ¶45.

B. Mori (EX.1007, EX.1008)

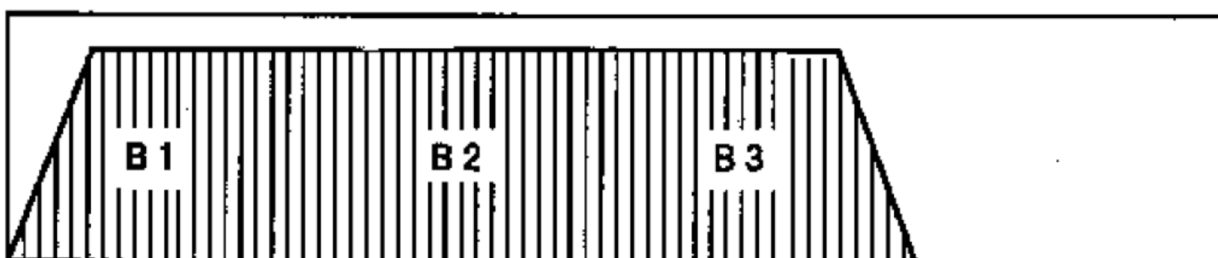
Mori describes increasing data rates in IEEE 802.11-type systems by combining adjacent channels and filling the intervening guard band(s) with data subcarriers:



Mori, Fig. 8(c)



Mori, Fig. 8(d)



Mori, Fig. 8(e)

See EX.1008, ¶¶[0120]-[0127].

C. Bolin (EX.1009)

Bolin states “WLAN radio networks...in accordance with the IEEE 802.11 Standard” “simultaneously [use] a number of carrier frequencies” for “transmission,” but “these carrier frequencies are only modulated with a reduced transmission rate in relation to the overall transmission rate available (across all carriers).” EX.1009, ¶[0001].

Bolint observes “sub-carriers in edge areas of a [channel] are not modulated, in order to eliminate interference on adjoining” channels. EX.1009, ¶[0009]. Bolint teaches “[f]iltering the sub-carriers in the edge area of an OFDM symbol also allows the guard band (i.e., the number of the unused sub-carriers at the edge of the OFDM symbol) to be reduced so, in addition, a comparatively higher data rate can be achieved.” EX.1009, ¶[0014]. The filtering combats non-constant doppler shift due to different relative speeds of the mobile subscribers and uncorrelated phase noise generated by unsynchronized oscillators of individual users in multi-user systems. EX.1009, ¶[0010].

D. Lu (EX.1010)

Lu describes “a first wireless protocol (e.g., 802.11a, 802.11g)” and “a second wireless protocol (e.g., 802.11n)” each of which have data transfer rates dependent on various parameters. EX.1010, ¶¶[0015]-[0018]. Lu describes enabling “devices that use the first protocol to communicate with devices that use the second protocol and vice versa.” EX.1010, ¶[0014]. Specifically, for the second protocol Lu describes “bits (B4-B0),” in which (EX.1010, ¶[0026]):

- “the bit “B4” may be a MIMO (Multiple Input Multiple Output) indication bit,”
- the “bit “B3” may be defined as a channel bonding indicator bit, wherein a “1” value indicates a channel bonding mechanism is used” to

“simultaneously transmit data frames over two adjacent channels as if it were a single channel with twice the bandwidth,” and

- the “bit “B2” may be defined as a shortened guard interval indicator bit, wherein a “1” value indicates a shortened guard interval has been used (e.g., the interval guard may be shortened from 800 ns to 400 ns when a data rate of 140 Mbps is used).”

E. Williams (EX.1011)

Williams observes “multi-carrier techniques such as” “orthogonal frequency division multiplexing (OFDM) use a plurality of carrier frequencies to transmit large amounts of data” “in the IEEE technical standard 802.11a for wireless local area network (LANs).” EX.1011, ¶[0002]. “[I]nter-symbol interference (ISI)” “can introduce errors into the signal stream, which in turn results in a reduction of the overall data transfer rate.” EX.1011, ¶[0006].

Williams explains “guard bands [containing repeated data, unused data, or a specified signal sequence] are inserted periodically within the signal stream...to help mitigate the effects of ISI,” and the guard bands “can be a significant portion of the overall signal stream” such as “20%.” Williams describes generation of “the guard bands...uses a relatively simple procedure known as cyclic extension, wherein after the data stream is partitioned in to units of appropriate size for transmission purposes, 25% of the information at one end of the unit is replicated at the other

end,” although the “percentage...depends upon the communications system in question” EX.1011, ¶¶[0007]-[0008].

Each of the Cited References is analogous art and is usable in an obviousness analysis. *Unwired Planet, LLC v. Google, Inc.*, 841 F.3d 995, 1000-01 (Fed. Cir. 2016). A POSITA is presumed to have been aware of such analogous art. *In re Nilssen*, 851 F.2d 1401, 1403 (Fed. Cir. 1988).

Gardner, Mori, Bolin, Lu, and Williams (Cited References) are in the same field of endeavor as the '326 Patent, *e.g.*, IEEE 802.11 wireless communication. *E.g.*, EX.1001, 1:15 (“wireless communication”), 4:10-12 (“the invention defines a high data rate mode of operation to mesh cleanly with existing and future IEEE 802.11 systems”); EX.1006, 1:14 (“wireless communication”), 1:41-42 (“IEEE 802.11a standard...for data transmission in a wireless LAN”); EX.1008, ¶[0002] (“wireless LANs (local area network)” using an IEEE 802.11-type system, see EX.1004, ¶53); EX.1009, ¶[0001] (“WLAN radio networks such as those functioning in accordance with the IEEE 802.11 Standard”); EX.1010, ¶[0001] (“the 802.11 standard...for wireless local area networks (WLANs)”); EX.1011, ¶¶[0002], [0006] (for “OFDM...used in the IEEE technical standard 802.11a for wireless local area network (LANs).” Thus, the Cited References are analogous art. *Unwired*, 841 F.3d at 1000.

VII. GROUND 1: CLAIMS 1-18 ARE OBVIOUS OVER GARDNER AND MORI

A. Motivations to Combine

Gardner and Mori use the same IEEE 802-11-type wireless channels and subcarrier arrangements for OFDM. Both Gardner and Mori are concerned with improving data transfer in such systems. EX.1006, 2:64-66 (“supported increased data rate and operating range while not requiring additional bandwidth...at every network node”); EX.1008, ¶[0001] (“accommodate a wide range of transmission speeds by flexibly managing communication bandwidth, and has favorable channel utilization”). Both describe, either explicitly or implicitly, the concept of channel bonding—that is, “us[ing] multiple channels to transmit the data stream; for example, data could be multiplexed between two 54 Mbps streams occupying two contiguous 20 MHz channels.” EX.1006, 2:17-19; EX.1007, Fig.9(f); EX.1008, ¶[0121] (“consecutive multi-carrier signals are arranged between the adjacent [channels] B1 and B2”); EX.1004, ¶¶46,49,51,56,122,124.

Gardner and Mori have complementary purposes. EX.1004, ¶124. Gardner addresses leveraging MIMO, using “modulation format[s]...designed so that the transmit and/or receive operations of each network node are unaffected.” EX.1006, 3:3-10. Mori addresses an “OFDM signal generation device and decoding device [that] perform[s] the generation and decoding operations of the OFDM signal

without disrupting synchronization even for information signals with large differences in data rates.” EX.1008, ¶[0024].

The combination of Gardner and Mori allows multiple spatial transmission paths to be employed, each for OFDM symbols resulting from channel bonding, to improve throughput for a data stream. EX.1004, ¶125.

To the extent that any feature is not disclosed in either Gardner or Mori, it would have been routine to add the features of Mori to the system of Gardner or vice versa. EX.1004, ¶126. A POSITA would have thus been motivated to combine Gardner and Mori with a reasonable expectation of success. EX.1004, ¶125.

B. Gardner and Mori meet all claim elements.

1. Independent Claims 1, 16, and 18

Claims 1, 16, and 18 recite substantially overlapping elements and are discussed together. *See* EX.1012.

[1.0]/[16.0]/[18.0] [1.0:A method][16.0:A system] for increasing data rates and data throughput in a network

[18.0:A non-transitory computer-readable medium having instructions stored thereon]

To the extent the preambles are limiting, Gardner discloses increasing data rates and data throughput. EX.1006, 2:15-16 (“Various options for IEEE 802.11a extensions that would support higher data rates...”). Gardner also discloses a method

and a system. EX.1006, 2:50-51, 5:58-6:20. Gardner discloses a “non-transitory computer-readable medium having instructions stored thereon,” stating that “the various components described herein may be implemented digital signal processors singly or in combination, or any other combination of hardware and/or software components.” EX.1006, 12:3-6.

Mori discloses a “method of utilizing a guard band between those unit communication bands for communication [that] increases frequency utilization efficiency and can further enhance the transmission speed of the information signals.” EX.1008, [0141]. Mori also addresses increasing data rates and data throughput. EX.1008, ¶[0036] (“a transmission system with high channel utilization and frequency utilization efficiency”). Mori discloses “a 256-point IFFT processor performing 64-point IFFT operations simultaneously on four systems” that is necessarily programmable. EX.1008, [0066]; EX.1004, ¶136.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶137.

**[1.1]/[16.1]/[18.1] [1.1:selecting] [16.0:means for selecting] [18.0]:
instructions to select]**

at least a first channel and a second channel,

[1.1/18.1]: wherein the first channel and the second channel are adjacent] [16.1]: wherein the first channel is adjacent to the second channel]

without any other channels therebetween,

[1.1/18.1]: wherein the first channel and the second channel each have a plurality of data subcarriers,] [16.1: wherein the first channel comprises a first plurality of subcarriers, and the second channel comprises a second plurality of subcarriers,]

[1.1/18.1]: wherein the data subcarriers of the first channel and the data subcarriers of the second channel are separated by a frequency gap corresponding to one or more guard bands between the first and second channels] [16.1]: wherein a frequency gap corresponding to at least one guard band between the first channel and the second channel separates the first plurality of subcarriers from the second plurality of subcarriers]

Gardner describes extending IEEE 802.11a to “support higher data rates” “us[ing] multiple channels to transmit the data stream; for example, data could be multiplexed between two 54 Mbps streams occupying two contiguous 20 MHz channels” (i.e., channel bonding, see EX.1004, ¶138). EX.1006, 2:15-16, 2:17-20.

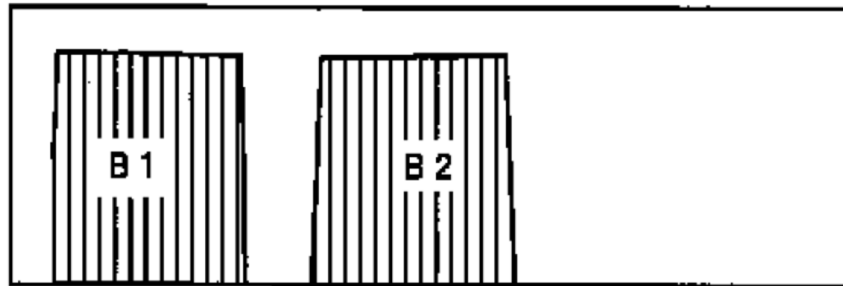
Gardner also describes extending IEEE 802.11a by “us[ing] multiple input, multiple output (MIMO) systems to increase the data rate and the operating range without increasing bandwidth,” through “a transmitter split[ting] the data into

multiple streams and send[ing] each via a separate antenna” with “a distinctive vector signature” that the “receiver, which also has multiple antennas,” uses to “process[]received signals” and discriminate the “multiple transmitted streams, based on the differences in vector signatures of the transmitted streams.” EX.1006, 2:49-58. Channel bonding and MIMO are distinct but compatible technologies, suitable for use either separately or together. EX.1004, ¶190.

Gardner discloses an exemplary (“non-degenerate”) MIMO system including transmitter 100 with antennas 110a, 110b and receiver 150 with antennas 160a, 160b. EX.1006, Fig. 1A, 5:58-6:20. The MIMO system would be backwards compatible with IEEE 802.11a, as a standard “extension.” EX.1004, ¶140. IEEE 802.11a channels each have “a plurality of data subcarriers,” with “the data subcarriers of” adjacent channels “separated by a frequency gap corresponding to one or more guard bands between the [adjacent] channels.” EX.1004, ¶141. A POSITA would be motivated to select adjacent channels for channel bonding. EX.1004, ¶142.

Mori describes “adjacent bands B1 and B2.” EX.1008, Figs.8(c),9(f)-(g), ¶[0121]. Fig.9(f) depicts that first channel B1 and second channel B2 are adjacent without any other channels therebetween, that first channel B1 and second channel B2 each have a plurality of data subcarriers,” and that the data subcarriers of

channels B1 and B2 are separated by a frequency gap corresponding to an intervening guard band:



Mori, Fig. 9(f)

Mori implicitly discloses “selecting” adjacent channels B1 and B2 for the channel bonding discussed below. EX.1004, ¶¶144-146.

A POSITA would be motivated to select Mori’s adjacent channels B1 and B2 for Gardner’s non-degenerate MIMO by the suggestion of combining channel bonding and MIMO in Gardner. EX.1004, ¶147.

See §V.A regarding interpretation of “means for” in claim [16.1] and “instructions to” in claim [18.1]. Gardner and Mori disclose “means” for selecting and instructions to select adjacent channels B1 and B2 (Gardner’s splitter 105, optionally “implemented...[as a] combination of hardware and/or software components”; Mori’s multi-carrier signal generation device 10 and the programmable 256-point IFFT therein). EX.1004, ¶¶148-151.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶152.

[1.2]/[16.2]/[18.2] [16.2: means for] [18.2: instructions to]

partially

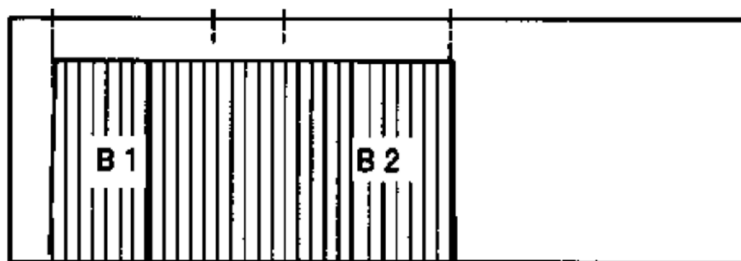
[1.2/16.2: filling] [18.2: fill]

the frequency gap

**[1.2/18.2: between the first channel and the second channel by
adding one or more data subcarriers into the frequency gap] [16.2:
with at least one additional subcarrier]**

such that the one or more guard bands are at least partially filled with
at least some of the one or more data subcarriers using full spectral
synthesis capability of a fast fourier transform or an inverse fast fourier
transform

Mori discloses an “increase in transmission rate due to...the addition of 10
subcarriers in the guard band area,” thereby “increas[ing] the number of data carriers
by allocating subcarrier data to the guard band between the consecutive [channels]
B1 and B2” so that “the area of the guard band may be effectively utilized”:



Mori, Fig. 9(g)

EX.1007, Fig. 9(g); EX.1008, ¶¶[0125], [0131]-[0132]; EX.1004, ¶¶153-156.

A POSITA would be motivated by Mori to insert data subcarriers in place of null subcarriers within the guard band between channel bonded IEEE 802 channels for OFDM symbols in Gardner, in order to “increase...transmission rate due to...the addition of...subcarriers” as taught by Mori. EX.1008, ¶[0125]; EX.1004, ¶162.

As discussed above, Gardner discloses channel bonding and MIMO as compatible IEEE 802.11a extension options. Gardner also describes “[e]ach of OFDM modulators 221, 222...[as] perform[ing] OFDM modulation using an inverse fast Fourier transform (IFFT), thereby providing a time-domain signal” for one of “two streams” from splitter 105 that uses “any...algorithm employed in existing MIMO systems.” EX.1006, Fig. 1A, 7:57-65, 8:1-4.

As discussed above, “using full spectral synthesis capability of a fast Fourier transform or an inverse fast Fourier transform” is satisfied by use of an IFFT on all subcarriers of a channel, including the subcarriers within the frequency gap corresponding to a guard band. Mori discloses that the IFFT circuit 14 may be implemented by “a 256-point IFFT processor performing 64-point IFFT operations simultaneously on four systems.” Ex.1008, [0066]. A POSITA would recognize that each 64-point IFFT operation uses all channel subcarriers, including those within the frequency gap corresponding to a guard band. EX.1004, ¶360. By using IFFT, Gardner’s OFDM modulators “us[e the] full spectral synthesis capability of...an inverse fast fourier transform.” EX.1004, ¶158.

Mori (Fig. 3) depicts “conversion from the frequency domain to the time domain [by] a 256-point IFFT processor performing 64-point IFFT operations simultaneously on four” channels B1 through B4. EX.1008, ¶[0066]. The 256-point IFFT calculator of Mori “us[e the] full spectral synthesis capability of...an inverse fast fourier transform.” EX.1004, ¶161.

Moreover, to the extent the claim requires partially (as opposed to completely) filling the frequency gap, it would be obvious to a POSITA to modify the teachings of Gardner and Mori to the extent necessary to satisfy the claim limitation. EX.1004, ¶156.

See §V.A regarding interpretation of “means for” in claim [16.2] and “instructions to” in claim [18.2]. Mori discloses “means” for (at least) partially filling, and instructions to (at least partially fill), the frequency gap between channels B1 and B2 with data subcarriers (Mori’s multi-carrier signal generation device 10 and the programmable 256-point IFFT therein). EX.1004, ¶¶165-166.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶¶167.

[1.3]/[16.3]/[18.3] [16.3: means for] [1.3/16.3: combining] [18.3: instructions to combine] the first channel and the second channel using channel bonding with orthogonal frequency division multiplexing (OFDM)

“Channel bonding with orthogonal frequency division multiplexing (OFDM)” is satisfied by use of IFFTs operating separately on each channel. EX.1004, ¶168.

As discussed above, Gardner discloses channel bonding and MIMO as compatible IEEE 802.11a extension options. Gardner describes “[e]ach of OFDM modulators 221, 222...[as] perform[ing] OFDM modulation using an inverse fast Fourier transform (IFFT), thereby providing a time-domain signal” for one of “two streams” from splitter 105 that uses “any...algorithm employed in existing MIMO systems.” EX.1006, Fig. 1A, 7:57-65, 8:1-4. Gardner’s OFDM modulators, when receiving adjacent channels B1 and B2 with data subcarriers inserted into the guard band therebetween as disclosed in Mori, combine those channels using channel bonding with OFDM. EX.1004, ¶158.

Mori describes “the OFDM signals of multiple bands generated by a single IFFT” using “a 256-point IFFT processor performing 64-point IFFT operations simultaneously on four” channels B1 through B2 (“setting the input signal level of the subcarriers for bandwidth B3 to 0” so that “the time-domain signal obtained...will be generated as a multi-carrier transmission signal that has the

spectrum of subcarrier signals only in the three bandwidths of B1, B2, and B4”). EX.1008, ¶¶[0066], [0081], [0117]. Mori discloses combining adjacent, gap-filled channels B1 and B2 using channel bonding with OFDM. EX.1004, ¶¶171-172.

Adjacent channels B1 and B2 with data subcarriers inserted into the guard band therebetween as disclosed in Mori may be directed into one of, or split into, two separate OFDM streams by splitter 105 for antennas 110a, 110b as disclosed in Gardner. A POSITA would be motivated to employ Mori’s adjacent channels B1 and B2 (and the data subcarriers inserted into the guard band therebetween) for Gardner’s non-degenerate MIMO by the suggestion of combining channel bonding and MIMO in Gardner. EX.1004, ¶147.

See §V.A regarding interpretation of “means for” in claim [16.3] and “instructions to” in claim [18.3]. Gardner discloses “means” for combining, and instructions to combine, channels B1 and B2 with data subcarriers inserted into the guard band therebetween as disclosed in Mori (Gardner’s OFDM modulators 221, 222, optionally “implemented...[as a] combination of hardware and/or software components”).

Mori discloses “means” for combining, and “instructions to” combine, channels B1, B2, and the guard band therebetween filled with data subcarriers (Mori’s multi-carrier signal generation device 10 and the programmable 256-point IFFT therein). EX.1004, ¶¶174-175.

Therefore, the combination of Gardner and Mori meets these elements.

EX.1004, ¶176.

[1.4]/[16.4]/[18.4] [16.4: means for] [1.4/16.4: transmitting] [18.4: instructions to transmit] data subcarriers occupying the first channel, the second channel, and the frequency gap in parallel to a receiver

“In parallel” is satisfied by either (a) channel subcarriers that are parallel (non-overlapping) in frequency, or (b) use of spatial diversity (MIMO). EX.1004, ¶177.

As discussed above, Gardner discloses channel bonding and MIMO as compatible IEEE 802.11a extension options. Gardner describes an exemplary non-degenerate MIMO system including transmitter 100 splitting data into two streams and sending each via either antenna 110a or 110b. Transmitter 100 includes OFDM modulators 221, 222 performing OFDM modulation to “provid[e] a time-domain signal” for one of “two streams” from splitter 105. EX.1006, Fig. 1A, 7:57-65, 8:1-4. A POSITA would understand Gardner’s OFDM modulators to generate OFDM symbols for adjacent channels B1 and B2 and the data subcarriers inserted into the guard band therebetween as disclosed in Mori, for transmission using antenna 110a for one OFDM symbol and antenna 110b for the other OFDM symbol. EX.1004, ¶178.

As also discussed above, Mori describes transmitting data for user C on adjacent channels B1 and B2 with the guard band therebetween filled with data

subcarriers using multi-carrier signal generation device 10. Mori states that “the signal generated by frequency conversion is radiated from an antenna 19 into a spatial transmission path” for “reception of the OFDM signal radiated into the spatial transmission path” by antenna 21. EX.1008, ¶¶[0014]-[0016]. Channel B1 and its associated guard band subcarriers and channel B2 and its associated guard band subcarriers are parallel (non-overlapping) in frequency.

A POSITA would be motivated to employ Mori’s adjacent channels B1 and B2 (and the data subcarriers inserted into the guard band therebetween) for Gardner’s non-degenerate MIMO by the suggestion of combining channel bonding and MIMO in Gardner. EX.1004, ¶147.

When adjacent channels B1 and B2 with data subcarriers inserted into the guard band therebetween as disclosed in Mori are combined with Gardner’s non-degenerate MIMO, splitter 105 may either direct both resulting OFDM symbols to one of antennas 110a or 110b, or split the two OFDM symbols between antennas 110a and 110b. EX.1004, ¶181. In either case, channel B1 and its associated guard band subcarriers and channel B2 and its associated guard band subcarriers are parallel (non-overlapping) in frequency, and the spatial transmission path from antenna 110a and the spatial transmission path from antenna 110b are parallel. EX.1004, ¶182.

See §V.A regarding interpretation of “means for” in claim [16.4] and “instructions to” in claim [18.4]. Gardner and Mori disclose “means for” transmitting, and “instructions to” transmit, the subcarriers for channel B1, the subcarriers for channel B2, and the subcarriers inserted into the associated guard band regions, via one or both of antennas 110a, 110b (Gardner’s transmitter 100, optionally “implemented...[as a] combination of hardware and/or software components”; Mori’s multi-carrier signal generation device 10 and the programmable 256-point IFFT therein, and antenna 19). EX.1004, ¶¶182-185.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶186.

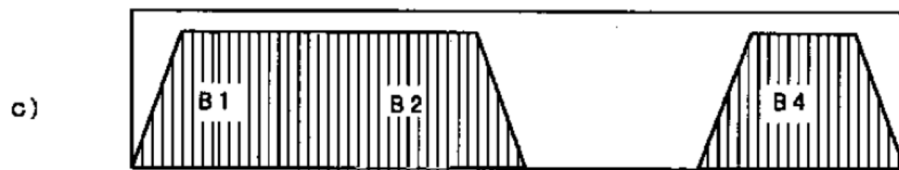
2. Claim 2

[2.0]: wherein combining the first channel and the second channel further comprises: interleaving one of a legacy signal and a wide signal during packet transmission

“Legacy signal” is a single channel and “wide signal” is two adjacent, channel bonded and gap-filled channels. EX.1004, ¶187. For example, the ’326 Patent states that “[l]egacy signals (e.g., one-channel) and wide signals (e.g., multiple-channels) may be arbitrarily interleaved in time (dynamic bandwidth switching) during packet transmission.” Ex.1001, 14:710.

As discussed above, Gardner describes channel bonding and MIMO as “options for IEEE 802.11a extensions that would support higher data rates,” describes “non-degenerate” MIMO systems. Channel bonding and MIMO are distinct but compatible technologies, suitable for use either separately or together. EX.1004, ¶190. However, channel bonding will not always be used, based on the size of data to be transmitted. EX.1004, ¶191. Interleaving of channel-bonded OFDM symbol pairs and single “legacy” OFDM symbols will necessarily occur. EX.1004, ¶191.

Mori (Fig. 8(c)) depicts “transmitting signals using three [channels] B1, B2, and B4 [for user C], where consecutive multi-carrier signals are arranged between the adjacent [channels] B1 and B2”:



Mori, Fig. 8(c)

EX.1007, Fig. 8(c); EX.1008, ¶[0121]. Mori also describes “the OFDM signals of multiple bands generated by a single IFFT” using “a 256-point IFFT processor performing 64-point IFFT operations simultaneously on four” channels B1 through B2. EX.1008, ¶¶[0066], [0081], [0117]. Mori also discloses that the OFDM symbols are “supplied to an antenna 19 and radiated into the spatial transmission path from that antenna,” with “the content information...modulated as a multi-carrier signal of

multiple blocks and radiated onto the spatial transmission path.” EX.1008, ¶¶[0045], [0054]. The OFDM symbols corresponding to channels B1 and B2 comprise a “wide signal,” while the OFDM symbol corresponding to channel B4 comprises a “legacy signal,” and transmitting the OFDM symbols comprises interleaving such signals. EX.1004, ¶192.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶194.

3. Claim 3

[3.0]: wherein the legacy signal comprises one channel and the wide signal comprises multiple channels

OFDM symbol pairs for two contiguous, channel bonded channels as suggested by Gardner comprise a “wide signal,” while OFDM symbols for a single channel comprise a “legacy signal.” EX.1004, ¶191. A POSITA would be motivated to use “wide” and “legacy” signals according to the size of “one data stream relative to the other” (EX.1009, 8:23). EX.1004, ¶191.

In Mori’s example of using adjacent channels B1 and B2 together with non-contiguous channel B2 for user C (EX.1008, ¶¶[0074], [0077]), the OFDM symbols corresponding to channels B1 and B2 comprise a “wide signal,” while the OFDM symbol corresponding to channel B4 comprises a “legacy signal.” EX.1004, ¶195.

Therefore, the combination of Gardner and Mori meets these elements.
EX.1004, ¶197.

4. Claim 4

[4.0]: wherein transmitting the first channel and the second channel
comprises transmitting to multiple radios

When multiple radios are located within a transmitter's spatial transmission
path, transmissions intrinsically comprise transmitting to those multiple radios.
EX.1004, ¶198.

Also, “transmitting to multiple radios” is satisfied by “using two existing
legacy circuits or radios in parallel” using MIMO. EX.1004, ¶199. For example, the
'326 Patent teaches that “the invention may be achieved” “by 1) using two existing
legacy circuits or radios in parallel” with “one physical implementation of a dual-
chain wideband radio” employing “a ‘multiple radios in a box’ implementation” in
which “multi-chain radios each with a single bandwidth...are used.” Ex.1001,
11:24-26, 12:9-15.

Gardner teaches that “MIMO systems require all network components to have
additional RF chains and antennas” and that “‘antenna’ refers generally to any
apparatus for coupling a transmitter or receiver to a channel and is to be understood
as including any associated components such as a standard radio-frequency (RF)
chain.” EX.1006, 2:59-60, 5:65-6:1. Gardner's non-degenerate MIMO system

includes two antennas 110a, 110b. EX.1006, Fig.1A, 6:1-4. Antennas 110a, 110b would include separate RF chains. EX.1004, ¶200.

Mori describes three users (user A, user B, and user C) sharing eight channels B1 through B8: “[A]mong bandwidths B1 to B8, B3 indicated as a) is already used by user A, and B6 and B7 are already used by user B, while user C is in a situation where communication is performed by setting three of the remaining B1, B2, B4, B5, and B8 bandwidths.” EX.1008, ¶[0074]. In one example, “a multi-carrier signal is generated using the bandwidths B1, B2, and B4 for user C to communicate using the multi-carrier signal generation device,” for “communicating using multiple unit communication [channels], even when they are not consecutive, thus improving channel utilization efficiency.” EX.1008, ¶¶[0075], [0077], [0148]. The multi-carrier signal for channels B1, B2, and B4 transmitted via antenna 19 in Mori would be transmitted to radios for user A and user B, which share the same channels. EX.1004, ¶201.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶203.

5. Claim 5

[5.0]: wherein transmitting the first channel and the second channel comprises transmitting to a single radio

When only a single radio is located within a transmitter's spatial transmission path, transmissions intrinsically comprise transmitting to that radio. EX.1004, ¶204.

Mori discloses “a multi-carrier signal...generated using the bandwidths B1, B2, and B4 for user C to communicate using the multi-carrier signal generation device,” with “the signal generated by frequency conversion...radiated from an antenna 19 into a spatial transmission path” and “reception of the OFDM signal radiated into the spatial transmission path” occurring “by an antenna 21.” EX.1008, ¶¶[0014]-[0016],[0077]. The multi-carrier signal for channels B1, B2, and B4 transmitted via antenna 19 in Mori would be transmitted to the radio for user C. EX.1004, ¶207.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶210.

6. Claim 6

[6.0]: wherein the method is extensible to additional channels

Mori depicts and describes channel bonding and gap filling of three channels B1, B2, and B3, “since bands B1 to B3 are used consecutively, consecutive multi-carrier signals are arranged in bands B1 to B3”:



Mori, Fig. 8(e)

Ex.1008, Fig.8(e), ¶[0122]. Mori states that “data may be allocated to 10 subcarriers each between B1 and B2 and between B2 and B3, totaling 20 subcarriers, resulting in an increase in transmission rate.” Ex.1008, [0126]. Mori further states that, when communication is conducted using four consecutive bands, data allocation may be made to a total of 30 subcarriers” (e.g., between each of channels B1 through B4), and “when communication is conducted using four consecutive bands, data allocation may be made to a total of 30 subcarriers, resulting in an increase in transmission rate.” Ex.1008, ¶¶[0126]-[0127].

Therefore, the combination of Gardner and Mori meets these elements.
EX.1004, ¶213.

7. Claim 7

[7.0]: eliminating synthesizer frequency popping during bandwidth switching between packets

Elimination of synthesizer frequency popping during bandwidth switching is accomplished when dual-chain signal processing operate with two parallel IFFTs that remain tuned to legacy channel centers. EX.1004, ¶¶214-215. For example, the '326 Patent states “the present invention is directed to increasing the data rate” “without increasing the analog and mixed signal requirements...using a full spectral synthesis capability of the Inverse Fast Fourier Transform/Fast Fourier Transform

(IFFT/FFT).” Ex.1001, 10:48-53. The ’326 Patent describes “the invention” as “(1) using two existing legacy circuits or radios in parallel” with “one physical implementation of a dual-chain wideband radio” employing “a ‘multiple radios in a box’ implementation” in which “multi-chain radios each with a single bandwidth...are used.” Ex.1001, 11:24-26, 12:9-15. The ’326 Patent teaches that “no synthesizer frequency-popping exists when bandwidth switching between packets” if “[s]ynthesizers...stay tuned to legacy channel centers for most or at all times.” EX.1001, 4:50-54.

Gardner discloses use of separate “OFDM modulators 221, 222, which may be implemented using standard components, [and] perform[] OFDM modulation using an inverse fast Fourier transform (IFFT), thereby providing a time-domain signal suitable for feeding to” antennas 110a, 110b. Ex.1006, 8:1-5, see also Figs. 2A-2B and 4.

Mori describes “simultaneously generating the subcarrier signals provided to the two or more unit communication bands,” using a 256-point IFFT “performing 64-point IFFT operations simultaneously” on four channels, and that “modulation signals for the four bands ... are generated simultaneously by the aforementioned IFFT.” EX.1008, ¶¶[0066],[0071].

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶219.

8. Claim 8

[8.0]: tuning a first synthesizer to the first channel, wherein the first synthesizer remains tuned to the first channel during mode switching

Gardner discloses OFDM modulator 221 performing OFDM modulation using an IFFT to provide a time-domain signal “suitable for feeding to” antenna 110a. Ex.1006, Fig. 1A, 8:1-5.

Mori describes “simultaneously generating the subcarrier signals provided to the two or more unit communication bands,” using a 256-point IFFT “performing 64-point IFFT operations simultaneously” on four channels, and that “modulation signals for the four bands ... are generated simultaneously by the aforementioned IFFT.” Ex.1008, [0066], [0071]. A 64-point IFFT for channel B1 is performed on inputs 127 to 191 of the 256-point IFFT in Fig. 3, and a 64-point IFFT for channel B2 is performed on inputs 192 to 255. EX.1004, ¶222.

Inputs 127 to 191 remain tuned to the subcarriers for channel B1, regardless of whether channel bonding with channel B2 is performed. EX.1004, ¶223.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶224.

[8.1]: tuning a second synthesizer to the second channel, wherein the second synthesizer remains tuned to the second channel during mode switching

Gardner discloses OFDM modulator 222 performing OFDM modulation using an IFFT to provide a time-domain signal “suitable for feeding to” antenna 1108. Ex.1006, Fig. 1A, 8:1-5.

Mori describes “simultaneously generating the subcarrier signals provided to the two or more unit communication bands,” using a 256-point IFFT “performing 64-point IFFT operations simultaneously” on four channels, and that “modulation signals for the four bands ... are generated simultaneously by the aforementioned IFFT.” Ex.1008, [0066], [0071]. A 64-point IFFT for channel B1 is performed on inputs 127 to 191 of the 256-point IFFT in Fig. 3, and a 64-point IFFT for channel B2 is performed on inputs 192 to 255. EX.1004, ¶222.

Inputs 192 to 255 remain tuned to the subcarriers for channel B2 regardless of whether channel bonding with channel B1 is performed. EX.1004, ¶226.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶227.

9. Claim 9

[9.0]: channel bonding comprises use of common synthesizers

Use of the “full spectral synthesis capability of the Inverse Fast Fourier Transform/Fast Fourier Transform (IFFT/FFT)” with dual chain “multiple radios in a box” design including “multi-chain radios, each with a single bandwidth and multiple FFTs” results in “use [of] common synthesizer” frequencies without

bandwidth switching by “stay[ing] tuned to legacy channel centers.” See EX.1001, 4:50-54, 10:48-53, 12:9-17; EX.1004, ¶228. The IFFT frequency synthesis is “common” to both using adjacent channels individually and using the same adjacent channels with channel bonding and gap filling, without switching center frequencies. EX.1004, ¶228.

As discussed above, Gardner discloses use of separate “OFDM modulators 221, 222, which may be implemented using standard components, [and] perform[] OFDM modulation using an inverse fast Fourier transform (IFFT), thereby providing a time-domain signal suitable for feeding to” antennas 110a, 110b. Ex.1006, 8:1-5, see also Figs. 2A-2B and 4.

Mori describes “simultaneously generating the subcarrier signals provided to the two or more unit communication bands,” using a 256-point IFFT “performing 64-point IFFT operations simultaneously” on four channels, and that “modulation signals for the four bands ... are generated simultaneously by the aforementioned IFFT.” Ex.1008, [0066], [0071]. A 64-point IFFT for channel B1 is performed on inputs 127 to 191 of the 256-point IFFT in Fig. 3, and a 64-point IFFT for channel B2 is performed on inputs 192 to 255. EX.1004, ¶222.

Inputs 127 to 191 remain tuned to the subcarriers for channel B1, regardless of whether channel bonding with channel B2 is performed. EX.1004, ¶223. Inputs

192 to 255 remain tuned to the subcarriers for channel B2 regardless of whether channel bonding with channel B1 is performed. EX.1004, ¶231.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶232.

10. Claim 10

[10.0]: wherein the plurality of data subcarriers are OFDM subcarriers

Gardner describes “orthogonal frequency division multiplexing (OFDM)” with “48 mutually orthogonal data-carrying subcarrier frequencies.” EX.1006, 1:42-54.

Mori describes “multi-carrier signal transmission techniques such as OFDM (Orthogonal Frequency Division Multiplexing)” in which “the number of subcarriers used for data transmission in one band is 48.” EX.1008, ¶¶[0002], [0101].

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶236.

11. Claim 11

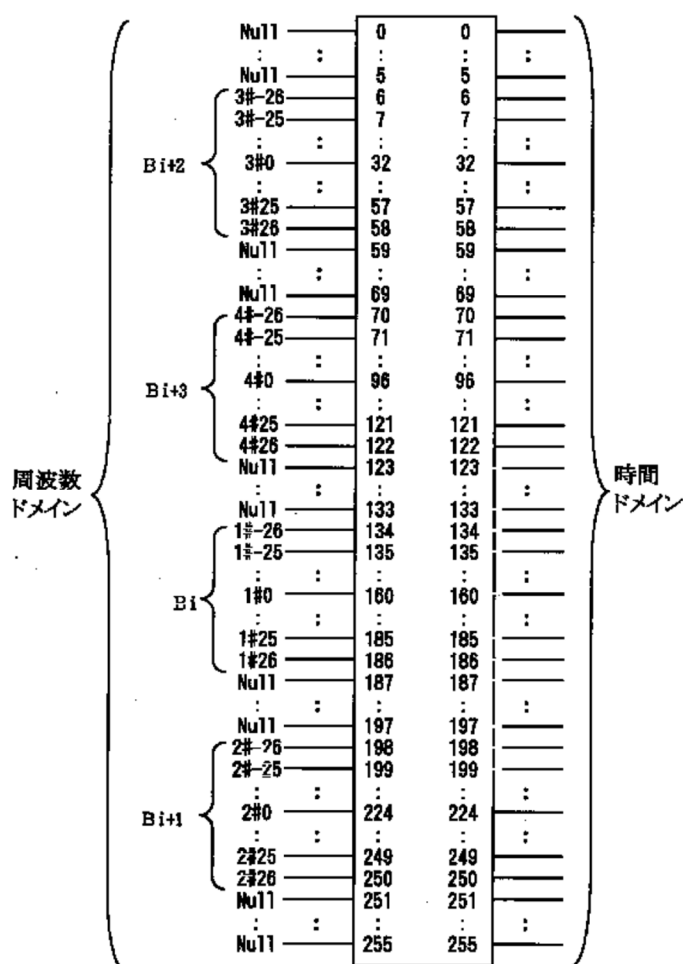
[11.0]: identifying additional points in a Fast Fourier Transform (FFT) across the first and second channels

FFT/IFFT points refer to subcarriers (data samples) used during the transformation from the time domain to the frequency domain or vice versa. The ’326 Patent describes “64-point FFTs” for 48 data subcarriers (and four pilot

subcarriers) in a single “legacy” channel, a “128-point FFT” for 96 data subcarriers (and 8 pilot subcarriers) in two adjacent “legacy” channels, and “[using] all usable points in FFT [a]cross 2 channels” when employing two channels with all subcarriers carrying data (including subcarriers assigned null data for the guard band areas in “legacy” channels). EX.1001, Fig. 4, 11:24-27 (“2-64-point FFTs...1-128-point FFT”), 12:23 (“large FFT (e.g., 128-point)”). The ’326 Patent also states that “dual channel with all gaps filled” results in “120 data subcarriers” (allowing for eight subcarriers for pilot signals, four subcarriers per channel). EX.1001, 10:45-48; EX.1004, ¶¶237-239. Each subcarrier corresponds to one “point” in an FFT/IFFT, with a 64-point FFT/IFFT corresponding to 64 subcarriers and a 128-point FFT/IFFT corresponding to 128 subcarriers. EX.1004, ¶111. The number of points in a 64-point or 128-point FFT/IFFT, and the number of subcarriers processed by the correspondingly sized FFT/IFFT, does not change; only the number of data-carrying subcarriers (versus “null” guard band subcarriers) changes. EX.1004, ¶112.

Accordingly, “additional points” simply refer to channel edge subcarriers, whether used for data or null (guard band) signals. EX.1004, ¶239.

Mori teaches that IFFT circuit 14 is “a 256-point IFFT processor performing 64-point IFFT operations simultaneously on four” adjacent channels B1, B2, B3, and B4:



Mori, Fig. 3

EX.1007, Fig. 3; EX.1008, ¶[0066]. The same four 64-point IFFT operations may be used for channels B1, B2, B3, and B4 regardless of whether subcarriers between two adjacent channels (e.g., B1 and B2) are used for data or a guard band. EX.1004, ¶240. The guard band subcarriers between channels B1 and B2 in Mori correspond to the recited “additional points.” EX.1004, ¶240-243.

Therefore, the combination of Gardner and Mori meets these elements.
EX.1004, ¶244.

[11.1]: adding subcarriers to the additional points

See the above discussion regarding “additional points” in claim [11.0].

Channel edge subcarriers corresponding to the recited “additional points” in a 64-point or 128-point IFFT intrinsically exist, but are normally not used to carry data. EX.1004, ¶¶245-246.

For an alternative claim limitation “adding **data** subcarriers to the additional points,” supplying data to guard band subcarriers within (for example) “the frequency gap between the first channel and the second channel,” “corresponding to one or more guard bands between the first and second channels,” while using two 64-point FFTs or one 128-point FFT satisfies claim [11.2]. EX.1004, ¶¶245-246.

Mori states that “data allocation...for 10 subcarriers at 10 input terminals” produces an “increase in transmission rate due to the increase in [data] subcarriers” by “the addition of 10 [data] subcarriers in the guard band area.” EX.1008, ¶¶[0124]-[0125]. Mori also states that, “because subcarrier signals [to be] inserted between bands B1 and B2 are generated, data allocation may be made for 10 subcarriers at 10 input terminals ... among input terminals 187 to 197” of the 256-point IFFT processor. EX.1008, ¶[0124]. Input terminals 187 to 197, labeled “Null” in Fig. 3, correspond to guard band “subcarriers ... #+27 to #+31” for one channel (B1) and guard band “subcarriers #-32 to #-27” for an adjacent channel, corresponding to a

guard band between the two channels. See EX.1008, ¶¶[0113]-[0115]; EX.1004, ¶246.

Therefore, the combination of Gardner and Mori meets these elements.
EX.1004, ¶244.

12. Claim 12

[12.0]: wherein the additional points exist on an outer edge of the first channel or the second channel

See the above discussion regarding “additional points” in claim [11.0].

Mori states that “data allocation...for 10 subcarriers at 10 input terminals” produces an “increase in transmission rate due to the increase in [data] subcarriers” by “the addition of 10 [data] subcarriers in the guard band area.” EX.1008, ¶¶[0124]-[0125]. Mori also states that, “because subcarrier signals [to be] inserted between bands B1 and B2 are generated, data allocation may be made for 10 subcarriers at 10 input terminals ... among input terminals 187 to 197” of the 256-point IFFT processor. EX.1008, ¶[0124]. Filling the guard band between adjacent channels B1 and B2 with data subcarriers, as taught by Mori, includes adding data subcarriers corresponding to “additional points” on an outer edge of channel B1 (closest to channel B2) and on an outer edge of channel B2 (closest to channel B1). EX.1004, ¶249.

Mori further discloses using “additional points” of an IFFT for data subcarriers inserted into the guard bands at both ends of a channel (B2) “when three consecutive [channels] B1, B2, and B3” are used:



Mori, Fig. 8(e)

EX.1007, Fig. 8(e); EX.1008, ¶¶ [0122],[0126]. This embodiment in Mori includes data subcarriers corresponding to “additional points” on an outer edge of the channel bonded, gap-filled adjacent channels B1 and B2 (closest to channel B3). EX.1004, ¶250.

Therefore, the combination of Gardner and Mori meets these elements.
EX.1004, ¶253.

13. Claim 13

[13.0]: wherein a guard band on each edge is filled with data

Mori discloses filling both edges of channel B2 with data subcarriers “when three consecutive [channels] B1, B2, and B3” are used:



Mori, Fig. 8(e)

EX.1007, Fig. 8(e); EX.1008, ¶¶ [0122],[0126].

Mori describes communicating on “four consecutive bands” B1 through B4 with “data allocation...to a total of 30 subcarriers” for the intervening guard bands, “using an IFFT that may generate OFDM signals for four bands.” Ex.1008, ¶¶[0127],[0136]. Mori also teaches that “there is no need to provide...guard bands” with “a 256-point IFFT processor performing 64-point IFFT operations simultaneously on four” channels B1 through B4, because “the OFDM signals of [the four channels] generated by a single IFFT are orthogonal to each other, and thus do not interfere with one another.” EX.1008, ¶¶[0066],[0117]. “Even when the OFDM signals that are orthogonal among multiple bands are generated using multiple[, separate 64-point] IFFTs, when those IFFTs are...synchronized to operate at the same symbol period, each subcarrier remains orthogonal, allowing for the omission of guard bands.” EX.1008, ¶ [0118]. Mori suggests filling all channel edge subcarriers (guard bands) for any channel with data subcarriers, to increase transmission rates, when either a single IFFT uses all subcarriers for that channel and adjacent channels, or when multiple IFFTs using the subcarriers of individual channels are “synchronized to operate at the same symbol period.” EX.1004, ¶257. In that case, “guard bands on each edge,” either of individual channels or of groups of channel bonded, gap-filled channels, would be “filled with data.” *Id.*

Therefore, the combination of Gardner and Mori meets these elements.
EX.1004, ¶259.

14. Claim 14

[14.0]: utilizing an anti-aliasing technique at a receiver.

The '326 Patent describes various anti-aliasing techniques. EX.1004, ¶¶260-265. Based on both general knowledge and the various forms of anti-aliasing described in the '326 Patent, low pass filtering is “an anti-aliasing technique.” EX.1004, ¶¶114-116,260,266. For example, for anti-aliasing by separately filtering channels, the '326 Patent suggests “low pass filter[s]...with normal Q factors” for each radio chain “in a dual-chain wideband radio.” EX.1001, Figs. 11-12, 12:30-34; EX.1004, ¶264.

Mori discloses a receiver (e.g., decoding device 20) including bandpass filter (BPF) 23 in which “the signal components of the frequency bandwidth necessary for demodulation are frequency-selected.” EX.1007, Fig. 15; EX.1008, ¶[0088]. In Mori, “the frequency band signal necessary for demodulation [are] selected and extracted by a BPF 23.” EX.1008, ¶¶[0015]-[0019]. Mori’s bandpass filter 23 comprises an anti-aliasing technique. EX.1004, ¶267.

Therefore, the combination of Gardner and Mori meets these elements.
EX.1004, ¶270.

15. Claim 15

[15.0]: the anti-aliasing technique comprises passing upper signals and lower signals through a first filter and a second filter

As discussed above in connection with [14.0], Mori at least suggests anti-aliasing by separately filtering channels (e.g., B1 and B2). Simultaneously decoding multiple channels (e.g., B1 and B2) with separate instances of decoding device 20a for each channel would result in a first BPF 23 for channel B1 and a second BPF 23 for channel B2. EX.1004 ¶¶270-76.

Mori further that “the multi-carrier signal composed of subcarrier signals of multiple blocks [as] simultaneously demodulated in the FFT 25, [and] the demodulated signals of multiple blocks obtained through demodulation are simultaneously decoded.” EX.1008, ¶[0060]. Mori states that “FFT 25...has an input terminal for 256 time-domains corresponding to the IFFT illustrated in FIG. 3,...and 256 point FFT operations are performed.” EX.1008, ¶[0083]. Mori teaches that the 256-point FFT simultaneously performs four 64-point FFTs, analogous to simultaneous performance of four 64-point IFFTs by the 256-point IFFT processor of Fig. 3. Ex.1004, ¶273.

“Simultaneously demodulat[ing]” “subcarrier signals of multiple blocks” “in the [256-point] FFT 25” and “simultaneously decod[ing]” the “multiple blocks obtained through demodulation” describe separate demodulator/decoder chains for

each channel B1 through B2. EX.1004, ¶274. A POSITA would be motivated to provide separate BPFs 23 for each signal chain, filtering for the respective channel B1/B2/B3/B4. EX.1004, ¶275. This would have been a combination of known elements with predictable results. *Id.*

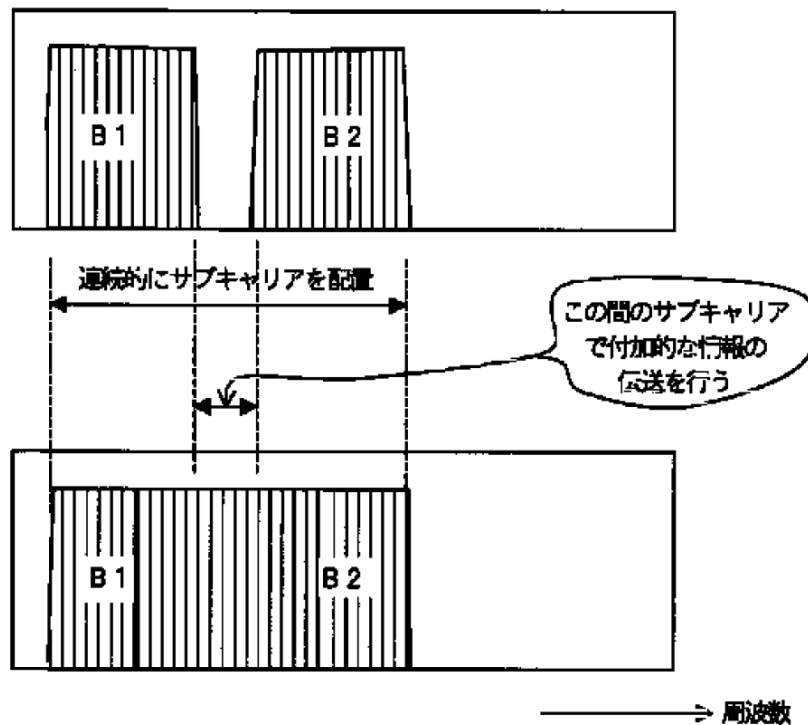
Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶277.

16. Claim 17

[17.0]: wherein the frequency gap is filled with a portion of the first plurality of subcarriers and a portion of the second plurality of subcarriers

In Claim 16 (from which Claim 17 depends), the “first plurality of subcarriers” are those within the “first channel” and the “second plurality of subcarriers” are those within the “second channel,” while the “frequency gap” is “partially fill[ed]...with at least one additional [data] subcarrier.”

Mori discloses “the addition of 10 [data] subcarriers in the guard band area” between adjacent channels (e.g., B1 and B2), filling that guard band area:



Mori, Figs. 9(f)-(g)

EX.1007, Figs. 9(f)-(g); see also EX.1008, ¶¶[0124]-[0125]. Some of the 10 additional data subcarriers correspond to an edge of channel B1, and some to an edge of channel B2. EX.1004, ¶280.

Therefore, the combination of Gardner and Mori meets these elements.

EX.1004, ¶277.

Claims 1-18 are therefore obvious over Gardner and Mori.

VIII. GROUND 2: CLAIMS 12-13 ARE OBVIOUS OVER GARDNER, MORI, AND EITHER OF BOLINTH OR WILLIAMS

Bolint and Williams are capable of being used independently or together.

EX.1004, ¶283.

A. Motivations to Combine Bolinth with Gardner and Mori

See Section VII(A). Like Gardner and Mori, Bolinth relates to improving data rates/data throughput in IEEE 802.11 systems. EX.1009, ¶[0001] (“[I]n accordance with the IEEE 802.11...simultaneously a number of carrier frequencies...are employed for the transmission of a digital signal. However, these carrier frequencies are only modulated with a reduced transmission rate in relation to the overall transmission rate available (across all carriers).”). Bolinth observes that “sub-carriers in edge areas of a [channel] are not modulated, in order to eliminate interference on adjoining” channels. EX.1009, ¶[0009]. Bolinth teaches that “[f]iltering the sub-carriers in the edge area of an OFDM symbol also allows the guard band (i.e., the number of the unused sub-carriers at the edge of the OFDM symbol) to be reduced so that, in addition, a comparatively higher data rate can be achieved.” EX.1009, ¶[0014]. Bolinth and Mori share the objective of increasing data rate through use of guard band subcarriers to carry data. EX.1004, ¶288. Bolinth’s teachings refine Mori and are complementary to Gardner. EX.1004, ¶289. A POSITA would have thus been motivated to combine Bolinth with Gardner and Mori. EX.1004, ¶290.

It would have been routine to add the features of Bolinth to the system(s) of Gardner and/or Mori, and a POSITA would have a reasonable expectation of success in doing so. EX.1004, ¶291.

B. Motivations to Combine Williams with Gardner and Mori

See Section VII(A). Like Gardner and Mori, Williams relates to systems with an IEEE 802.11 channel structure, using OFDM. EX.1004, ¶¶293-294.

Williams describes filling the guard band with repeated data, replicated from the last data segment on remaining subcarriers. A POSITA would understand that the repeated data allows for error correction at the receiver, potentially improving data rates. EX.1004, ¶296. Repeated data therefore is a specific implementation for Mori’s teaching to “add[] error correction codes” to guard band subcarriers. It would have been routine to add the features of Williams to the system(s) of Gardner and/or Mori, and a POSITA would have a reasonable expectation of success in doing so. EX.1004, ¶297.

C. Gardner, Mori, and Bolin/Williams meet all claim elements.

1. Claim 12

[12] wherein the additional points exist on an outer edge of the first channel or the second channel

Mori teaches “the addition of 10 subcarriers in the guard band area” between adjacent channels (e.g., B1 and B2), filling that guard band area (“additional points” of channel B1 and of channel B2) using an IFFT. Half of the additional data subcarriers exist on an outer edge of the first channel (e.g., B1) and half exists on an outer edge of the second channel (e.g., B2). EX.1004, ¶300.

Mori teaches that “there is no need to provide such guard bands” between channel bonded, gap-filled channels. EX.1008, ¶[0117]. Mori does not discuss guard bands between channels for which IFFTs are not “synchronized to operate at the same symbol period,” such that “each subcarrier remains orthogonal, allowing for the omission of guard bands.” See EX.1008, ¶[0118]. For example, while Mori describes “communication bandwidths B1 to B8” and “user C” communicating using “three of...[channels] B1, B2, B4, B5, and B8” (Ex.1008, [0074]), Mori does not discuss guard bands between channels B4 and B5, for which separate IFFTs may need to be performed. EX.1004, ¶303.

Bolinh teaches that “a comparatively higher data rate can be achieved” by reducing “the number of the unused sub-carriers at the edge of the OFDM symbol” that form the guard band, by filtering the subcarriers in the receiver of a multi-user system of the type described in Mori. EX.1009, ¶[0014]. As discussed above, Mori discloses BPF 23 in the receive chain. Filtering edge subcarriers for an OFDM symbol as described in Bolinh may be combined with BPF 23, to filter (outer) edge subcarriers of Mori’s channel bonded, gap-filled channels B1 and B2 when all guard bands are omitted as suggested by Mori. EX.1004, ¶305.

Alternatively, Williams describes filling the guard band with repeated data, “to combat [inter-symbol interference (ISI)]” in wireless signals. EX.1011, ¶¶[0006]-[0008]. Mori suggests “adding error correction codes” to guard band

subcarriers. EX.1008, ¶[0129]. William’s repeated data “to combat ISI” is a form of the error correction suggested by Mori. EX.1004, ¶309. Since the repeated data fills the guard band between channels, the subcarriers carrying repeated data are necessarily on outer edges of Mori’s channel bonded, gap-filled channels B1 and B2. EX.1004, ¶310.

Therefore, the combination of Gardner and Mori with either of Bolinith or Williams meets these elements. EX.1004, ¶311.

2. Claim 13

[13] wherein a guard band on each edge is filled with data

Mori suggests omitting guard bands when IFFTs for channels are calculated synchronously, and increasing transmission rates by allocating data to guard band subcarriers. EX.1008, ¶¶[0118],[0124]-[0127]. Bolinith teaches filtering subcarriers at a receiver to reduce guard bands in multi-user systems, despite inter-channel interference in a multi-user system. EX.1009, ¶[0014]. A POSITA would be motivated to use Bolinith’s filter with the system of Mori to increase transmission rates by filling all guard bands, with a reasonable expectation of success in combining known elements. EX.1004, ¶315.

Mori suggests “adding error correction codes” to guard band subcarriers. EX.1008, ¶[0129]. Williams describes filling the guard band with repeated data, “to combat [inter-symbol interference (ISI)]” in wireless signals. EX.1011, ¶¶[0006]-

[0008]. William’s repeated data “to combat ISI” is a form of the error correction suggested by Mori. EX.1004, ¶309. A POSITA would be motivated to use Williams’ repeated data in guard bands within the system of Mori to improve error correction, with a reasonable expectation of success in combining known elements. EX.1004, ¶319.

Therefore, the combination of Gardner and Mori with either of Bolinith or Williams meets these elements. EX.1004, ¶320.

IX. GROUND 3: CLAIMS 1-18 ARE OBVIOUS OVER MORI, LU, AND WILLIAMS

A. Motivations to Combine

Each of Mori, Lu, Bolinith, and Williams are concerned with improving data transfer in wireless communications. EX.1008, ¶[0001] (“accommodate a wide range of transmission speeds by flexibly managing communication bandwidth and [with] good channel utilization”); EX.1010, ¶[0001] (“pre-existing wireless standards may limit the data transfer rate between devices”); EX.1011, ¶[0001] (“a reduced transmission rate in relation to the overall transmission rate available”), ¶[0014] (“higher data rate”).

Both Mori and Lu describe, either explicitly or implicitly, the concept of channel bonding—that is, “simultaneously transmit[ing] data . . . over two adjacent channels as if it were a single channel with twice the bandwidth.” EX.1010, ¶[0026];

EX.1007, Figs. 8(c)-(e), 9(g); EX.1008, ¶[0126] (“data may be allocated to 10 subcarriers each between B1 and B2 and between B2 and B3”).

Both Mori and Lu describe or suggest using guard band subcarriers for data. EX.1008, ¶[0119] (“there is no need to suppress the signal components in the guard band portions that exist between the consecutive bands, so [data] subcarrier signals...are placed there”), EX.1010, ¶[0026] (“the interval guard may be shortened from 800 ns to 400 ns when a data rate of 140 Mbps is used”). Williams describes inserting repeated data in guard bands, to combat inter-symbol interference. EX.1011, ¶¶ [0006]-[0008].

Both Mori and Lu describe or suggest use of MIMO (spatial diversity) in combination with channel bonding and guard band data subcarriers. EX.1008, ¶[0016] (“a spatial transmission path”); EX.1010, ¶[0026].

Mori and Lu are complementary, with Mori describing channel bonding and gap-filling in detail while Lu describes signaling to ensure compatibility between systems that use MIMO, channel bonding, and gap-filling with those that do not. EX.1004, ¶327.

It would have been routine to add the features of Lu and Williams to the system of Mori. EX.1004, ¶328. A POSITA would have been motivated to combine Mori, Lu, and Williams, with a reasonable expectation of success. *Id.*

B. Mori, Lu, and Williams meet all claim elements.

1. Independent Claims 1, 16, and 18

See §VII(B)(1) regarding overlap of Claims 1, 16, and 18, and interpretation of “means for” and “instructions to.” See §VII(B)(1). and Ex.1012 for full claim language.

[1.0]/[16.0]/[18.0] “Method”/“System”/“Non- transitory computer-readable medium...

To the extent the preambles are limiting, Mori discloses a “method of utilizing a guard band between those unit communication bands for communication [that] increases frequency utilization efficiency and can further enhance the transmission speed of the information signals.” Mori also addresses increasing data rates and data throughput. EX.1008, ¶[0036] (“a transmission system with high channel utilization and frequency utilization efficiency”). Mori discloses “a 256-point IFFT processor performing 64-point IFFT operations simultaneously on four systems” that is necessarily programmable. EX.1008, [0066]; EX.1004, ¶136.

Lu also addresses increasing data rates and data throughput. EX.1010, ¶[0013] (“provide information (e.g., data transfer rate, amount of data) in each wireless data packet”).

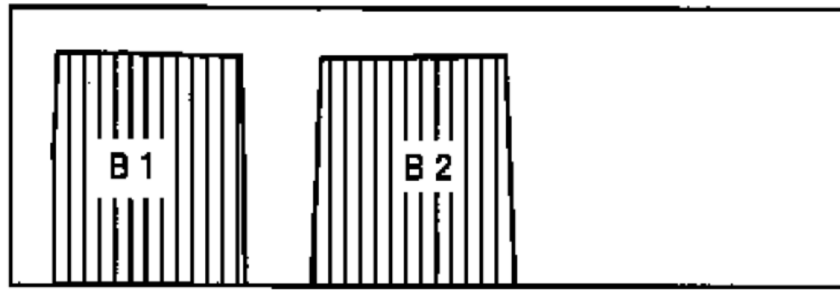
Lu is directed to a “Method and Systems for Multi-Protocol Communication.” EX.1010, Title. Lu discloses devices 102, 110A, and 110B each having transceivers operated according to “one or more fields of a data packet 200 [that] may be added

and/or modified in order to permit the devices 110A, 110B to transmit data to each other according to the second protocol,” or to “permit the devices 110A, 110B to transmit data to the device 102 using the first protocol.” EX.1010, ¶[0022]. The transceivers in devices 102, 110A, and 110B of Lu each comprise a non-transitory computer-readable medium having instructions stored thereon, as that language is apparently interpreted by Patent Owner. EX.1004, ¶336.

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶137.

[1.1]/[16.1]/[18.1] selecting/select at least a first channel and a second channel...adjacent...without any other channels therebetween...have/comprise...a plurality of subcarriers...separated by a frequency gap...

Mori describes “adjacent bands B1 and B2.” EX.1008, Figs.8(c),9(f)-(g), ¶[0121]. A POSITA would understand Fig.9(f) to depict that first channel B1 and second channel B2 are adjacent without any other channels therebetween, that first channel B1 and second channel B2 each have a plurality of data subcarriers,” and that the data subcarriers of channels B1 and B2 are separated by a frequency gap corresponding to an intervening guard band:



Mori, Fig. 9(f)

A POSITA would understand Fig.9(f) to depict that first channel B1 and second channel B2 are adjacent without any other channels therebetween, that first channel B1 and second channel B2 each have a plurality of data subcarriers,” and that the data subcarriers of channels B1 and B2 are separated by a frequency gap corresponding to an intervening guard band. EX.1004, ¶¶144-146.

Lu describes maintaining compatibility between “a first wireless protocol (e.g., 802.11a, 802.11g)” and “a second wireless protocol (e.g., 802.11n).” Ex.1010, [0015]. For the second wireless protocol, Lu describes use of a “channel bonding mechanism [that] may simultaneously transmit data frames over two adjacent channels as if it were a single channel with twice the bandwidth.” Ex.1010, [0026]. The term “adjacent” necessarily precludes any other channels between the two channels to be bonded. A POSITA would be motivated to select Mori’s adjacent channels B1 and B2 “two adjacent channels” as described by Lu. EX.1004, ¶¶144-146.

Because the first and second wireless protocols in Lu are IEEE 802.11-based (having the same channel structure), the channels in Lu each comprise a plurality of subcarriers. EX.1004, ¶346. Lu describes a “guard interval.” Ex.1010, [0026]. That “guard interval” corresponds to a frequency gap (at least one guard band) separating the subcarriers of one channel from the subcarriers of the other channel. EX.1004, ¶346.

See §V.A regarding interpretation of “means for” in claim [16.1] and “instructions to” in claim [18.1]. Mori and Lu disclose “means” for selecting and instructions to select adjacent channels B1 and B2 (Mori’s multi-carrier signal generation device 10 and the programmable 256-point IFFT therein; Lu’s transceivers 112A, 112B, which are necessarily programmable). EX.1004, ¶¶351-354.

Therefore, the combination of Gardner and Mori meets these elements. EX.1004, ¶355.

[1.2]/[16.2]/[18.2] partially filling/fill...the frequency gap...such that the one or more guard bands are at least partially filled with at least some of the one or more data subcarriers...

Mori discloses embodiments that achieve an “increase in transmission rate due to the increase in subcarriers” by “the addition of 10 subcarriers in the guard band area.” Ex.1008, [0125]. Mori graphically depicts “a case where subcarriers are

arranged consecutively in consecutive bands” by “addition of 10 subcarriers in the guard band area” to “increase the number of data carriers by allocating subcarrier data to the guard band between the consecutive bands B1 and B2” to obtain an “increase [in] the number of multi-carriers compared to when guard bands are provided, resulting in a larger transmission rate.” Ex.1008, [0123], [0125], [0128], [0132], see also, EX.1007, Figs. 9(f)-(g).

As discussed above, “using full spectral synthesis capability of a fast Fourier transform or an inverse fast Fourier transform” is satisfied by use of an IFFT on all subcarriers of a channel, including the subcarriers within the frequency gap corresponding to a guard band. Mori discloses that the IFFT circuit 14 may be implemented by “a 256-point IFFT processor performing 64-point IFFT operations simultaneously on four systems.” Ex.1008, [0066]. Each 64-point IFFT operation uses all channel subcarriers, including those within the frequency gap corresponding to a guard band. EX.1004, ¶360. A POSITA would therefore recognize that the 256-point IFFT processor of Fig. 3 in Mori “us[es] full spectral synthesis capability of a fast Fourier transform or an inverse fast Fourier transform” when operating on “adjacent bands B1 and B2” with “10 subcarriers in the guard band area” between channels B1 and B2, as disclosed by Mori. EX.1004, ¶161.

In the context of “a second wireless protocol (e.g., 802.11n),” Lu describes “a channel bonding indicator bit, wherein a ‘1’ value indicates that a channel bonding

mechanism is used” with “one such channel bonding mechanism ... simultaneously transmit[ting] data frames over two adjacent channels as if it were a single channel with twice the bandwidth” and “a shortened guard interval indicator bit, wherein a ‘1’ value [that] indicates a shortened guard interval has been used (e.g., the interval guard may be shortened from 800 ns to 400 ns when a data rate of 140 Mbps is used).” Ex.1010, [0026]. The “shortened guard interval” combined with “when a data rate of 140 [megabits per second (Mbps)]” indicates that guard band subcarriers are used for data. EX.1004, ¶361. Channel bonding and a shortened guard interval are distinct but compatible, suitable for use either separately or together. *Id.*

A POSITA would be motivated to employ channel bonding and a shortened guard interval, each disclosed by Lu, together in order to obtain the known benefits of those distinct techniques. EX.1004, ¶362. In implementing both channel bonding and a shortened guard interval as described by Lu, a POSITA would recognize the channel bonded and gap-filled adjacent bands B1 and B2 of Mori as an example of the two techniques in combination, and would use that approach so that “the area of the guard band may be effectively utilized” as taught by Mori. *Id.* This would be a combination of known elements with predictable results. *Id.*

Mori suggests “adding error correction codes” to guard band subcarriers. EX.1008, ¶[0129]. Williams describes filling the guard band with repeated data, replicated from one end of the data on the remaining subcarriers, to “combat ISI.”

Ex.1011, [0008]. A POSITA would recognize Williams’ repeated data as a form of error correction, and a specific option for Mori’s error correction codes. EX.1004, ¶364.

See §V.A regarding interpretation of “means for” in claim [16.1] and “instructions to” in claim [18.1]. Mori and Lu disclose “means” for (at least) partially filling, and instructions to (at least partially fill), the frequency gap between adjacent channels with data subcarriers (Mori’s multi-carrier signal generation device 10 and the programmable 256-point IFFT therein; Lu’s PHY layer(s) 116A and 116B transmitting channel bonding and shortened guard interval indicators, which are software parameters enabling devices 110A, 110b to send, receive, and interpret data according to the second wireless protocol). EX.1004, ¶¶366-369.

Moreover, to the extent the claim requires partially (as opposed to completely) filling the frequency gap, it would be obvious to a POSITA to modify the teachings of Mori, Lu, and Williams to the extent necessary to satisfy the claim limitation. EX.1004, ¶359.

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶370.

[1.3]/[16.3]/[18.3] combining/combine the first channel and the second channel using channel bonding with...OFDM

“Channel bonding with orthogonal frequency division multiplexing (OFDM)” is satisfied by use of IFFTs operating separately on each channel. EX.1004, ¶168.

Mori describes “the OFDM signals of multiple bands generated by a single IFFT” using “a 256-point IFFT processor performing 64-point IFFT operations simultaneously on four” channels B1 through B2 (“setting the input signal level of the subcarriers for bandwidth B3 to 0” so that “the time-domain signal obtained...will be generated as a multi-carrier transmission signal that has the spectrum of subcarrier signals only in the three bandwidths of B1, B2, and B4”). EX.1008, ¶¶[0066], [0081], [0117]. Mori discloses combining adjacent, gap-filled channels B1 and B2 using channel bonding with OFDM. EX.1004, ¶¶171-172.

Lu describes “a second wireless protocol (e.g., 802.11n)” in which “a channel bonding indicator bit...indicates that a channel bonding mechanism is used” and “a shortened guard interval indicator bit...indicates a shortened guard interval has been used.” EX.1010, ¶[0026]. Lu also explicitly depicts and describes use of OFDM for at least portions of header 302 and header extension 304 for data frames of wireless signals according to the second wireless protocol by the PHY layers 116A, 116B of those devices 110A, 110B. EX.1010, Fig.3, ¶[0024]-[0025]. Lu discloses channel bonding with OFDM. EX.1004, ¶374.

See §V.A regarding interpretation of “means for” in claim [16.3] and “instructions to” in claim [18.3]. Mori discloses “means” for combining, and

instructions to combine, channels B1 and B2 with data subcarriers inserted into the guard band therebetween as disclosed in Mori (Gardner's OFDM modulators 221, 222, optionally "implemented...[as a] combination of hardware and/or software components").

Mori and Lu disclose "means" for combining, and "instructions to" combine, channels B1, B2, and the guard band therebetween filled with data subcarriers (Mori's multi-carrier signal generation device 10 and the programmable 256-point IFFT therein; Lu's PHY layer(s) 116A and 116B transmitting channel bonding and shortened guard interval indicators, which are software parameters enabling devices 110A, 110b to send, receive, and interpret data according to the second wireless protocol). EX.1004, ¶¶174-175,378.

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶379.

[1.4]/[16.4]/[18.4] transmitting/transmit data subcarriers occupying the first channel, the second channel, and the frequency gap in parallel to a receiver

A POSITA would understand "in parallel" to be satisfied by either (a) channel subcarriers that are parallel (non-overlapping) in frequency, or (b) use of spatial diversity (MIMO). EX.1004, ¶177.

Mori describes transmitting data for user C on adjacent channels B1 and B2 with the guard band therebetween filled with data subcarriers using multi-carrier signal generation device 10. Channel B1 and its associated guard band subcarriers and channel B2 and its associated guard band subcarriers are parallel (non-overlapping) in frequency.

Additionally, Lu describes “a second wireless protocol (e.g., 802.11n)” and “MIMO (Multiple Input Multiple Output) indication bit” indicating whether an “antenna configuration” for MIMO is used. EX.1010, ¶¶[0015]-[0018], [0025]-[0026], [0030]. EX.1004, ¶¶383-384. Mori states that “the signal generated by frequency conversion is radiated from an antenna 19 into a spatial transmission path” for “reception of the OFDM signal radiated into the spatial transmission path” by antenna 21. EX.1008, ¶¶[0014]-[0016]. A POSITA would be motivated to employ MIMO, channel bonding, and a shortened guard interval, each disclosed by Lu, together in order to obtain the known benefits of those distinct techniques. EX.1004, ¶385.

When adjacent channels B1 and B2 with data subcarriers inserted into the guard band(s) therebetween, as disclosed in Mori, are combined with MIMO based on Lu, the two OFDM symbols for channels B1 and B2 (and associated guard band region data subcarriers) will be transmitted according to the antenna configuration

corresponding to the MIMO indicator, using the spatial transmission paths for that antenna configuration. EX.1004, ¶386.

Mori and Lu discloses “means for” transmitting, and “instructions to” transmit, the subcarriers for channel B1, the subcarriers for channel B2, and the subcarriers inserted into the associated guard band regions (Mori’s multi-carrier signal generation device 10 and the programmable 256-point IFFT therein; Lu’s PHY layer(s) 116A and 116B transmitting channel bonding and shortened guard interval indicators, which are software parameters enabling devices 110A, 110b to send, receive, and interpret data according to the second wireless protocol). EX.1004, ¶¶174-175,389.

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶379.

2. Claim 2

[2.0]: ...interleaving one of a legacy signal and a wide signal...

See §VII(B)(2) regarding the understanding of a POSITA concerning “legacy signal” and “wide signal,” and the disclosure of Mori satisfying claim [2.0].

Lu describes “interleaving data packet formatting.” EX.1010, ¶[0012]. Lu also teaches that “data packets sent by devices configured according to the second [wireless] protocol” (e.g., 802.11n) are “sent according to parameters that are not supported by the first [wireless] protocol” (e.g., 802.11a, 802.11g). EX,1008,

¶[0003]. Those parameters include a MIMO indicator, a channel bonding indicator, and a shortened guard interval indicator. EX.1010, ¶[0026]. When either channel bonding and a shortened guard interval or MIMO, channel bonding, and a shortened guard interval are used, a POSITA would understand that a “legacy” (802.11a/802.11g) signal sent by a device will be interleaved with a “wide” (802.11n with channel bonding) signal during data packet transmission. EX.1004, ¶394.

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶395.

3. Claim 3

[3.0]: ...legacy signal comprises one channel...wide signal comprises multiple channels

See §VII(B)(3) regarding the disclosure of Mori satisfying claim [3.0].

The first wireless protocol in Lu necessarily uses one channel “legacy” signals, while the second wireless protocol in Lu may use channel bonded, multiple channel “wide” signals. EX.1004, ¶397.

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶398.

4. Claim 4

[4.0]: ...transmitting to multiple radios

See §VII(B)(4) regarding the disclosure of Mori satisfying claim [4.0].

Lu discloses devices 102, 110A, and 110B each having transceivers. EX.1010, Fig. 1. Lu also describes a case in which “devices (e.g., 110A, 110B)...implement the second [wireless] protocol.” EX.1010, ¶[0050]. A POSITA would therefore understand that when either of devices 110A or 110B transmits OFDM symbols using the second wireless protocol with channel bonding, the resulting signal is transmitted to a radio for device 102 and a radio for the other one of devices 110A or 110B, which are in wireless communication. EX.1004, ¶402.

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶407.

5. Claim 5

[5.0]: ...transmitting to a single radio

See §VII(B)(5) regarding the disclosure of Mori satisfying claim [5.0].

Lu discloses device 102, 110A, and 110B each having transceivers. EX.1010, Fig. 1. Lu also describes that “device 102 may implement a first wireless protocol (e.g., 802.11a, 802.11g)” and “devices (e.g., 110A, 110B)...implement the second [wireless] protocol” where “the devices that use the first protocol may communicate with each other using a different (e.g., lower) data transfer rate than the devices that communicate using the second protocol.” EX.1010, ¶¶[0014]-[0015]. A POSITA would therefore understand that when either of devices 110A or 110B transmits OFDM symbols using the second wireless protocol with channel bonding, the

resulting signal is “received by” the other one of devices 110A or 110B and not by device 102. EX.1004, ¶412.

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶414.

6. Claim 6

[6.0]: ...extensible to additional channels

See §VII(B)(6) regarding the disclosure of Mori satisfying claim [6.0].

Lu teaches a single channel bonding indicator bit for bonding two channels, and a single shortened guard [band] indicator bit. A POSITA would recognize that merely extending the single channel bonding indicator bit to two bits would allow indication of channel bonding for zero, two, three, or four consecutive channels. EX.1004, ¶416.

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶419.

7. Claim 7

[7.0]: eliminating synthesizer frequency popping...

See §VII(B)(7) regarding the understanding of a POSITA concerning elimination of synthesizer frequency popping during bandwidth switching, and the disclosure of Mori satisfying claim [7.0].

Therefore, the combination of Mori, Lu, and Williams meets these elements.

EX.1004, ¶423.

8. Claim 8

[8.0]: tuning a first synthesizer to the first channel...

See §VII(B)(8) regarding the disclosure of Mori satisfying claim [8.0].

Therefore, the combination of Mori, Lu, and Williams meets these elements.

EX.1004, ¶426.

[8.1]: tuning a second synthesizer to the second channel...

See §VII(B)(8) regarding the disclosure of Mori satisfying claim [8.1].

Therefore, the combination of Mori, Lu, and Williams meets these elements.

EX.1004, ¶429.

9. Claim 9

[9.0]: channel bonding comprises use of common synthesizers

See §VII(B)(9) regarding the understanding of a POSITA concerning “common,” and the disclosure of Mori satisfying claim [9.0].

Therefore, the combination of Mori, Lu, and Williams meets these elements.

EX.1004, ¶433.

10. Claim 10

[10.0]: ...the plurality of data subcarriers are OFDM subcarriers

See §VII(B)(10) regarding the understanding of a POSITA concerning elimination of synthesizer frequency popping during bandwidth switching, and the disclosure of Mori satisfying claim [10.0].

Lu discloses OFDM symbols transmitted using “a first wireless protocol (e.g., 802.11a, 802.11g)” or “a second wireless protocol (e.g., 802.11n).” EX.1010, Fig. 3, ¶[0015]. A POSITA would understand that OFDM symbols transmitted according to IEEE 802.11a/g each use a plurality of data subcarriers. EX.1004, ¶436.

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶437.

11. Claim 11

[11.0]: identifying additional points in a...FFT...

See §VII(B)(11) regarding the understanding of a POSITA concerning “additional points,” and the disclosure of Mori satisfying claim [11.0].

Therefore, the combination of Mori, Lu, and Williams meets these elements. EX.1004, ¶442.

[11.1]: adding subcarriers to the additional points

See §VII(B)(11) regarding the understanding of a POSITA concerning “additional points,” and the disclosure of Mori satisfying claim [11.1].

Therefore, the combination of Mori, Lu, and Williams meets these elements.

EX.1004, ¶447.

12. Claim 12

[12.0]: ...additional points exist on an outer edge...

See §§VII(B)(11)-(12) regarding the understanding of a POSITA concerning “additional points,” and the disclosure of Mori satisfying claim [12.0].

Therefore, the combination of Mori, Lu, and Williams meets these elements.

EX.1004, ¶452.

13. Claim 13

[13.0]: ...guard band on each edge is filled with data

See §§VIII(B)(12)-(13) regarding the disclosure of Mori satisfying claim [13.0].

Therefore, the combination of Mori, Lu, and Williams meets these elements.

EX.1004, ¶458.

14. Claim 14

[14.0]: utilizing an anti-aliasing technique at a receiver.

See §VII(B)(14) regarding the understanding of a POSITA concerning “anti-aliasing technique,” and the disclosure of Mori satisfying claim [14.0].

Therefore, the combination of Mori, Lu, and Williams meets these elements.

EX.1004, ¶463.

15. Claim 15

[15.0]: ...passing upper signals and lower signals through a first filter and a second filter

See §§VII(B)(14)-(15) regarding the disclosure of Mori satisfying claim [15.0].

Therefore, the combination of Mori, Lu, and Williams meets these elements.
EX.1004, ¶470.

16. Claim 17

[17.0]: wherein the frequency gap is filled with a portion of the first plurality of subcarriers and a portion of the second plurality of subcarriers

See §VII(B)(17) regarding the disclosure of Mori satisfying claim [17.0].

Therefore, the combination of Mori, Lu, and Williams meets these elements.
EX.1004, ¶470.

X. THE BOARD SHOULD INSTITUTE *INTER PARTES* REVIEW

A. The *Fintiv* factors either favor institution or are neutral

Institution should not be denied under *Fintiv* because all factors favor institution or, at the very least, are neutral. Factor 1 is neutral because neither party has requested a stay. *See, e.g., Sand Revolution II, LLC v. Continental Intermodal Grp.-Trucking LLC*, IPR2019-01393, Paper 24 at 7 (P.T.A.B. June 16, 2020) (informative).

Factor 2 is neutral because, although no trial date is yet set in IV's case against American, the schedule jointly submitted to the district court would provide for a trial more than eighteen months after the filing date of this petition. And although trial is set for July 27, 2026 in the case against Southwest, that date often changes. For example, the most recent time-to-trial data show that the median time to trial for jury trials in the Western District of Texas is 34.9 months. Table T-3—U.S. District Courts—Trials Statistical Tables For The Federal Judiciary (December 31, 2024), U.S. Courts, <https://www.uscourts.gov/data-news/data-tables/2024/12/31/statistical-tables-federal-judiciary/t-3> (last visited May 14, 2025). The Board has instituted IPR based on other petitions with similar facts. *Ericsson Inc. v. XR Commc'ns LLC*, IPR2024-00613, Paper 9, 33-34 (Oct. 9, 2024).

Factor 3 favors institution because the parties have expended limited resources in the litigations and Petitioners acted expeditiously—*i.e.*, by filing the petition within seven months of the original complaints and well before the start of the of the claim construction process, in the early stages of fact discovery, and before expert discovery. *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 at 16-17 (P.T.A.B. Dec. 1, 2020) (precedential).

Factor 4 favors institution because Petitioners challenge all claims of the '326 Patent, although IV asserts only a subset in the litigation. EXS.1013, 1014, 1015, 1016. Petitioners also stipulate that, if trial is instituted, Petitioners will not pursue

in the District Court Litigation any ground raised or that could have been reasonably raised in an IPR. *Sotera*, Paper 12 at 18.

Factor 5 favors institution because institution will promote judicial efficiency and integrity by reducing the number of issues to be addressed in the parallel litigations against American and Southwest. *Sand Revolution*, Paper 24 at 12.

Factor 6 favors institution because Petitioners have set forth a strong case of unpatentability. *Sand Revolution*, Paper 24 at 13.

B. An analysis under 35 U.S.C. § 325(d) also favors institution

None of the references in the above grounds were substantively addressed or even cited during prosecution of the '326 Patent, and nothing suggests their teachings relied on herein—much less the combination of those teachings as informed by a POSITA's knowledge and expert testimony—were considered by the Examiner. *Mylan Pharmaceuticals Inc., v. Regeneron Pharmaceuticals, Inc.*, IPR2022-01226, Paper 22 at 27-29 (PTAB Jan. 11, 2023).

XI. CONCLUSION

Claims 1-18 are unpatentable under Pre-AIA §103. Petitioners request cancellation of claims 1-18.

Dated: May 24, 2025

Respectfully submitted,

By: /Keith D. Harden/
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CERTIFICATE OF WORD COUNT UNDER 37 C.F.R. § 42.24(d)

The undersigned certifies that the word count of the foregoing PETITION FOR *INTER PARTES* REVIEW, excluding the table of contents, table of authorities, exhibit list, mandatory notices, certificate of service, certificate of word count, and any appendix of exhibits or claim listing, is 13,916.

Dated: May 24, 2025

/Keith D. Harden/
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CERTIFICATE OF SERVICE

The undersigned certifies that a copy of the foregoing PETITION FOR *INTER PARTES* REVIEW and all exhibits identified herein were served on May 24, 2025 at the following address of record for the subject patent:

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