

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

GENGHISCOMM HOLDINGS LLC,
Patent Owner

Case: IPR2025-00792
U.S. Patent No. 11,381,285

**PETITION FOR *INTER PARTES* REVIEW OF CLAIMS 1, 2, 6, 7, 9-12,
16, 17, 19-22, 26, 27, 29, AND 30 OF U.S. PATENT NO. 11,381,285**

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I.		GROUND'S FOR STANDING.....	1
II.		TECHNICAL OVERVIEW	1
III.		THE ’85 PATENT	6
	A.	Overview of the Patent and Challenged Claims	6
	B.	Prosecution History	7
IV.		EFFECTIVE FILING DATE; POST-AIA.....	9
	A.	The ’07 Application Describes An Invention Requiring Cooperation Among Multiple Wireless Terminals To Send And/OR Receive Communications.....	10
	B.	The Incorporation Of Publications From Other Patent Families Cannot Convert The ’07 Application Into A Different Invention.	13
V.		IDENTIFICATION OF THE CHALLENGE	14
VI.		THE PERSON OF ORDINARY SKILL IN THE ART (“POSITA”).....	15
VII.		CLAIM CONSTRUCTION	16
VIII.		PRIOR ART STATUS OF THE REFERENCES; ANALOGOUS ART	16
	A.	Galda.....	16
	A.	Doufexi.....	19
	B.	Lucent.....	20
	C.	Ma.....	22
	D.	Dowling	23
IX.		DETAILED DISCUSSION.....	24
	A.	Grounds 1 and 2: Claims 1, 7, 9, and 10 are (Ground 1) anticipated by or (Ground 2) obvious over Galda	24
		1. Claim 1	24
		a. [1Pre]: Method for communication in wireless network.....	24
		b. [1A]: encoding data symbols to produce subcarrier values	25
		c. [1B]: modulating subcarrier values onto OFDM subcarriers.....	27

d.	[1C]: producing time-domain waveform.....	29
e.	[1D]: subcarrier values comprise first, second polyphase codes	31
f.	[1E]: interference producing periodic pulse waveforms	35
2.	Claim 2.....	47
3.	Claim 6.....	49
4.	Claim 7.....	50
5.	Claim 10.....	50
B.	Ground 3: Claims 11, 12, 16, 17, 20-22, 26, 27, and 30 would have been obvious over Galda in view of Dowling.....	51
1.	Overview of the combination; motivation to combine; expectation of success.....	51
2.	Claims 11 and 21.....	54
a.	[11Pre], [11A], [11B], [21Pre]: Apparatus, processor, memory, computer program product.....	54
b.	[11Ci], [21A]: encoding data symbols to produce subcarrier values	56
c.	[11Cii], [21B]: modulating subcarrier values onto OFDM subcarriers.....	56
d.	[11Ciii], [21C]: producing time-domain waveform	57
e.	[11Civ], [21D]: subcarrier values comprise first, second polyphase codes	57
f.	[11Cv], [21E]: interference producing periodic pulse waveforms.....	58
3.	Claims 12 and 22.....	58
4.	Claims 16 and 26.....	59
5.	Claims 17, 27	59
6.	Claims 20, 30	59
C.	Ground 4: Claim 9 is obvious over Galda in view of Doufexi;	60
	Ground 5: Claims 19 and 29 are also obvious over Galda in view of Dowling and further in view of Doufexi;	60
	Ground 6: Claim 9 is obvious over Galda in view of Lucent;	60

Ground 7: Claim 19 and 29 are obvious over Galda in view of Dowling and further in view of Lucent;	60
Ground 8: Claim 9 is obvious over Galda in view of Ma;.....	60
Ground 9: Claims 19 and 29 are obvious over Galda in view of Dowling and further in view of Ma.	60
1. Overview of the combinations; motivations to combine; expectation of success.....	60
2. Claim 9	66
3. Claims 19 and 29.....	70
X. DISCRETIONARY DENIAL UNWARRANTED.....	70
A. <i>Fintiv</i> Factors Favor Institution.....	70
1. Petitioner Will Seek a Stay	71
2. Parallel Proceeding Trial Date	71
3. Investment in Parallel Proceeding	73
4. Stipulation Favors Institution.....	73
5. Identity of the Parties	74
6. Merits Heavily Favor Institution.....	74
B. Denial Under §325(d) Unwarranted.....	75
XI. MANDATORY NOTICES	75
A. Real Party-In-Interest	75
B. Related Matters.....	75
C. Lead and Back-Up Counsel.....	77
D. Service	78
XII. FEES	78

LISTING OF CLAIMS

Claim 1. [1Pre] A method for communication by a user device in a wireless network, comprising:

[1A] encoding a set of data symbols with a set of complex-valued codes, to produce a set of subcarrier values;

[1B] modulating the set of subcarrier values onto a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers assigned for use by the user device, to produce a plurality of modulated subcarriers; and

[1C] producing a time-domain waveform that comprises a superposition of the plurality of modulated subcarriers, the time-domain waveform to be transmitted in the wireless network by the user device;

[1D] wherein the set of subcarrier values comprises a first polyphase code that encodes a first of the set of data symbols and at least a second polyphase code that encodes at least a second of the set of data symbols;

[1E] wherein the first polyphase code causes constructive and destructive interference between the plurality of modulated subcarriers to produce a first periodic pulse waveform having a peak value that is centered at a first time in an OFDM symbol interval, and the second polyphase code causes constructive and destructive interference between the plurality of modulated subcarriers to produce a

second periodic pulse waveform having a peak value that is centered at a second time in the OFDM symbol interval, the second time different from the first time.

Claim 2. The method of claim 1, wherein an m^{th} one of the plurality of polyphase codes comprises a set of N code chips, wherein each code chip is expressed by $e^{j2\pi nm/N}$, where i is the square root of -1 , π is Pi, and n is an integer that varies to provide incremental phase offsets to the set of N code chips.

Claim 6. The method of claim 1, wherein the set of subcarrier values comprise a product of a matrix with a vector, wherein the matrix comprises the first polyphase code and the at least second polyphase code and the vector comprises the set of data symbols.

Claim 7. The method of claim 1, further comprising adding a cyclic prefix to the time-domain waveform.

Claim 9. The method of claim 1, wherein modulating comprises selecting one of a set of subcarrier frequency spacings.

Claim 10. The method of claim 1, wherein modulating is configured to provide for orthogonal frequency division multiple access.

Claim 11. [11Pre] An apparatus for communication in a wireless communication network, the apparatus comprising:

[11A] at least one processor; and

[11B] a non-transitory computer-readable memory communicatively coupled

to the at least one processor, the non-transitory computer-readable memory including a set of instructions stored thereon and executable by the at least one processor for:

[11Ci] encoding a set of data symbols with a set of complex-valued codes, to produce a set of subcarrier values;

[11Cii] modulating the set of subcarrier values onto a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers assigned for use by the user device, to produce a plurality of modulated subcarriers; and

[11Ciii] producing a time-domain waveform that comprises a superposition of the plurality of modulated subcarriers, the time-domain waveform to be transmitted in the wireless network by the user device;

[11D] wherein the set of subcarrier values comprises a first polyphase code that encodes a first of the set of data symbols and at least a second polyphase code that encodes at least a second of the set of data symbols;

[11E] wherein the first polyphase code causes constructive and destructive interference between the plurality of modulated subcarriers to produce a first periodic pulse waveform having a peak value that is centered at a first time in an OFDM symbol interval, and the second polyphase code causes constructive and destructive interference between the plurality of modulated subcarriers to produce a second periodic pulse waveform having a peak value that is centered at a second

time in the OFDM symbol interval, the second time different from the first time.

Claim 12. The apparatus of claim 11, wherein an m^{th} one of the plurality of polyphase codes comprises a set of N code chips, wherein each code chip is expressed by $e^{j2\pi nm/N}$, where i is the square root of -1 , π is Pi, and n is an integer that varies to provide incremental phase offsets to the set of N code chips.

Claim 16. The apparatus of claim 11, wherein the set of subcarrier values comprise a product of a matrix with a vector, wherein the matrix comprises the first polyphase code and the at least second polyphase code and the vector comprises the set of data symbols.

Claim 17. The apparatus of claim 11, further comprising adding a cyclic prefix to the time-domain waveform.

Claim 19. The apparatus of claim 11, wherein modulating comprises selecting one of a set of subcarrier frequency spacings.

Claim 20. The apparatus of claim 11, wherein modulating is configured to provide for orthogonal frequency division multiple access.

Claim 21. [21Pre] A computer program product for communication in a wireless communication network, the computer program product comprising a non-transitory computer readable storage device having computer readable program code stored therein, said program code containing instructions executable by one or more processors of a computer system for

[21A] encoding a set of data symbols with a set of complex-valued codes, to produce a set of subcarrier values;

[21B] modulating the set of subcarrier values onto a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers assigned for use by the user device, to produce a plurality of modulated subcarriers; and

[21C] producing a time-domain waveform that comprises a superposition of the plurality of modulated subcarriers, the time-domain waveform to be transmitted in the wireless network by the user device;

[21D] wherein the set of subcarrier values comprises a first polyphase code that encodes a first of the set of data symbols and at least a second polyphase code that encodes at least a second of the set of data symbols;

[21E] wherein the first polyphase code causes constructive and destructive interference between the plurality of modulated subcarriers to produce a first periodic pulse waveform having a peak value that is centered at a first time in an OFDM symbol interval, and the second polyphase code causes constructive and destructive interference between the plurality of modulated subcarriers to produce a second periodic pulse waveform having a peak value that is centered at a second time in the OFDM symbol interval, the second time different from the first time.

Claim 22. The computer program product of claim 21, wherein an m^{th} one of the plurality of polyphase codes comprises a set of N code chips corresponding to a set

of integers $n=\{0, \dots, N-1\}$, wherein each code chip is expressed by $e^{i2\pi nm/N}$, where i is the square root of -1 , and π is Pi.

Claim 26. The computer program product of claim 21, wherein the set of subcarrier values comprise a product of a matrix with a vector, wherein the matrix comprises the first polyphase code and the at least second polyphase code and the vector comprises the set of data symbols.

Claim 27. The computer program product of claim 21, further comprising adding a cyclic prefix to the time-domain waveform.

Claim 29. The computer program product of claim 21, wherein modulating comprises selecting one of a set of subcarrier frequency spacings.

Claim 30. The computer program product of claim 21, wherein modulating is configured to provide for orthogonal frequency division multiple access.

PETITIONER’S EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 11,381,285 (“’285 Patent”)
1002	Declaration of Harry Bims, Ph.D.
1003	Angela Doufexi, et al., <i>Design Considerations and Initial Physical Layer Performance Results for a Space Time Coded OFDM 4G Cellular Network</i> , In The 13th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (Vol. 1, pp. 192-196). IEEE (Sept. 18, 2002) (“Doufexi”)
1004	Dirk Galda & Hermann Rohling, <i>A Low Complexity Transmitter Structure for OFDM-FDMA Uplink Systems</i> , Vehicular Technology Conference. IEEE 55 th Vehicular Technology Conference, vol. 4, pp.1737-1741 (May 6, 2002) (“Galda”)
1005	RESERVED
1006	Lucent Technologies, <i>Proposed Baseline OFDM Systems for Study</i> , 3GPP TSG-RAN1 #28 bis, R1-02-01246 (Oct. 8-9, 2002) (“Lucent”)
1007	Andres Bury & Jurgen Linder, <i>Comparison of Amplitude Distributions for Hadamard Spreading and Fourier Spreading in Multi-Carrier Code Division Multiplexing</i> , Globecom ’00-IEEE. Global Telecommunications Conference, Vol. 2, pp.857-860 (Nov. 27, 2000) (“Bury”)
1008	Kwang-Cheng Chen, et al., <i>A Programmable Architecture for OFDM-CDMA</i> , IEEE Communications Magazine, pp.76-82 (Nov. 1999) (“Chen”)
1009	José Francia, <i>Proposal for an OFDM-based 802.16.3 Air Interface Physical Layer</i> , IEEE 802.16.3c-00/44 (Oct. 30, 2000)
1010	John Langley, <i>PHY Layer System Proposal for Sub 11 GHz BWA Having SC-FDE and OFDM Modules</i> , IEEE802.16.3c-01/31r2

Exhibit No.	Description
	(Mar. 12, 2001)
1011	U.S. Patent Application Publication No. 2003/0081538 to Walton et al.
1012	Declaration of Sylvia Hall-Ellis, Ph.D.
1013	Hermann Rohling, et al., <i>Broad-Band OFDM Radio Transmission for Multimedia Applications</i> , Proceedings of the IEEE, Vol. 87, No. 10, Oct. 1999 (“Rohling”)
1014	Stephen B. Weinstein, <i>The History of Orthogonal Frequency-Division Multiplexing</i> , IEEE Communications Magazine, pp.26-35 (Nov. 2009)
1015	Richard van Nee & Ramjee Prasad, <i>OFDM for Wireless Multimedia Communications</i> (Artech House 2000)
1016	Karsten Bruninghaus & Herman Rohling, <i>Multi-carrier spread spectrum and its relationship to single-carrier transmission</i> , Vehicular Technology Conference. IEEE 48 th Vehicular Technology Conference, vol. 3, pp.2329-2332 (May 18-21, 1998) (“Brüninghaus”)
1017	File History of U.S. Patent Application No. 17/105,574 as obtained from Patent Center
1018	RESERVED
1019	File History of U.S. Patent Application No. 14/967,633 as obtained from Patent Center (excerpts)
1020	RESERVED
1021	File History of U.S. Patent Application No. 11/187,107 as obtained from Patent Center (excerpts)
1022	File History of Provisional No. 60/589,187
1023	File History of U.S. Patent Application No. 10/145,854 as

Exhibit No.	Description
	obtained from Patent Center (excerpts)
1024	RESERVED
1025	RESERVED
1026	RESERVED
1027	RESERVED
1028	RESERVED
1029	RESERVED
1030	File History of U.S. Patent Application No. 14/727,769 as obtained from Patent Center (excerpts)
1031	File History of U.S. Patent Application No. 14/276,309 as obtained from Patent Center (excerpts)
1032	File History of U.S. Patent Application No. 12/545,572 as obtained from Patent Center (excerpts)
1033	U.S. Patent Application Publication No. 2015/0256308 to Ma et al. (“Ma”)
1034	Declaration of Craig Bishop
1035	RESERVED
1036	RESERVED
1037	RESERVED
1038	3GPP TS 36.211 V8.8.0 (2009-09) 3 rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation (Release 8)
1039	Exhibit 1 to Plaintiff’s P.R. 3-1(c) Infringement Contentions

Exhibit No.	Description
	(U.S. Pat. No. 9,768,842)
1040	RESERVED
1041	RESERVED
1042	U.S. Patent No. 6,597,745 to Dowling
1043	RESERVED
1044	RESERVED
1045	RESERVED
1046	Docket Control Order, <i>Genghiscomm Holdings, LLC v. Samsung Elecs., Am., Inc.</i> , No. 2:24-cv-0242-RWS-RSP, Dkt. 25 (Sept. 24, 2024)
1047	Complaint, <i>Genghiscomm Holdings, LLC v. Samsung Elecs., Am., Inc.</i> , No. 2:24-cv-0242-RWS-RSP, Dkt. 1 (Apr. 12, 2024)
1048	RESERVED
1049	Interview Agenda from U.S. Patent Application No. 16/194,290 (obtained from Patent Center)
1050	RESERVED
1051	RESERVED
1052	RESERVED
1053	RESERVED
1054	RESERVED
1055	RESERVED
1056	RESERVED
1057	RESERVED

Exhibit No.	Description
1058	RESERVED
1059	Declaration of Gary Swatzell including Exhibits A-D
1060	Guidance on USPTO’s recission of “Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation” (Mar. 24, 2025).
1061	Docket Control Order, <i>Slyde Analytics LLC v. Apple Inc.</i> , No. 2:24-cv-00331-RWS-RSP, Dkt. 46 (E.D. Tex. Sept. 23, 2024)
1062	Docket Control Order, <i>Innomemory, LLC v. Truis Financial Corp.</i> , No. 2:24-cv-00146-RWS-RSP, Dkt. 38 (E.D. Tex. Sept. 24, 2024)
1063	Docket Control Order, <i>Husky Injection Molding Systems Ltd. V. Ningbo Ao Sheng Mold Co., Ltd. D/B/A Aosimi</i> , No. 2:24-cv-00348-RWS-RSP, Dkt. 46 (E.D. Tex. Oct. 21, 2024)
1064	Docket Sheet for <i>Partec Ag, et al v. Microsoft Corporation</i> , No. 2:24-cv-00433 (downloaded Mar. 25, 2025).
1065	Combined asserted patents in <i>Genghiscomm Holdings, LLC v. Samsung Elecs., Am., Inc.</i> , No. 2:24-cv-0242-RWS-RSP, Dkt. 25 (Sept. 24, 2024).
1066	File History of U.S. Patent Application No. 16/796,888 as obtained from Patent Center (excerpts).
1067	File History of U.S. Patent Application No. 16/199,221 as obtained from Patent Center (excerpts).
1068	File History of U.S. Patent Application No. 16/027,191 as obtained from Patent Center (excerpts).
1069	File History of U.S. Patent Application No. 15/642,850 as obtained from Patent Center (excerpts).
1070	RESERVED

Exhibit No.	Description
1071	RESERVED
1072	RESERVED
1073	RESERVED
1074	Exhibit 4 to Plaintiff's P.R. 3-1(c) Infringement Contentions (U.S. Pat. No. 11,075,786)
1075	RESERVED
1076	RESERVED
1077	RESERVED
1078	RESERVED
1079	RESERVED
1080	RESERVED
1081	RESERVED
1082	RESERVED
1083	RESERVED
1084	RESERVED
1085	RESERVED
1086	RESERVED
1087	Exhibit 6 to Plaintiff's P.R. 3-1(c) Infringement Contentions (U.S. Pat. No. 11,252,005)
1088	RESERVED
1089	Exhibit 7 to Plaintiff's P.R. 3-1(c) Infringement Contentions (U.S. Pat. No. 11,381,285)

Exhibit No.	Description
1090	RESERVED
1091	RESERVED
1092	RESERVED
1093	RESERVED
1094	RESERVED
1095	RESERVED
1096	Results of Docket Navigator Search for '285 Patent

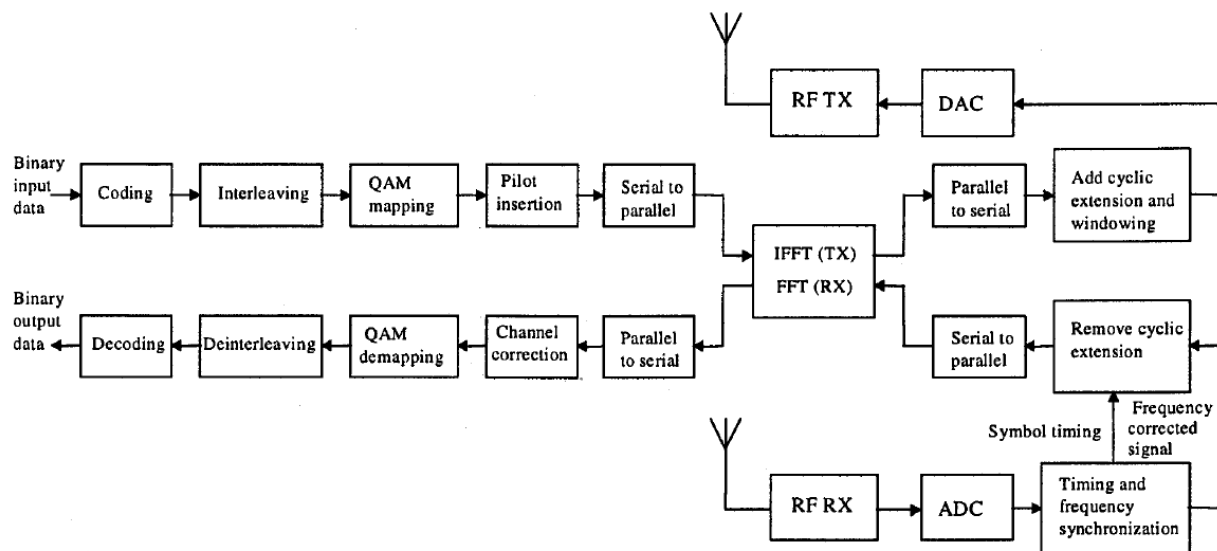
I. GROUNDS FOR STANDING

Petitioner has standing to bring this challenge because neither it nor any privy or real party-in-interest was served with a Complaint more than one year before the filing of this Petition and it is not estopped from bringing this challenge.

II. TECHNICAL OVERVIEW

The Challenged Patent relates to processes for use in orthogonal frequency division multiplexing (“OFDM”) wireless communications. OFDM has been studied for more than 50 years. EX1014, pp.26-28; EX1015, pp.20-24.

A textbook example of an OFDM transceiver is shown below.



EX1015, p.48. An OFDM signal is formed at the transmitter using an inverse Fourier transform, typically implemented using an inverse fast Fourier transform (“IFFT”).

Id., pp.42, 47-48. A guard interval including a cyclic prefix is added to minimize intersymbol interference (“ISI”) and intercarrier interference (“ICI”). Id., pp.39-40.

OFDM systems can exhibit high peak-to-average power ratios (“PAPR” or “PAR”). EX1013, p.1780; EX1014, pp.31-32. The Challenged Patent reduces PAPR in OFDM systems by spreading input data using complex-valued codes called “CI codes” or “orthogonal polyphase CI codes.” EX1001, 56:2-7, 68:3-7. Reducing PAPR in OFDM using complex-valued DFT spreading codes was not new. Various publications described using DFT spreading codes to reduce PAPR in OFDM systems before the earliest claimed effective filing date. For example, a 1998 article by Brüninghaus observes that when an “FFT matrix” is used “as a spreading matrix for OFDM-CDM” signals, this “leads to a single-carrier system with guard interval.” EX1016, p.2332. A 2000 article by Bury explains that “Fourier spreading” can be “implemented by a discrete Fourier transform (DFT) operation” and the resulting transmission can have a “much lower” PAPR. EX1007, p.857. A 2002 article by Galda “shows how an OFDM-FDMA uplink system can be combined with a user data spreading technique based on the DFT spreading matrix to reduce the PAR of the uplink signal without increasing the computational complexity of the transmitter.” EX1004, p.1738.

Additionally, a POSTIA knew using variable subcarrier allocations and spacing assignments to provide for more control over uplink communications was

being considered. For instance, various documents submitted to the IEEE for WiMax show variable subcarrier spacings were being considered:

Table 5: Example of numerical values for the OFDM parameters

RF Channel (MHz)	B	7	6	5	3,5	3	1,75
Sampling rate 1/T (MHz)	B	7	6	5	3,5	3	1,75
FFT size N	64	64	64	64	64	64	64
Subcarrier spacing f_c (KHz)	B/64	109,375	93,75	78,125	54,688	46,875	27,344
FFT time T_c (μ s)	64 x T	9,143	10,667	12,800	18,286	21,333	36,571
Cyclic prefix time T_p (μ s)	16 x T	2,286	2,667	3,200	4,571	5,333	9,143
Symbol duration T_s (μ s)	80 x T	11,429	13,333	16,000	22,857	26,667	45,714
Symbol rate f_s (Ksym/s)	1 / T_s	87,500	75,000	62,500	43,750	37,500	21,875
Number of data subcarriers	48	48	48	48	48	48	48
Number of pilot subcarriers	4	4	4	4	4	4	4
Total number of subcarriers	52	52	52	52	52	52	52
Occupied BW (KHz)	53 x f_c	5797	4969	4141	2898	2484	1449

EX1009, p.11.

The tables below show another WiMAX proposal in which the base station chooses a FFT size depending on the nature of the traffic (Table 3.5), and the DFT size results in changes to the “OFDM subcarrier spacing” calculated as the sampling rate divided by the FFT size (Table 3.6), thus providing the subcarrier spacings shown in Table 3.7.

Selection Level	Parameter	Symbol	Set of Values
System-Dependent Parameters	Channel Width (MHz)	W	1.75, 3.5, 7, 14, 1.5, 3, 6, 12
	Design Maximum Delay Spread (μsec)	d	4, 10, 20
	Spectral Guard Factor	γ	0.18, 0.25
	Sample Rate (MSam/sec)	R	See Tables 2.1, 2.2
	Number of Pilot Tones	L	[Note 1]
	Number of Guard Tones	G	[Depends on adjacent channel constraints (Note 2)]
Link-Dependent Parameters	Number of QAM States	M	4, 16, 64
	Code Rate	r	1/2, 2/3, 3/4, 7/8
Traffic-Dependent Parameter	FFT Size	N	256, 512, 1024, 2048

Table 3.5 Parameters and Values Defining Operating Modes for MC Systems

Dependent Parameter	Symbol	Formula	Note
Number of Samples in Cyclic Prefix+Postfix	C	$2 \bullet R \bullet d$	2.
Number of Payload Subcarriers	P	$N - G - L$	
Frequency Spacing of Available Channel Estimates Measurable In One Block	e	W / L	
OFDM Symbol Period	S	$(N + C - w) / R$	
OFDM Subcarrier Spacing	s	R / N	3.

Table 3.6 Guidelines for Subsidiary Parameters In MC Systems

FFT Size N	Sample Rate R (MSam/sec)	Subcarrier Spacing (Hz)
256	1.25	4882.813
	1.5	5859.375
	2.5	9765.625
	3	11718.750
	5	19531.250
	6	23437.500
512	10	39062.500
	12	46875.000
	1.25	2441.406
	1.5	2929.688
	2.5	4882.813
	3	5859.375
1024	5	9765.625
	6	11718.750
	10	19531.250
	12	23437.500
	1.25	1220.703
	1.5	1464.844
2048	2.5	2441.406
	3	2929.688
	5	4882.813
	6	5859.375
	10	9765.625
	12	11718.750
	1.25	610.352
	1.5	732.422
	2.5	1220.703
	3	1464.844
	5	2441.406
	6	2929.688
	10	4882.813
	12	5859.375

Table 3.7 Subcarrier Spacing in MC Mode

EX1010, pp.17-19 (describing “Traffic-Dependent Parameters”). Adjusting transmission parameters “greatly increases the efficiency of spectrum utilization.” *Id.*, p.17.

Selecting subcarrier spacing was also being proposed for the nascent LTE standard by 2002. For example, Doufexi describes “key link parameters of OFDM for a potential 4G cellular standard” including “subchannel spacing.” EX1003, p.1. But, because 4G systems “will be deployed in a wide range of environments, a fixed set of parameters is not capable of achieving high performance in all cases.” *Id.*

Therefore, Doufexi proposes “dynamically adapting one or more of the” parameters and provides an example of a system with selectable subcarrier spacings:

Table 2. OFDM Parameters for 4G.

Parameter	Value 1	Value 2
Operating Frequency	2GHz	2GHz
Bandwidth (B)	4096 kHz	4096 kHz
Useful Symbol Duration (T)	62.5 μ s	125 μ s
Guard Interval Duration (T_g)	15.625 μ s ($T/4$)	31.25 μ s ($T/4$)
Total Symbol Duration (T_{symbol})	78.125 μ s (with $GI = T/4$)	156.25 μ s (with $GI = T/4$)
Inner Channel Coding	Punctured 1/2 rate convolution code, Constraint length 7, {133, 171} _{octal}	Punctured 1/2 rate convolution code, Constraint length 7, {133, 171} _{octal}
FFT Size	256	512
Number of data sub-carriers (N_D)	216	432
Sub-carrier spacing (Δf)	16 kHz	8 kHz

EX1003, pp.1-2. An LTE standards submission from Lucent similarly proposed the following parameters for a baseline OFDM system for consideration by 3GPP:

System Parameters	Configuration 1	Configuration 2	Configuration 3
Suitable deployment environment	Indoor, Pedestrian A	Vehicular A	Pedestrian B
Symbol per 0.67 msec time slot	12	6	3
Number of FFT points	256	512	1024
Number of sub-carriers	256	512	1024
OFDM Symbol period (usec)	55.6	111	222
Sub-carrier spacing (kHz)	19.2	9.6	4.8
Guard band on each side of the 5MHz band (kHz)	42.4	42.4	42.4
Sampling period (usec)	0.20345025	0.20345025	0.20345025
Guard time $T_g = T_{prefix} + T_{postfix}$ (samples/usec)	17/3.46	34/6.92	68/13.8
Cyclic prefix length (samples/usec)	5/1.017252604	16/3.255204	50/10.17252604
Power amplifier ramp-up and ramp-down period (samples)	6 samples each	9 samples each	9 samples each

Table 4. Parameters for baseline OFDM systems

EX1006, p.5. Thus, tailoring the number of subcarriers and their spacing to suit different environments and traffic loads was known to a POSA. EX1002, ¶¶52-58.

III. THE '285 PATENT

A. Overview of the Patent and Challenged Claims

The '285 Patent's specification was overhauled by amendment to describe material found in two applications that were supposedly incorporated by reference into the earlier-field applications. EX1017, pp.25-27, 88-122, 125-139, 152. The newly added material relates to “a multicarrier protocol that controls interference relationships between the carriers,” thus enabling “lower PAPR.” EX1001, 48:37-41. “[S]ubcarrier frequencies are selected to provide” some “predetermined response” and then “[p]olyphase codes are applied to each subcarrier” to control “the time-domain characteristics of the superposition signal, as well as provide for orthogonality between data symbols and/or users.” EX1001, 48:42-46.

FIG. 29B shows CI subcarrier weights (w_1 to w_N) generated from data symbols d_1 to d_N , where the CI polyphase codes “resemble the vectors of complex values used in DFTs ...” EX1001, 68:8-25.

	$d_1 ()$	$d_2 ()$	$d_3 ()$	$d_N ()$
$w_1 = \sum ():$	$e^{i2\pi(0)(0)/(N)}$	$e^{i2\pi(1)(0)/(N)}$	$e^{i2\pi(2)(0)/(N)}$	$e^{i2\pi(N-1)(0)/(N)}$
$w_2 = \sum ():$	$e^{i2\pi(0)(1)/(N)}$	$e^{i2\pi(1)(1)/(N)}$	$e^{i2\pi(2)(1)/(N)}$	$e^{i2\pi(N-1)(1)/(N)}$
$w_3 = \sum ():$	$e^{i2\pi(0)(2)/(N)}$	$e^{i2\pi(1)(2)/(N)}$	$e^{i2\pi(2)(2)/(N)}$	$e^{i2\pi(N-1)(2)/(N)}$
		$\vdots$		
$w_N = \sum ():$	$e^{i2\pi(0)(N-1)/(N)}$	$e^{i2\pi(1)(N-1)/(N)}$	$e^{i2\pi(2)(N-1)/(N)}$	$e^{i2\pi(N-1)(N-1)/(N)}$

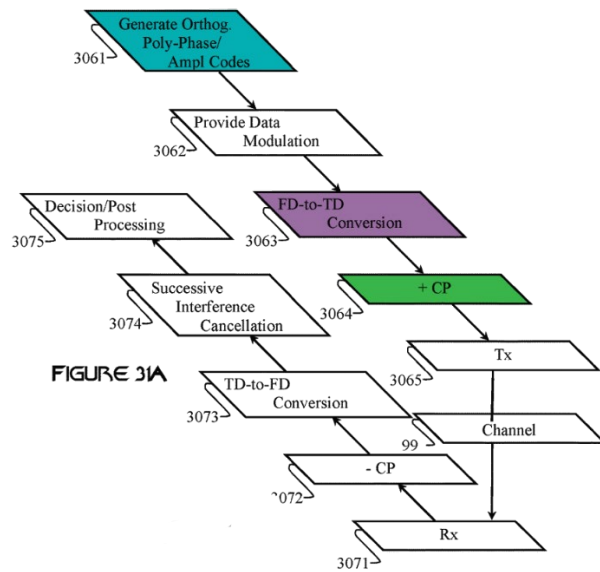
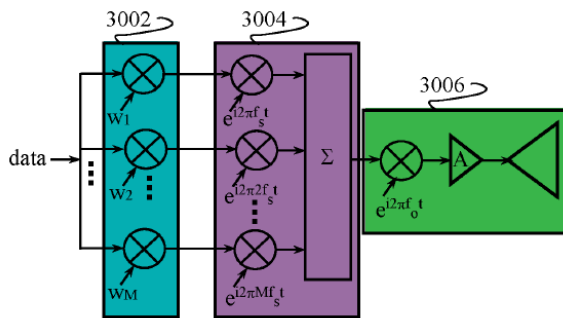
2951

2953

EX1001, FIG. 29B.

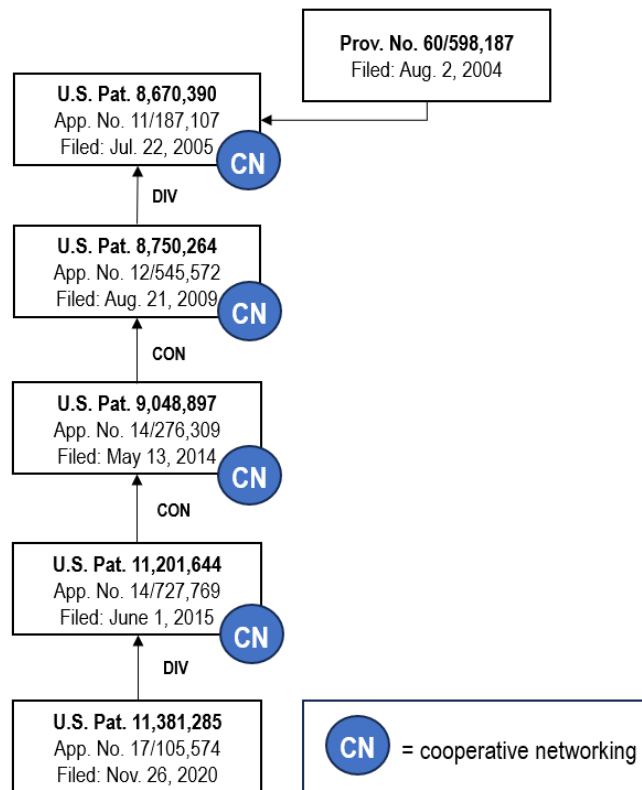
An exemplary transmitter is shown in FIG. 30A in which a “weighting module 3002” can apply “polyphase values,” the “weights are converted to at least one time-domain waveform in a frequency-domain to time-domain converter 3004” (e.g., an IFT), and “transmission system 3006” can provide a “guard interval or cyclic prefix,” among other things to couple the signal to the communication channel.

EX1001, 68:26-45. FIG. 31A illustrates a corresponding process flow.



B. Prosecution History

The '285 Application claims the benefit of an effective filing date through a chain of applications leading back to U.S. Provisional Application No. 60/598,187. The '285 Patent family is illustrated below.



'285 Pat. Related U.S. Application Data

The application leading to the '285 Patent was allowed on first Office Action. EX1017, pp.2-3. The Application was examined under post-AIA law. *Id.*, p.2. No prior art was applied and the reasons for allowance parroted most of the independent claims. EX1017, p. None of the grounds presented herein were applied against the claims or addressed by the Examiner.

The prosecution histories of the parents to the '285 Patent are of no relevance because the claims are directed to different techniques involving cooperative networking among multiple wireless terminals. EX1021, p.76 (claiming “cooperative beam-forming in the at least one group of wireless terminals”);

EX1030, p.3 (claiming “selecting a plurality of nodes in an array-processing network”); EX1031, p.3 (claiming a “cooperative [MIMO] system for communicating with a plurality of wireless terminals”); EX1032, p.2 (claiming “a plurality of the mobile wireless terminals to perform cooperative subspace processing”).

IV. EFFECTIVE FILING DATE; POST-AIA

The '285 Patent is not entitled to an effective filing date of any earlier than November 26, 2020 because that was when new embodiments were added into the specification and the claims diverged from the cooperative networking techniques disclosed in the earlier-filed applications. Patent Owner was not required to prove entitlement to an earlier effective filing date during prosecution. *Supra* §III. “[C]laims in a patent or patent application are not entitled to priority under § 120 at least until the patent owner proves entitlement to the” Board. *Nat. Alts. Int’l, Inc. v. Iancu*, 904 F.3d 1375, 1380 (Fed. Cir. 2018); *Inari Agriculture, Inc. v. Corteva Agriscience LLC*, IPR2024-01014, Paper 15 (Dec. 16, 2024) (Petitioner must persuade the Board only after “a Patent Owner presents argument and evidence that the challenged claims are entitled to [an earlier] priority date.”).

A. The '107 Application Describes An Invention Requiring Cooperation Among Multiple Wireless Terminals To Send And/Or Receive Communications.

The '107 Application describes cooperative networking techniques.¹ To be entitled to the effective filing date of the '107 Application that application must describe the subject matter of the claims of the application seeking the benefit of an earlier effective filing date. *See Lockwood v. Am. Airlines, Inc.*, 107 F.3d 1565, 1571 (Fed. Cir. 1997) (“[E]ach application in the chain leading back to the earlier application must comply with the written description requirement of 35 U.S.C. § 112.”); 35 U.S.C. § 120 (requiring the claimed invention be “disclosed . . . in an application previously filed”).

Here, the '107 Application fails to describe the subject matter claimed in the '285 Patent. Claim 1 of the '285 Patent claims a method including “modulating ... subcarrier values onto [OFDM] subcarriers assigned for use by the user device,” and then “producing a time-domain waveform to be transmitted in the wireless network by the user device,” and “encoding” to produce “subcarrier values” that include “first” and “second” polyphase codes that produce two “periodic pulse waveform[s]”

¹ The '187 Provisional has substantially the same description as the '107 Application. EX1022. And each application identified with “CN” above has substantially the same specification as the '107 Application.

with peak values at different times in different OFDM symbol intervals. EX1001, 72:47-73:6. The apparatus and “computer program product” claims include essentially the same limitations. *Id.*, 73:42-74:8, 74:45-75:7. These features are not described in the ’107 Application.

Independent claims 1, 11, and 21 require “a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers assigned for use by the user device.” EX1001, cls. 1, 11, and 21. Claims 9, 19, and 31 further require: “wherein modulating comprises selecting one of a set of subcarrier frequency spacings.” *Id.*, cls. 9, 19, and 31. These features are not described in the ’107 Application. EX1002, ¶64.

Using the ’769 Application as exemplary,² these features are not described in the ’769 Application. While the ’769 Application describes dividing a “WWAN transmission ... into spectral components (such as denoted by f_1 , f_2 , and f_3 by the WLAN group,” and the WTs “maybe adapted to transmit one or more associated

² For the purposes of this analysis, the ’309, ’572, and ’107 Applications have no relevant distinctions in their disclosures. The disclosures from the ’187 Provisional through the ’769 Application were expanded over time to describe additional aspects of the cooperative networking techniques, but not in respects relevant to Petitioner’s arguments.

predetermined spectral components to the WWAN node,” these spectral components are not described as being subcarriers that are “selected” or “assigned for use by a user device.” EX1030, p.247; EX1002, ¶65. Subcarrier spacings are not even mentioned. Nor is technique for selecting subcarrier spacings when selecting subcarriers.

Moreover, the ’769 Application describes a different invention than the one being claimed now. That application was titled “Cooperative Wireless Networks.” EX1030, p.233. Its field is “providing cooperative signal processing between a plurality of wireless terminal devices.” EX1030, p.234. The Abstract describes “a cooperative multi-user multiple input, multiple output (MIMO) antenna array,” EX1030, p.311, and all its claims require “a plurality of geographically distributed wireless terminals,” *id.*, pp.304, 305, 308. The ’769 Application purports to address a problem that “power, cost, and size constraints typically make the implementation of antenna arrays on mobile wireless terminals ... impractical.” *Id.*, pp.235. The invention coordinated among multiple wireless terminals to make them operate as if they were a single antenna array. *Id.*, p.236. Indeed, the embodiments are consistent in that they utilize multiple WTs operating together to transmit or receive signals. EX1002, ¶¶66-67. The claims of the ’285 Patent, however, are directed to methods, apparatus, and computer-readable media for transmitters that do not depend in any way on other transmitters. EX1002, ¶68. Therefore, they are directed to different

subject matter than the '769 Application.

Therefore, the effective filing date of the '285 Patent is no earlier than November 26, 2020 when the application for the '285 Patent was filed as a “divisional” of the '769 Application.

B. The Incorporation Of Publications From Other Patent Families Cannot Convert The '107 Application Into A Different Invention.

The '107 Application describes a different invention than the one being claimed now. That application was titled “Cooperative Beam-Forming in Wireless Networks.” EX1021, p.7. Its field was “providing cooperative signal processing between a plurality of wireless devices.” EX1021, p.7. The Abstract describes “a cooperative array of wireless terminals,” EX1021, p.82, and all of its claims required “multiple wireless terminals,” *id.*, pp.76-77. The '107 Application purports to address a problem that “power, cost, and size constraints typically make the implementation of antenna arrays on mobile wireless terminals ... impractical.” *Id.*, pp.9, 16-17. The invention coordinated among multiple wireless terminals to make them operate as if they were a single antenna array. *Id.*, p.16. Indeed, the embodiments are consistent in that they utilize multiple WTs operating together to transmit or receive signals. EX1002, ¶¶59-68. The claims of the '285 Patent, however, are directed to a transmitter (or transmission method or computer-readable

medium) that does not depend in any way on other transmitters. *Id.* Therefore, they are directed to different subject matter than the '107 Application.

Insofar as Patent Owner attempts to rely on the patent application publications incorporated by reference into the disclosure, *see* EX1021, p.49, these applications describe different inventions and are found in a different patent family. Patent Owner's reliance on incorporation by reference would have the Board convert the invention of the '107 Application into the invention disclosed in those other applications. This is improper. *See, e.g., Modine Mfg. Co. v. U.S. Int'l Trade Comm'n*, 75 F.3d 1545, 1553 (Fed. Cir. 1996) (“[I]ncorporation by reference does not convert the invention of the incorporated patent into the invention of the host patent.”).

Because the effective filing date of the '285 Patent is no earlier than November 26, 2020, the '285 Patent should be evaluated under post-AIA law. This issue is relevant only to grounds that rely on the Ma reference as prior art.

V. IDENTIFICATION OF THE CHALLENGE

Petitioner challenges the following claims on the following grounds:

Ground	Claims	Challenge	Statute
1	1, 2, 6, 7, 10	Anticipation by Galda	Post-AIA §102(a)(1) or Pre-AIA §102(b)

Ground	Claims	Challenge	Statute
2	1, 2, 6, 7, 10	Obviousness over Galda	Post- or Pre-AIA §103
3	11, 12, 16, 17, 20-22, 26, 27, 30	Obviousness over Galda in view of Dowling	Post- or Pre-AIA §103
4	9	Obviousness over Galda in view of Doufexi	Post- or Pre-AIA §103
5	19, 29	Obviousness over Galda and Dowling and further in view of Doufexi	Post- or Pre-AIA §103
6	9	Obviousness over Galda in view of Lucent	Post- or Pre-AIA §103
7	19, 29	Obviousness over Galda and Dowling and further in view of Lucent	Post- or Pre-AIA §103
8	9	Obviousness over Galda in view of Ma	Post-AIA §103
9	19, 29	Obviousness over Galda and Dowling and further in view of Ma	Post-AIA §103

VI. THE PERSON OF ORDINARY SKILL IN THE ART (“POSITA”)

Based on the '285 Patent, the prior art and other documentation cited herein, and on Dr. Bims’s testimony a POSITA as of the earliest claimed effective filing date of August 2, 2004 would have had “either a Master’s degree in electrical engineering or a related field, or a Bachelor’s degree in electrical engineering or a

related field with three years of experience in wireless communication systems, signal processing, and related technologies.” EX1002, ¶¶70-72. A POSITA would have known that DFT spreading would reduce PAPR in OFDM systems and would have been familiar with hardware and software implementations of mobile device transmitters. *Id.*

VII. CLAIM CONSTRUCTION

Petitioner submits that no formal claim constructions are necessary because “claim terms need only be construed to the extent necessary to resolve the controversy.” *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011). Petitioner reserves the right to respond to any constructions offered by Patent Owner or adopted by the Board.

VIII. PRIOR ART STATUS OF THE REFERENCES; ANALOGOUS ART

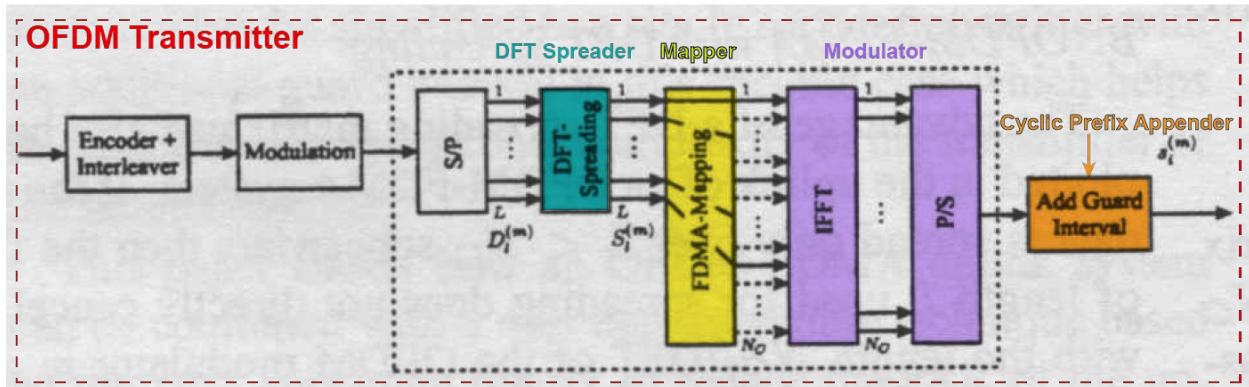
Each reference discussed below and relied upon in the challenges is analogous prior art and in the same field of endeavor as the '285 Patent. EX1002-Bims, ¶¶75-99.

A. Galda

Galda is a prior art printed publication because it was distributed and thus accessible to those skilled in the art between May 6th to 9th on CD ROM to as many as 400 attendees at IEEE's 55th Vehicular Technology Conference in Birmingham,

Alabama. EX1059, ¶¶4-10. The “main focus” of the conference was “voice and data wireless mobile communications,” *Id.*, ¶6, and there were more than 100 presenters skilled in the field at the conference. *Id.* CD ROMs were given to attendees when they checked in for the conference and included as part of the conference registration fee. *Id.*, ¶¶7-10, 11 (Exhibit D). The conference was open to the public and there were no confidentiality restrictions imposed on the conference proceedings, EX1059, ¶¶11-12, and it was expected that the proceedings would be shared widely as confirmed by the fact that the conference proceedings were cataloged into the Linda-Hall Library of Science, Engineering, and Technology less than two months later, then made available on the IEEE website by August 7, 2002. EX1012, ¶52; EX1002, ¶76. Galda is a prior art printed publication by at least May 6, 2002 and is prior art under pre-AIA §§ 102(a) or (b) (depending on the claim and effective filing date) or post-AIA § 102(a)(1). *E.g., GoPro, Inc. v. Contour Holding LLC*, 908 F.3d 690, 694-95 (Fed. Cir. 2018).

Galda teaches reducing PAPR (PAR) using “OFDM-FDMA multiple access ... combined with a data spreading technique based on a Discrete Fourier Transform spreading matrix using only the user specific subcarriers.” EX1004, p.1737. Galda’s transmitter is illustrated below.



Id., p.1740 (annotated).³

Galda is analogous because it is in the same field because it describes applying “[a] CI code matrix of dimension $N \times N$ containing polyphase code chips” which is “multiplied by a set of data vectors or a data matrix,” where the elements of the CI code matrix “resemble[s] the vectors of complex values used in DFTs....” EX1001, 68:8-24; EX1004, p.1737 (describing a “data spreading technique based on a Discrete Fourier Transform (DFT) spreading matrix”); EX1002, ¶¶77-78. Galda is also analogous art because one of the problems facing the inventor was reducing PAPR in OFDM communications, EX1001, 48:37-40 (“Some aspects provide a multicarrier protocol that controls interference relationships between the carriers. This control enables time-domain signal shaping, which provides for low PAPR and adaptability to single-carrier waveforms.”), and Galda seeks to solve that problem by spreading symbols using complex-valued polyphase codes from a DFT—like the

³ Coloring and/or colored text has been added to figures unless otherwise noted.

'285 Patent, EX1004, p.1737. EX1002, ¶79.

A. Doufexi

Doufexi is a paper from *The 13th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*. EX1003. Exhibit 1003 was obtained from the Linda Hall Library by Dr. Hall-Ellis. EX1012, ¶65. Doufexi was cataloged into that library on December 30, 2002. EX1012, ¶¶68-69. Additionally, Doufexi was added to the IEEE online database by December 10, 2002. *Id.*, ¶66. Doufexi would have been reasonably accessible to a POSITA because it was cataloged by subject matter including “Wireless communication systems; Mobile Communications systems” as reflected by the Library of Congress classification system, among other indices. *Id.*, ¶70; EX1002, ¶¶80-81. Doufexi is thus a prior art printed publication under pre-AIA §102(b) or post-AIA §102(a)(1).

Doufexi explains that “OFDM is proposed as a leading candidate for a 4G cellular communications standard.” EX1003, p.192. Doufexi “identifies and describes the key link parameters of OFDM for a potential 4G cellular standard” including “subchannel spacing.” *Id.* Doufexi explains that “a fixed set of parameters” would not “achieve high performance in all cases,” and proposes different parameters for different scenarios. *Id.*, pp.192-93.

Doufexi is analogous to the '285 Patent because it is in the field of wireless communications networks, and especially OFDM wireless communications

networks and techniques. EX1001, 50:52-54 (“In the OFDM implementation of the invention”); EX1006, p.192 (describing OFDM for 4G networks); EX1002, ¶83. Doufexi is also reasonably pertinent to a problem faced by the inventor of the ’285 Patent, including improvement of spectral/bandwidth efficiency. EX1001, 9:19-20 (describing MIMO systems as being able to “significantly increase bandwidth efficiency”); 20:65-21:1 (seeking to “maximize spectral efficiency”); EX1003, pp.192 (variable guard time can improve efficiency), 193 (“[c]hannel coding also affects bandwidth efficiency”); EX1002, ¶84.

B. Lucent

Lucent is a technical contribution submitted to the 3GPP TSG RAN Working Group 1 (WG1) meeting TSGR1 #28bis, which was held on October 8th and 9th, 2002. EX1034, ¶53; EX1006, p.1. Lucent was publicly available on the 3GPP “public file server from where an interested member of the public exercising reasonable diligence could freely access them.” EX1034, ¶¶41, 54. Lucent was uploaded to the 3GPP public file server on October 8, 2002, *id.*, ¶56, and it was distributed to the members of the RAN WG1 email list on October 8, 2002. *Id.*, p.223. A POSITA would have been able to locate Lucent with a reasonably diligent search based on its categorization on the 3GPP website—run by a prominent organization in the wireless communications industry, *id.*, ¶23—by working group and meeting. EX1034, ¶42; EX1002, ¶¶85-87. Lucent is therefore a prior art printed

publication under pre-AIA §102(b) or post-AIA §102(a)(1).

Lucent describes different configurations for a proposed OFDM baseline system in which the different configurations are associated with different “suitable deployment environment[s].” *Id.*; *see also id.*, p.7 (“We have suggested an OFDM system with multiple configurations that can be deployed in different environments.”). One difference between the three configurations proposed by Lucent is the subcarrier spacing. There are three options: 19.2 kHz, 9.6 kHz, and 4.8 kHz as shown in the table below.

System Parameters	Configuration 1	Configuration 2	Configuration 3
Suitable deployment environment	Indoor, Pedestrian A	Vehicular A	Pedestrian B
Symbol per 0.67 msec time slot	12	6	3
Number of FFT points	256	512	1024
Number of sub-carriers	256	512	1024
OFDM Symbol period (usec)	55.6	111	222
Sub-carrier spacing (kHz)	19.2	9.6	4.8
Guard band on each side of the 5MHz band (kHz)	42.4	42.4	42.4
Sampling period (usec)	0.20345025	0.20345025	0.20345025
Guard time $T_g = T_{prefix} + T_{postfix}$ (samples/usec)	17/3.46	34/6.92	68/13.8
Cyclic prefix length (samples/usec)	5/1.017252604	16/3.255204	50/10.17252604
Power amplifier ramp-up and ramp-down period (samples)	6 samples each	9 samples each	9 samples each

Id.

Lucent is analogous to the '285 Patent because it is in field of wireless

communications networks, and especially OFDM wireless communications networks and techniques. EX1001, 50:52-54 (“In the OFDM implementation of the invention”); EX1006, p.1 (“Proposed Baseline OFDM Systems for Study”); EX1002, ¶1. And Lucent is reasonably pertinent to a problem to be solved by the ’285 Patent inventor, namely subcarrier allocation including subcarrier frequency spacing to address channel conditions and/or interference. EX1001, 58:42-51; 70:32-41; EX1006, pp.3-5 (“Some benefit[s] of having multiple configurations are:” allowing shorter symbol durations “when the multipath is less severe, this would result in wider subcarrier spacing which would make the system more immune to frequency offset,” using a shorter symbol duration to make the “system less susceptible to high Doppler and hence reduces ICI [inter-carrier interference]”); EX1002, ¶92.

C. Ma

Ma is a U.S. Patent Application Publication filed on February 20, 2015 and published on September 10, 2015. EX1033, cover. Ma claims the benefit of Provisional Application No. 61/949,805 filed March 7, 2014. *Id.* If Petitioner prevails on its arguments regarding the effective filing date of the ’285 Patent, Ma is prior art under post-AIA §102(a)(1). *Supra* §IV.

Ma describes systems and methods for implementing variable subcarrier spacings and symbol durations in OFDM systems. EX1033, ¶[0002]. Ma partitions

frequency and time planes into “multiple access block” (“MAB”) regions where each MAB has a different subcarrier spacing and symbol duration. *Id.*, ¶¶[0004], [0028], [0030]-[0031], Fig. 5. This increases system flexibility. *Id.*, ¶[0003].

Ma is analogous to the '285 Patent because both relate to wireless communications networks, and especially OFDM wireless communications networks and techniques. EX1001, 50:52-54 (“In the OFDM implementation of the invention”); EX1033, ¶¶[0002], [0033]; EX1002, ¶95. And Ma is reasonably pertinent to a problem to be solved by the '285 Patent inventor, namely the improvement of spectral/bandwidth efficiency. EX1001, 9:19-20 (describing MIMO systems as being able to “significantly increase bandwidth efficiency”); 20:65-21:1 (seeking to “maximize spectral efficiency”); EX1033, ¶[0003], [0023], [0036]; EX1002, ¶96.

D. Dowling

Dowling was filed on April 6, 1999 and issued July 22, 2003. EX1042, cover. Dowling is prior art under post-AIA §102(a)(1) or pre-AIA §102(e).

Dowling discloses multicarrier modulation and OFDM systems that may be implemented as software modules executing on programmable processors. Dowling’s transmitters, receivers, and precoders may be implemented in either hardware or software. EX1042, 3:46-50, 5:66-6:1.

Dowling is analogous to the '285 Patent at least because it is in the same field

of endeavor—namely wireless communications including OFDM communications. EX1001, 50:52-54 (“In the OFDM implementation of the invention ...”); EX1042, 1:6-12 (“field” relates to “data transmission,” more specifically to a “precoder” for multicarrier (e.g., OFDM) systems), 21:62-64 (invention “applied to other FFT based multicarrier modulation and OFDM systems.”); EX1002, ¶¶99.

IX. DETAILED DISCUSSION

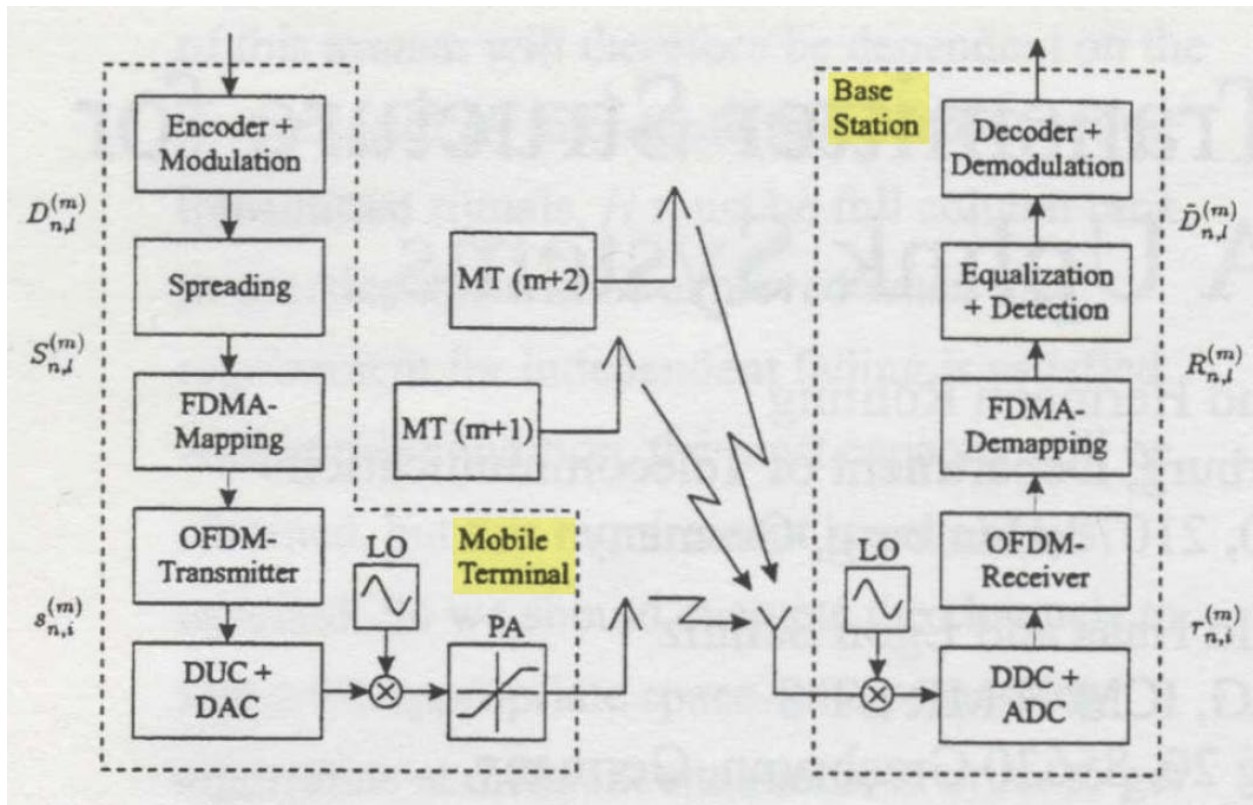
A. Grounds 1 and 2: Claims 1, 7, 9, and 10 are (Ground 1) anticipated by or (Ground 2) obvious over Galda

1. Claim 1

a. [1Pre]: Method for communication in wireless network

Even if the preamble is a limitation, Galda discloses and renders obvious a *method for communication by a user device in a wireless network*. EX1002, ¶¶100-14.

Galda describes an OFDM “transmission technique.” EX1004, p.1737. Galda’s OFDM transmission technique includes spreading data symbols with “a Discrete Fourier Transform (DFT) spreading matrix” before mapping and OFDM modulation, and ultimately *communication by a user device in a wireless network* as shown below where “Mobile Terminal” (the *user device*) transmits wirelessly to “Base Station”:



EX1004, p.1738 (Fig. 1).

Thus, Galda discloses and renders obvious (as explained below) [1Pre].

b. [1A]: encoding data symbols to produce subcarrier values

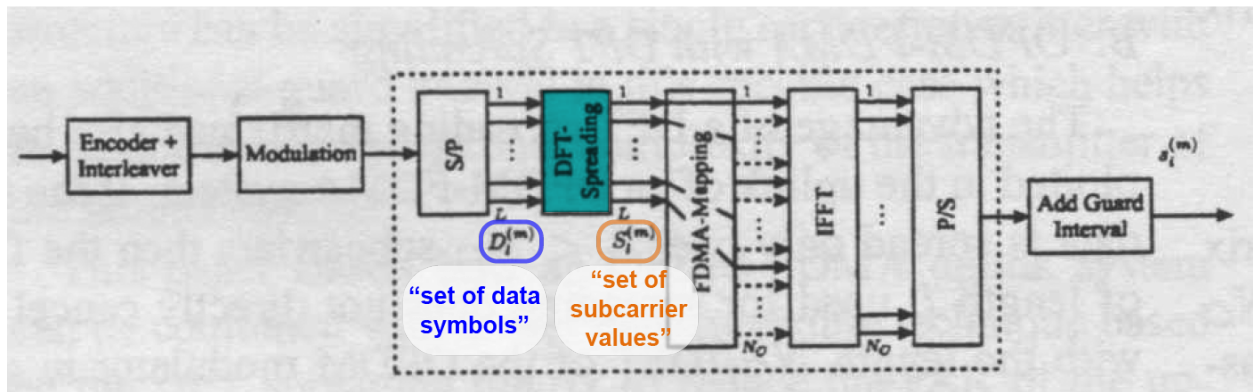
Galda discloses and renders obvious *encoding a set of data symbols* (“ $\vec{D}^{(m)}$ ”) which is also represented as “ L complex modulation symbols $D_l^{(m)}, l = 0, \dots, L - 1$ ”) *with a set of complex-valued codes* (with Galda’s DFT spreading codes having the form $C_{i,j} = \left(\frac{1}{\sqrt{L}}\right) \cdot e^{j2\pi ij/L}$), *to produce a set of subcarrier values* (encoding produces “ L complex transmit symbols $S_l^{(m)}$ ”). EX1002, ¶¶115-20.

Galda describes *encoding a set of data symbols with the first set of complex-*

valued codes because Galda describes multiplying “ L complex modulation symbols $D_l^{(m)}, l = 0, \dots, L - 1$ ” (also represented as vector “ $\vec{D}^{(m)}$ ”) by “an unitary spreading matrix $[C]$ resulting in L complex transmit symbols $S_l^{(m)}$ ” (which are represented by vector “ $\vec{S}^{(m)}$.” EX1004, p.1738; EX1002, ¶¶116-17 Galda explains that “[t]he spreading operation can be denoted mathematically by the following simple matrix multiplication: $\vec{S}^{(m)} = [C]\vec{D}^{(m)}$.” EX1004, p.1738. Thus, in Galda *a set of data symbols* (Galda’s “ L complex modulation symbols $D_l^{(m)}, l = 0, \dots, L - 1$ ”) are encoded with Galda’s matrix $[C]$ *to produce a set of subcarrier values* (Galda’s “ L complex transmit symbols $S_l^{(m)}$ ”).

Galda’s matrix $[C]$ includes *complex-valued codes* because “the elements of the discrete Fourier matrix” are represented by $C_{i,j} = \left(\frac{1}{\sqrt{L}}\right) \cdot e^{j2\pi ij/L}$. EX1004, p.1739; EX1002, ¶¶118-19. At the very least, a POSITA would have found this expression to refer to complex-valued codes because Patent Owner has admitted in co-pending litigation that exponential term “ $e^{j2\pi ij/L}$ ” is complex-valued because it includes “exponential function e ”. EX1074, p.9; EX1002, ¶119; *see also* EX1047, p.4 (Patent Owner admitting that “portion of the DFT $e^{-j\frac{2\pi ik}{M_{SC}^{PUSCH}}}$... correspond to complex-valued spreading codes”).

The encoding is performed in Galda’s “DFT-Spreading” block:



EX1004, p.1740 (Fig. 6(a)).

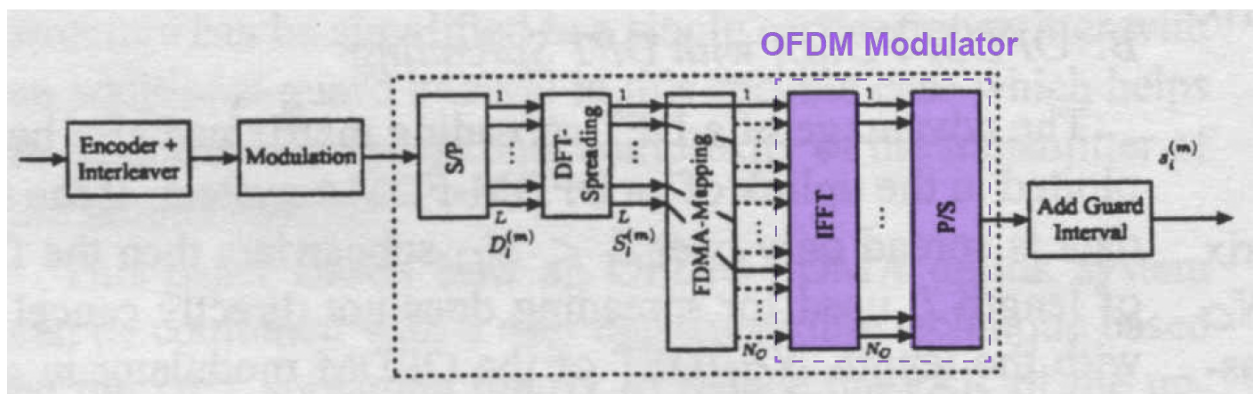
Accordingly, Galda discloses and renders obvious Limitation [1A].

- c. [1B]: modulating subcarrier values onto OFDM subcarriers

Galda discloses and renders obvious *modulating the set of subcarrier values onto a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers assigned for use by the user device, to produce a plurality of modulated subcarriers.*

EX1002, ¶¶121-24.

Galda discloses an OFDM modulator (called "OFDM-Transmitter" in Fig. 1) as shown below.



EX1004, p.1740 (Fig. 6(a)). The modulator uses an IFFT and thus modulates Galda's *subcarrier values* ($S_l^{(m)}$) *onto a set of OFDM subcarriers* (Galda's " L of the available N_C subcarriers") to produce a *plurality of modulated subcarriers*. EX1004, pp.1738, 1740. A POSITA knew that Galda's IFFT produces OFDM *modulated subcarriers*. EX1002, ¶¶122-23. This was textbook knowledge. EX1015, pp.33-39 (section titled "Generation of Subcarriers Using the IFFT" which explains that "[t]he complex baseband OFDM signal is defined by (2.2) is in fact nothing more than the inverse Fourier transform of N_s QAM input symbols.").

Galda's OFDM *subcarriers* are *assigned for use by the user device* because Galda describes selection of the L subcarriers on which to modulate the " L complex transmit symbols $S_l^{(m)}$ " (also expressed as $\vec{S}^{(m)}$) to a "selected subcarrier set" that is "exclusively allocated to user m ." EX1004, pp.1738, 1740 (Fig. 6(a)).

Based on the subcarriers uniquely allocated to user m , Galda's OFDM transmitter performs the function of selecting the L subcarriers from among N_C subcarriers that make up the aggregate of "available" subcarriers. EX1004, p.1738 ("The transmit symbols $S_l^{(m)}$ are then mapped onto L of the available N_C subcarrier which are exclusively allocated to user m "); EX1002, ¶¶122-23. Galda explains that "the set of subcarrier assigned to each user can be composed of any L out of N_C subcarrier that have not been assigned to another user." EX1004, p.1738. This

provides flexibility in the management of radio resources. EX1002, ¶¶122-23. Galda's *selecting* allows the transmitter to "spread the user data over the allocated subcarrier only." EX1004, p.1737. These allocated subcarriers are used by Galda's Mobile Terminal. EX1004, p.1738 (Fig. 1 ("Mobile Terminal.")).

Thus, Galda discloses Limitation **[1B]**.

d. **[1C]: producing time-domain waveform**

Galda discloses and renders obvious *producing a time-domain waveform that comprises a superposition of the plurality of modulated subcarriers* (Galda's modulated subcarriers are summed to create a time-domain waveform from a superposition of modulated subcarriers, i.e., $s_i^{(m)}$), *the time-domain waveform to be transmitted in the wireless network by the user device* (Galda's time-domain waveform $s_i^{(m)}$ is transmitted from "Mobile Terminal" to "Base Station"). EX1002, ¶¶125-30.

Galda describes *producing a time-domain waveform $s_i^{(m)}$* . For example, Galda provides the following expression for the *time-domain waveform*—what Galda calls the "resulting OFDM time signal of user m ":

$$s_i^{(m)} = e^{j2\pi im/N_C} \frac{1}{\sqrt{L}} \sum_{l=0}^{L-1} S_l^{(m)} e^{-j2\pi il/L} \quad (3)$$

for $i = -N_G, \dots, 0, \dots, N_C,$

where the summation of subcarriers from $l = 0$ to L represents *a superposition of the plurality of modulated subcarriers*, where the subcarriers are modulated by the set of subcarrier values $S_i^{(m)}$.⁴ EX1004, pp.1738, 1739; EX1002, ¶¶126-27.

Because Galda uses an IFFT for OFDM modulation the resulting signal *comprises a superposition of the plurality of modulated subcarriers*. EX1004, p.1737 (“[T]he OFDM transmit signal results from the superposition of a large number of independent data symbols....”). To the extent the Board determines that Galda does not expressly disclose that the time-domain signal *comprises a superposition of the plurality of modulated subcarriers*, it would have been obvious to a POSITA that Galda’s *time-domain waveform* is produced from a *superposition of the plurality of modulated subcarriers* based on Galda’s disclosure of an “OFDM time signal” (which is a “superposition”), EX1004, pp.1737, 1738, because Patent Owner has admitted in co-pending litigation that a POSITA “at the time of the invention would understand that an OFDM signal is a superposition of subcarriers” and is “a sum (i.e., a superposition) of the subcarrier frequencies modulated with

⁴ Galda provides another expression for the OFDM time-domain waveform that substitutes in the DFT matrix coefficients and the “complex modulation symbols”:

$$S_i^{(m)} = e^{j2\pi im/N_c} \cdot \frac{1}{\sqrt{L}} \cdot \sum_{l=0}^{L-1} \sum_{v=0}^{L-1} C_{l,v} D_v^{(m)} e^{-j2\pi il/L}. \text{ EX1004, p.1739.}$$

their corresponding symbols.” EX1039, p.10; EX1047, p.8 (Patent Owner admitting that a POSITA “would understand that an OFDM signal is a superposition of subcarriers”); EX1087, p.8 (same); EX1089, p.6 (same); EX1002, ¶128.

Galda’s *time-domain waveform is to be transmitted in the wireless network by the user device* as shown in Galda’s Fig. 1, which shows transmissions of the signal after DAC and amplification from “Mobile Terminal” to “Base Station.” EX1004, p.1738; EX1002, ¶129.

Galda thus discloses and renders obvious Limitation [1C].

- e. [1D]: subcarrier values comprise first, second polyphase codes

Galda discloses and renders obvious *wherein the set of subcarrier values* (“ L complex transmit symbols $S_l^{(m)}$ ” (also represented as column vector “ $\vec{S}^{(m)}$ ”)) *comprises a first polyphase code* (first of “ L orthogonal code vectors $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,L})$ with $l = 0, \dots, L - 1$ ”) *that encodes a first of the set of data symbols* (a first occurrence of “ L complex modulation symbols” $D_l^{(m)}$, which are also represented as column vector (matrix) $\vec{D}^{(m)}$) *and at least a second polyphase code* (second of “ L orthogonal code vectors $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,L})$ with $l = 0, \dots, L - 1$ ”) *that encodes at least a second of the set of data symbols* (a second occurrence of “ L complex modulation symbols” $D_l^{(m)}$, which are also represented as

column vector (matrix) $\vec{D}^{(m)}$). EX1002, ¶¶131-42.

Galda's *set of subcarrier values* is mathematically represented as $S_l^{(m)}$ where l ranges from 0 to $L-1$. EX1004, p.1738; EX1002, ¶¶132-35. Thus, the *set of subcarrier values* has L elements. Galda mathematically represents the encoded data symbols with the following expression:

$$S_l^{(m)} = \sum_{v=0}^{L-1} C_{l,v} D_v^{(m)} \quad \text{for } l = 0, \dots, L-1$$

EX1004, p.1738; EX1002, ¶136. Here l is a value that provides a row index and v is a column index where both l and v range from 0 to $L-1$. EX1002, ¶132-36. For the l^{th} subcarrier value Galda's equation 2 (above) expands as follows for all values of v :

$$S_l^{(m)} = C_{l,0} D_0^{(m)} + C_{l,1} D_1^{(m)} + \dots + C_{l,L-1} D_{L-1}^{(m)}$$

EX1002, ¶136. For the first subcarrier value of the L subcarrier values, this expression can be rewritten as follows:

$$S_0^{(m)} = C_{0,0} D_0^{(m)} + C_{0,1} D_1^{(m)} + \dots + C_{0,L-1} D_{L-1}^{(m)}$$

EX1002, ¶137. Because there are L subcarrier values (i.e., " L complex transmit symbols" in Galda's parlance), the *set of subcarrier values* can be expressed as follows:

$$\vec{S}^{(m)} = \begin{bmatrix} S_0^{(m)} = C_{0,0}D_0^{(m)} + C_{0,1}D_1^{(m)} + \dots + C_{0,L-1}D_{L-1}^{(m)} \\ S_1^{(m)} = C_{1,0}D_0^{(m)} + C_{1,1}D_1^{(m)} + \dots + C_{1,L-1}D_{L-1}^{(m)} \\ \vdots \\ S_{L-1}^{(m)} = C_{L-1,0}D_0^{(m)} + C_{L-1,1}D_1^{(m)} + \dots + C_{L-1,L-1}D_{L-1}^{(m)} \end{bmatrix}$$

EX1002, ¶137. Here, $\vec{S}^{(m)}$ is the column vector of subcarrier values $S_l^{(m)}$ from 0 to $L-1$. EX1002, ¶138; EX1004, p.1738. This expression is an alternative mathematical representation of Galda's equation 2. EX1002, ¶138. Each of the code values $C_{l,v}$ represents an element "of the discrete Fourier matrix" and is alternatively expressed in Galda as:⁵

⁵ Galda uses different indices i and j instead of l and v , but a POSITA would understand that no difference in meaning was intended. Moreover, a POSITA would have been familiar with the expression for a Fourier transform matrix and thus the fact that there are two instances of " j " would not impede understanding: the first instance represents $\sqrt{-1}$ and the second reflects an arbitrary index representing the row. EX1002, ¶139.

$$C_{i,j} = \frac{1}{\sqrt{L}} e^{j2\pi i j / L}$$

EX1004, p.1739; EX1002, ¶138. Codes of this form impart multiple phase shifts to the data symbol. EX1002, ¶140. For instance, for an arbitrary row i and values for j ranging from 0 to $L-1$ the elements of an “orthogonal code vector[.]”⁶ $\vec{C}_i = (C_{i,0}, C_{i,1}, \dots, C_{i,j})$ take the following values:

$$\vec{C}_i = (\frac{1}{\sqrt{L}} e^{j2\pi i(0)/L}, \frac{1}{\sqrt{L}} e^{j2\pi i(1)/L}, \dots, \frac{1}{\sqrt{L}} e^{j2\pi i(L-1)/L})$$

EX1002, ¶140. This can be simplified to:

$$\vec{C}_i = (\frac{1}{\sqrt{L}}, \frac{1}{\sqrt{L}} e^{j2\pi i/L}, \dots, \frac{1}{\sqrt{L}} e^{j2\pi i(L-1)/L})$$

EX1002, ¶140. Therefore, each of Galda’s “ L orthogonal code vectors $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,l})$ with $l = 0, \dots, L - 1$ ” has multiple phases—i.e., it is a *polyphase code*. EX1002, ¶140.

With this background, Galda discloses that *the set of subcarrier values—Galda’s column vector “ $\vec{S}^{(m)}$ ”—comprises a first polyphase code that encodes a first of the set of data symbols and at least a second polyphase code that encodes at least a second of the set of data symbols* as illustrated below:

⁶ Arbitrary index l has been replaced with i to facilitate understanding. EX1002, ¶140, n.1.

$$\vec{S}^{(m)} = \begin{bmatrix} S_0^{(m)} = \text{first polyphase code} D_0^{(m)} + \text{first polyphase code} D_1^{(m)} + \dots + \text{first polyphase code} D_{L-1}^{(m)} \\ S_1^{(m)} = \text{second polyphase code} D_0^{(m)} + \text{second polyphase code} D_1^{(m)} + \dots + \text{second polyphase code} D_{L-1}^{(m)} \\ \vdots \\ S_{L-1}^{(m)} = C_{L-1,0} D_0^{(m)} + C_{L-1,1} D_1^{(m)} + \dots + C_{L-1,L-1} D_{L-1}^{(m)} \end{bmatrix}$$

= first polyphase code = second polyphase code
 = set of data symbols

first of the set of data symbols
second of the set of data symbols

EX1002, ¶141.

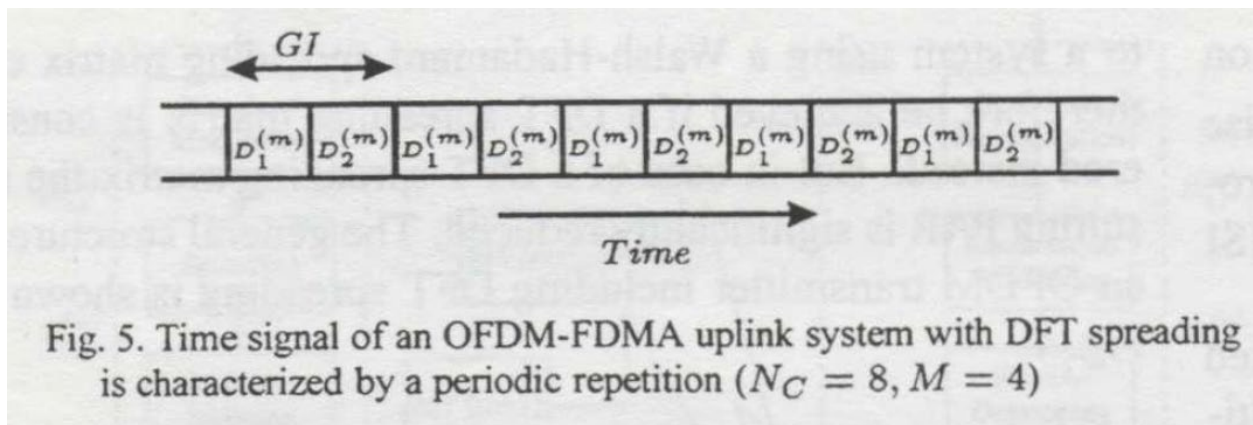
Galda thus discloses and renders obvious Limitation **[1D]**.

f. **[1E]: interference producing periodic pulse waveforms**

Galda discloses and renders obvious *wherein the first polyphase code* (a first one of Galda’s “*L* orthogonal code vectors $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,l})$ with $l = 0, \dots, L - 1$ ”) *causes constructive and destructive interference between the plurality of modulated subcarriers* (Galda’s transmit symbols $S_l^{(m)}$ are modulated onto “*L* of the available N_C subcarriers” by the IFFT) *to produce a first periodic pulse waveform*

having a peak value that is centered at a first time (e.g., $D_1^{(m)}$ in Galda's Fig. 5) in an OFDM symbol interval (Galda's Fig. 5 shows "a single OFDM symbol" with four periods and a guard interval), and the second polyphase code causes constructive and destructive interference between the plurality of modulated subcarriers to produce a second periodic pulse waveform having a peak value that is centered at a second time (e.g., $D_2^{(m)}$ in Galda's Fig. 5) in the OFDM symbol interval (Galda's Fig. 5 shows "a single OFDM symbol" with four periods and a guard interval), the second time different from the first time ($D_1^{(m)}$ in Galda's Fig. 5 and $D_2^{(m)}$ in Galda's Fig. 5 are at different times). EX1002, ¶¶143-67.

Galda explains that producing " $s_i^{(m)}$ of user m in an OFDM-FDMA uplink using DFT spreading matrix [(i.e., the set of polyphase codes " $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,L})$ with $l = 0, \dots, L - 1$ ") and an equidistant subcarrier allocation results therefore in a periodic repetition of the complex user data symbol $D_l^{(m)}$ sequence," as shown in Fig. 5. EX1004, pp.1739-40 (Fig. 5).



EX1004, p.1740 (Fig. 5). As Dr. Bims explains, this figure illustrates the periodic nature of the time-domain waveform “ $s_i^{(m)}$ ”, wherein each square represents a single “pulse waveform having a peak value that is centered at a [different] time in [the] OFDM symbol interval,” which comprises the time taken to transmit all ten pulse waveforms.⁷ EX1002, ¶¶144-47.

Galda’s first polyphase code causes constructive and destructive interference

⁷ A POSITA would understand that Galda’s Fig. 5 simplifies expression 7 and omits the term “ $e^{j2\pi im/8}$ ” to illustrate the periodic repetition of the complex user data symbol $D_l^{(m)}$ sequence. EX1002, ¶147. A POSITA would also have understood that the indices of the complex user data symbol $D_l^{(m)}$ sequence used in Galda’s Fig. 5 is one-based indexing (i.e., ranges from 1 to L), rather than the zero-based indexing (i.e., ranges from 0 to $1-L$) as used in expression 7 and Petitioner’s example. EX1002, ¶147. This difference in nomenclature is not substantive.

between the plurality of modulated subcarriers to produce the periodic pulse waveform for $D_1^{(m)}$ as a POSITA would have understood from Galda's math.⁸ For example, Galda's polyphase codes $\vec{C}_l$ impart cyclic shifts to the encoded data symbols—i.e., the claimed *subcarrier values*—("L complex transmit symbols $S_l^{(m)}$ ") and thus the resulting waveforms. EX1002, ¶148. For example, in a situation in which $L=4$, Galda's DFT spreading matrix takes on the following values:

$$[C] = \begin{bmatrix} C_{0,0} & C_{0,1} & C_{0,2} & C_{0,3} \\ C_{1,0} & C_{1,1} & C_{1,2} & C_{1,3} \\ C_{2,0} & C_{2,1} & C_{2,2} & C_{2,3} \\ C_{3,0} & C_{3,1} & C_{3,2} & C_{3,3} \end{bmatrix} = \begin{bmatrix} \frac{1}{2}e^{j\frac{2\pi(0)(0)}{4}} & \frac{1}{2}e^{j\frac{2\pi(0)(1)}{4}} & \frac{1}{2}e^{j\frac{2\pi(0)(2)}{4}} & \frac{1}{2}e^{j\frac{2\pi(0)(3)}{4}} \\ \frac{1}{2}e^{j\frac{2\pi(1)(0)}{4}} & \frac{1}{2}e^{j\frac{2\pi(1)(1)}{4}} & \frac{1}{2}e^{j\frac{2\pi(1)(2)}{4}} & \frac{1}{2}e^{j\frac{2\pi(1)(3)}{4}} \\ \frac{1}{2}e^{j\frac{2\pi(2)(0)}{4}} & \frac{1}{2}e^{j\frac{2\pi(2)(1)}{4}} & \frac{1}{2}e^{j\frac{2\pi(2)(2)}{4}} & \frac{1}{2}e^{j\frac{2\pi(2)(3)}{4}} \\ \frac{1}{2}e^{j\frac{2\pi(3)(0)}{4}} & \frac{1}{2}e^{j\frac{2\pi(3)(1)}{4}} & \frac{1}{2}e^{j\frac{2\pi(3)(2)}{4}} & \frac{1}{2}e^{j\frac{2\pi(3)(3)}{4}} \end{bmatrix}$$

EX1002, ¶148. These codes apply a set of carrier phases when producing Galda's subcarrier values $S_l^{(m)}$ where l ranges from 0 to $L-1$, such that when the subcarrier values are modulated onto the subcarriers the resulting subcarriers also exhibit the phase shift imparted by the code.

Galda explains

The transmit time signal $s_i^{(m)}$ of user m in an OFDM-FDMA uplink using DFT spreading matrix and an

⁸ With the understanding that Galda's Fig. 5 uses 1 as the starting index as a POSITA would have appreciated. EX1002, ¶148.

equidistant subcarrier allocation results therefore in a periodic repetition of the complex user data symbol $D_l^{(m)}$ sequence including an added guard interval as cyclic prefix, shown in Fig. 5. This periodic data sequence is multiplied by a user specific complex signal $e^{j2\pi im/N_c}$ due to the user individual frequency shift by m subcarriers of the complete allocated subcarrier set. The number of periods inside a single OFDM symbol is equal to the spacing M of the subcarriers allocated to user m .

EX1004, pp.1739-1740. Galda provides the following mathematical expressions for equally spaced subcarriers:

$$\begin{aligned}
 s_i^{(m)} &= e^{j2\pi im/N_c} \cdot \frac{1}{\sqrt{L}} \cdot \sum_{l=0}^{L-1} \sum_{v=0}^{L-1} C_{l,v} D_v^{(m)} e^{-j2\pi il/L} \\
 &= e^{j2\pi im/N_c} \cdot \frac{1}{L} \sum_{v=0}^{L-1} D_v^{(m)} \underbrace{\sum_{l=0}^{L-1} e^{j2\pi(v-i)l/L}}_{= L \delta_L(v-i)} \\
 &= e^{j2\pi im/N_c} \cdot \sum_{v=0}^{L-1} D_v^{(m)} \delta_L(v-i) \\
 s_i^{(m)} &= e^{j2\pi im/N_c} \cdot D_{i \bmod L}^{(m)} \quad (7)
 \end{aligned}$$

EX1004, p.1739. Here, a plurality of polyphase codes $\vec{C}_l$ (represented by element “ $C_{l,v}$ ” and highlighted blue), including a first polyphase code $\vec{C}_0$ and a second polyphase code $\vec{C}_1$, shape interference patterns (i.e., cause constructive and

destructive interference) (highlighted yellow) to produce a plurality of periodic waveforms in an OFDM symbol interval, including a first periodic waveform $\delta_L(0 - i)$ having a peak value that is centered at a first time and a second periodic waveform $\delta_L(1 - i)$ having a peak value that is centered at a second time (each periodic waveform is represented by “the periodic dirac pulse sequence $\delta_L()$ ” and highlighted green). EX1002, ¶¶149-51. Galda’s equation (7) includes the following expression which shows L periodic pulse waveforms that are shifted in time:

$$L \delta_L(v - i) = \sum_{l=0}^{L-1} e^{j2\pi(v-i)l/L},$$

where

- $\delta_L(v - i)$ represents L time-shifted periodic pulse waveforms produced from the interference patterns (i.e., *constructive and destructive interference*) of the superposition $\sum_{l=0}^{L-1} e^{j2\pi(v-i)l/L}$ and
- $\sum_{l=0}^{L-1} e^{j2\pi(v-i)l/L}$ is a restructuring of $\sum_{l=0}^{L-1} C_{l,v} e^{-j2\pi il/L}$ shown in the first line of expression 7 that represents how the polyphase codes $\vec{C}_l$ shape the interference patterns of the superposition to produce the L periodic pulse waveforms

$$\sum_{l=0}^{L-1} \overbrace{C_{l,v} = \vec{C}_l}^{e^{j2\pi lv/L}} \cdot e^{-j2\pi il/L} = \sum_{l=0}^{L-1} e^{j2\pi(v-i)l/L} = L \delta_L(v - i).$$

EX1002, ¶¶152-53; EX1004, p.1739.

As Dr. Bims explains, $\delta_L(v - i)$ represents L time-shifted periodic pulse waveforms defined as:

$$\delta_L(v - i) = \begin{cases} 1, & \text{for } v \bmod L = i \bmod L \\ 0, & \text{otherwise} \end{cases}$$

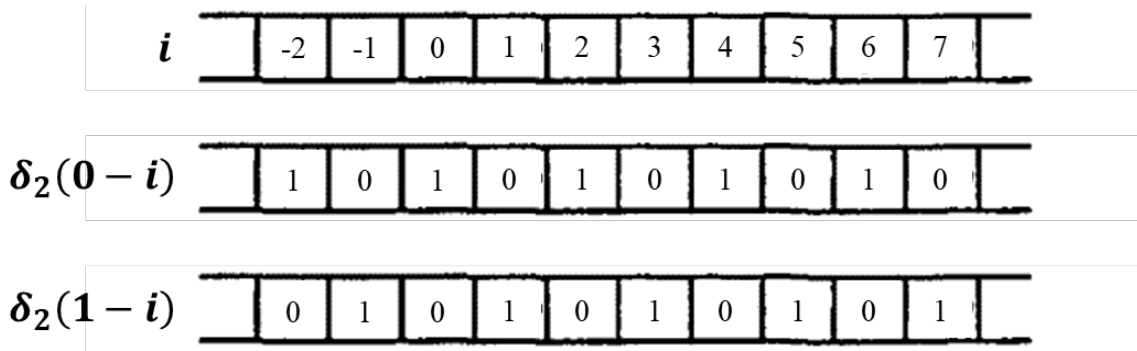
where v identifies a particular one of the L periodic pulse waveforms having a unique shift v , where $v = 0, \dots, L - 1$, i indexes the waveform samples, and L defines each waveform's periodic nature. EX1002, ¶¶153-54. For example, $\delta_L(0 - i)$ represents *a first periodic pulse waveform that has a peak value equal to 1 whenever $i \bmod L = 0$* , and $\delta_L(1 - i)$ represents *a second periodic pulse waveform that has a peak value equal to 1 whenever $i \bmod L = 1$* . EX1002, ¶155.

When $N_C = 8$, $M = 4$, and $L = 2$ as in the example illustrated in Fig. 5 of Galda, $\delta_L(v - i)$ becomes $\delta_2(v - i)$ and $s_i^{(m)}$ may be expressed as

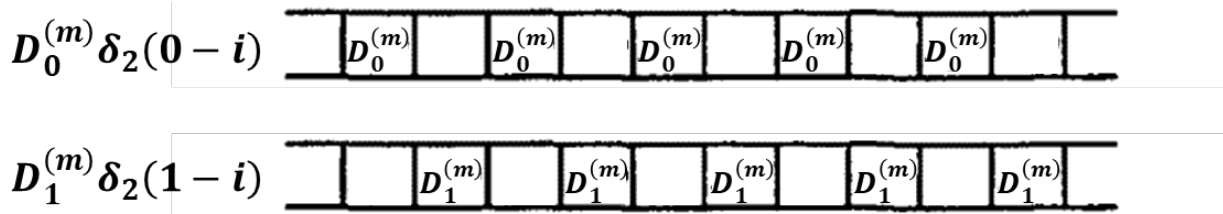
$$\begin{aligned} s_i^{(m)} &= e^{j2\pi im/8} \cdot \sum_{v=0}^{2-1} D_v^{(m)} \delta_2(v - i) \\ &= e^{j2\pi im/8} \left(D_0^{(m)} \delta_2(0 - i) + D_1^{(m)} \delta_2(1 - i) \right) \end{aligned}$$

where $\delta_2(0 - i)$ represents *a first periodic pulse waveform having a peak value that is centered at a first time in an OFDM symbol interval*, and $\delta_2(1 - i)$ represents *a second periodic pulse waveform having a peak value that is centered at a second time in an OFDM symbol interval*. EX1002, ¶¶156-57; EX1004, p.1739. In this

example, $\delta_2(0 - i)$ is a *first periodic pulse waveform* that has a *peak value* equal to 1 whenever $i \bmod 2 = 0$ (i.e., when $i = -2, 0, 2, 4, \text{ or } 6$), and $\delta_2(1 - i)$ is a *second periodic pulse waveform* that has a *peak value* equal to 1 when $i \bmod 2 = 1$ (i.e., when $i = -1, 1, 3, 5, \text{ or } 7$) as shown below:



EX1002, ¶158. Thus, $D_0^{(m)}\delta_2(0 - i)$ and $D_1^{(m)}\delta_2(1 - i)$ may be illustrated as:

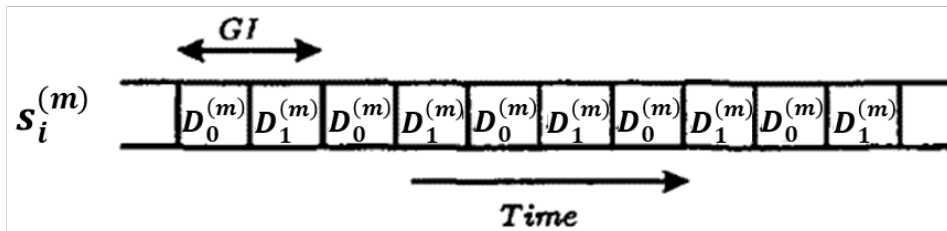


and

$$s_i^{(m)} = e^{j2\pi im/8} \left(D_0^{(m)}\delta_2(0 - i) + D_1^{(m)}\delta_2(1 - i) \right)$$

may be illustrated in a simplified form like that shown in Fig. 5 of Galda⁹ as

⁹ A POSITA would understand that Galda's Fig. 5 simplifies expression 7 and omits the term " $e^{j2\pi im/8}$ " to illustrate the periodic repetition of the complex user data symbol $D_l^{(m)}$ sequence. EX1002, ¶160. A POSITA would also have understood that

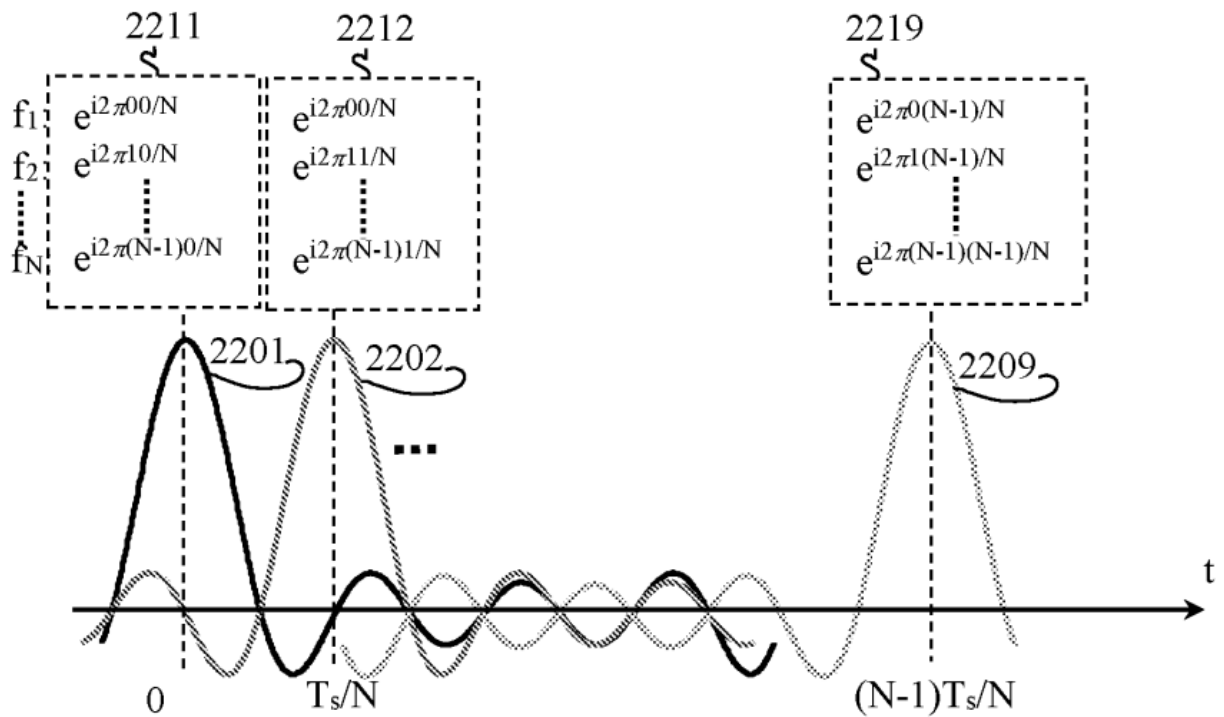


EX1002, ¶¶158-59.

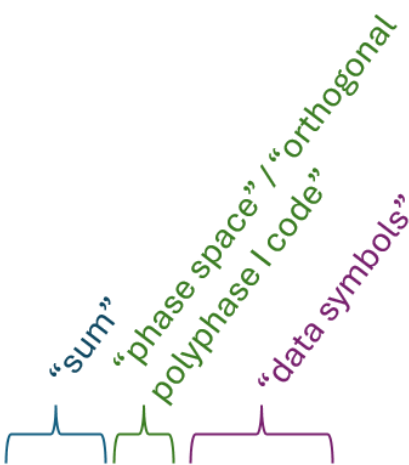
To further support the conclusion that Galda discloses Limitation [1E], Galda's disclosure corresponds to an embodiment of the '285 Patent. For instance, the '285 Patent's FIG. 22A is reproduced below:¹⁰

the indices of the complex user data symbol $D_l^{(m)}$ sequence used in Galda's Fig. 5 is one-based indexing (i.e., ranges from 1 to L), rather than the zero-based indexing (i.e., ranges from 0 to $L-1$) as used in expression 7 and Petitioner's example. EX1002, ¶160. This change in nomenclature has no bearing on the resulting mathematics nor how Galda meets the claims.

¹⁰ Item 2212 includes an error because in the top exponential term the second zero should be a "1." EX1002, ¶161. This would have been understood by a POSITA and because one can see that this value is being incremented until it is $N-1$ at the end of the sequence. EX1001, FIG. 22A (item 2219); EX1002, ¶161.



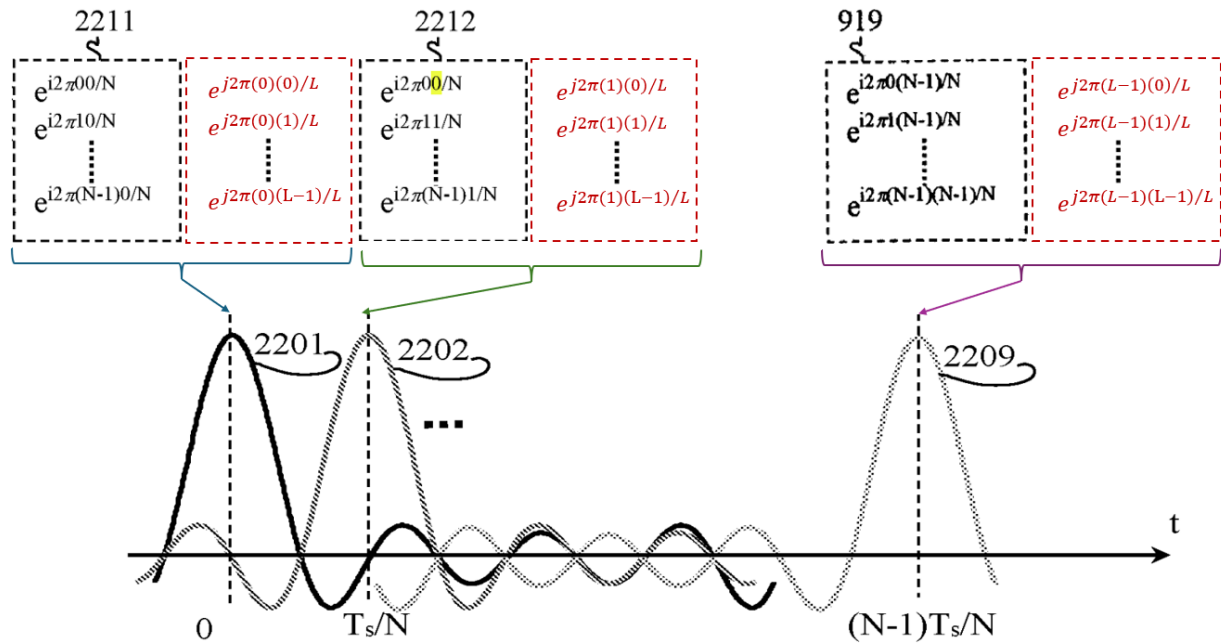
EX1001, FIG. 22A. Items 2211, 2212, and 2219 are referred to as “orthogonal polyphase CI code[s] (or phase space) applied to carriers to center a given pulse waveform at a corresponding instant in time.” EX1001, 56:2-7. “Complex carrier weights corresponding to each of the carriers $f_1, f_2, \dots, f_N$, represent a sum of the phase spaces [i.e., orthogonal polyphase codes] 2211, 2212, ..., 2219 multiplied by their corresponding data symbols.” *Id.*, 56:19-22. Galda also shows this relationship:



$$S_l^{(m)} = \sum_{\nu=0}^{L-1} C_{l,\nu} D_{\nu}^{(m)} \quad \text{for } l = 0, \dots, L-1. \quad (2)$$

EX1004, p.1738; EX1002, ¶¶161-63. FIG. 22A depicts a “plurality of CI pulse waveforms 2201 to 2209 orthogonally positioned in time.” EX1001, 55:66-67. The “equally spaced carriers ... are combined to generate the pulses 2201 to 2209,” and the application of the orthogonal polyphase CI codes to the carriers centers a “given pulse waveform at a corresponding instant in time.” EX1001, 55:67-56:7. Galda does just this as shown below:¹¹

¹¹ The yellow highlight identifies the typographical error identified in footnote 10, above (i.e., 0 should be “1”).



EX1002, ¶165. Here, Galda’s polyphase codes correspond to individual ones of “ L orthogonal code vectors $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,L})$ with $l = 0, \dots, L - 1$ ” where the first polyphase code is to the right of item 2211, the second polyphase code is to the right or 2212, etc. EX1002, ¶166. Because Galda’s polyphase codes are multiplied with the data symbols $(D_v^{(m)})$, just like the ’285 Patent says, the result is multiple waveforms having peaks centered at different times—namely a fraction of the OFDM symbol time indicated as T_s/L . EX1002, ¶166.

At the very least, a POSITA would have understood this to be the case because Patent Owner has admitted in co-pending litigation:

If values of a first polyphase code are chosen properly, the codes provide phase offsets to the subcarriers that cause all of the subcarriers’ phases to align at a particular time

inside the symbol period, which causes constructive interference, resulting in a pulse waveform being centered at that time. If a second polyphase code also produces a pulse waveform, that pulse waveform is preferably centered at a different time in order for it to be distinguished from the first pulse waveform. This happens when the codes are chosen from the rows or columns of a DFT matrix.

EX1089, p.9. As explained in connection with Limitation [1D], Galda's polyphase codes are chosen from the rows of a DFT matrix. *Supra* §VIII.A.1.e; EX1004, pp.1738, 1739.

Thus, Galda discloses and renders obvious Limitation [1E] and thus discloses and renders obvious claim 1.

2. Claim 2

Galda discloses and renders obvious *wherein an m^{th} one of the plurality of polyphase codes comprises a set of N code chips, wherein each code chip is expressed by $e^{i2\pi nm/N}$, where i is the square root of -1 , π is Pi, and n is an integer that varies to provide incremental phase offsets to the set of N code chips.* EX1002, ¶¶168-74.

As explained in connection with Limitation [1D], Galda teaches polyphase codes defined as “ L orthogonal code vectors $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,l})$ with $l = 0, \dots, L - 1$.” EX1004, p.1738. Claim 2 uses the arbitrary index m , while Galda uses

the arbitrary index l . EX1002, ¶¶169-70. Thus, the “ m^{th} ” code is Galda’s “ l^{th} ” code. *Id.* For example, where l is equal to 1, Galda’s “ l^{th} ” polyphase code is given by $\vec{C}_l = (C_{1,0}, C_{1,1}, \dots, C_{1,l})$ or $\frac{1}{\sqrt{L}} \left(e^{\frac{j2\pi 1(0)}{L}}, e^{\frac{j2\pi 1(1)}{L}}, \dots, e^{\frac{j2\pi 1(l)}{L}} \right)$ where $l=0$ to $l=L-1$. Galda’s polyphase code is *expressed as a set of N code chips*, where Galda uses L instead of N as shown in the denominator of the exponential term. And, *each code chip is expressed by $e^{i2\pi nm/N}$ —namely Galda’s expression $C_{i,j} = \frac{1}{\sqrt{L}} e^{j\pi i j/L}$ where j (which is also denoted as i) is $\sqrt{-1}$, π is Pi and n (i in Galda) is an integer from 0 to $L-1$.* EX1002, ¶¶171-72; EX1004, pp.1738, 1739. The integer n (which corresponds to Galda’s row index (e.g., l in equation (2) and i in equation (6)) *provides incremental phase offsets to the set of N code chips* as can be seen below because when the integer is incremented, the phase offsets change:

$$[C] = \begin{bmatrix} C_{0,0} & C_{0,1} & C_{0,2} & C_{0,3} \\ C_{1,0} & C_{1,1} & C_{1,2} & C_{1,3} \\ C_{2,0} & C_{2,1} & C_{2,2} & C_{2,3} \\ C_{3,0} & C_{3,1} & C_{3,2} & C_{3,3} \end{bmatrix} = \begin{bmatrix} \frac{1}{2} e^{j\frac{2\pi(0)(0)}{4}} & \frac{1}{2} e^{j\frac{2\pi(0)(1)}{4}} & \frac{1}{2} e^{j\frac{2\pi(0)(2)}{4}} & \frac{1}{2} e^{j\frac{2\pi(0)(3)}{L}} \\ \frac{1}{2} e^{j\frac{2\pi(1)(0)}{4}} & \frac{1}{2} e^{j\frac{2\pi(1)(1)}{4}} & \frac{1}{2} e^{j\frac{2\pi(1)(2)}{4}} & \frac{1}{2} e^{j\frac{2\pi(1)(3)}{4}} \\ \frac{1}{2} e^{j\frac{2\pi(2)(0)}{L}} & \frac{1}{2} e^{j\frac{2\pi(2)(1)}{4}} & \frac{1}{2} e^{j\frac{2\pi(2)(2)}{4}} & \frac{1}{2} e^{j\frac{2\pi(2)(3)}{4}} \\ \frac{1}{2} e^{j\frac{2\pi(3)(0)}{4}} & \frac{1}{2} e^{j\frac{2\pi(3)(1)}{4}} & \frac{1}{2} e^{j\frac{2\pi(3)(2)}{4}} & \frac{1}{2} e^{j\frac{2\pi(3)(3)}{4}} \end{bmatrix}$$

EX1004, pp.1738, 1739; EX1002, ¶173.

Therefore, Galda discloses and renders obvious claim 2.

3. Claim 6

Galda discloses and renders obvious *wherein the set of subcarrier values* (“*L* complex transmit symbols $S_l^{(m)}$,” also expressed as vector $\vec{S}^{(m)}$) *comprise a product of a matrix with a vector* ($\vec{S}^{(m)} = [C]\vec{D}^{(m)}$), *wherein the matrix comprises the first polyphase code and the at least second polyphase code* (Galda’s matrix $[C]$ comprises “*L* orthogonal code vectors $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,l})$ with $l = 0, \dots, L - 1$ ”) *and the vector comprises the set of data symbols* (Galda’s vector $\vec{D}^{(m)}$ “*L* complex modulation symbols $D_l^{(m)}, l = 0, \dots, L - 1$ ”). EX1002, ¶¶175-78.

Galda represents its *set of subcarrier values* as vector $\vec{S}^{(m)}$ which *comprises a product of a matrix with a vector* because Galda teaches: “[t]he spreading operation can be denoted mathematically by the following simple matrix multiplication: $\vec{S}^{(m)} = [C]\vec{D}^{(m)}$.” EX1004, p.1738; EX1002, ¶¶176-78. Galda’s matrix $[C]$ comprises *the first polyphase code and the at least second polyphase code* as shown below in an example where $L = 4$:

$$[C] = \begin{bmatrix} C_{0,0} & C_{0,1} & C_{0,2} & C_{0,3} \\ C_{1,0} & C_{1,1} & C_{1,2} & C_{1,3} \\ C_{2,0} & C_{2,1} & C_{2,2} & C_{2,3} \\ C_{3,0} & C_{3,1} & C_{3,2} & C_{3,3} \end{bmatrix} \begin{array}{l} \leftarrow \text{“first polyphase code”} \\ \leftarrow \text{“second polyphase code”} \end{array}$$

EX1002, ¶178; EX1004, p.1738 (“*L* orthogonal code vectors $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,l})$)

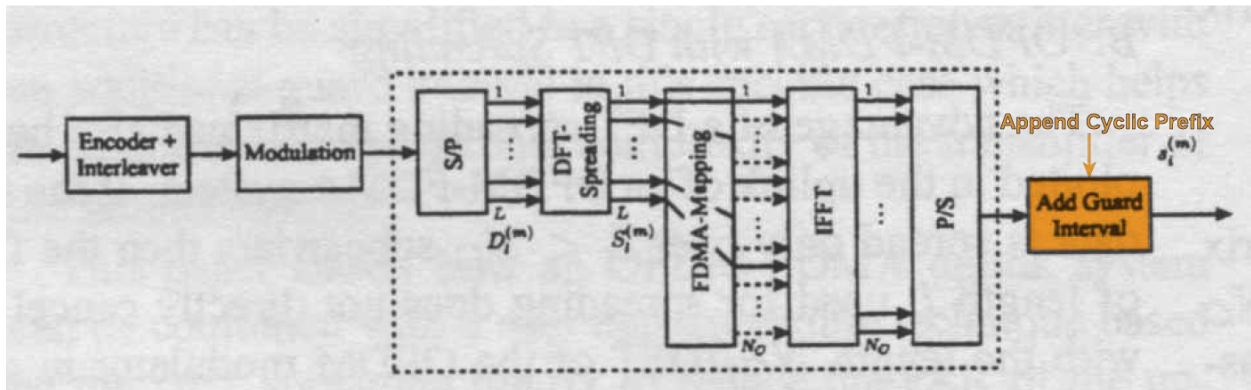
with $l = 0, \dots, L - 1$ ”).

Therefore, Galda discloses and renders obvious claim 6.

4. *Claim 7*

Galda further discloses and renders obvious *adding a cyclic prefix to the time-domain waveform.*” EX1002, ¶¶180-82.

Galda’s Fig. 6(a) shows a block “Add Guard Interval,” which Galda explains adds “a guard interval as a cyclic prefix” onto the DFT-spread OFDM signal:



EX1004, p.1740 (Fig. 6(a) (annotated); *see also id.*, pp.1737 (noting that interferences can be avoided by “by introducing an additional guard interval into the OFDM symbol”), 1739 (“a guard interval is added in the time domain as a cyclic prefix”); EX1002, ¶¶181.

Thus, Galda discloses and renders obvious claim 7.

5. *Claim 10*

Galda discloses or renders obvious *wherein modulating is configured to provide for orthogonal frequency division multiple access.* EX1002, ¶¶183-87.

Galda explains that the system can include a total of N_C subcarriers, of which L subcarriers are allocated to a particular user. EX1004, p.1038 (“In principle, the set of subcarrier assigned to each user can be composed of any L out of N_C subcarrier that have not been assigned to another user.”). Galda generates a “transmit time signal $s_i^{(m)}$ of user m in an OFDM-FDMA uplink” and also refers to this signal as an “OFDM time signal of user m .” EX1004, pp.1738, 1739. This is generated by the OFDM modulation in Galda. EX1002, ¶¶184-86. The OFDM modulation provides *orthogonal frequency division multiple access* for the users. This is the point of Galda’s “OFDM-FDMA” scheme, which stands for “orthogonal frequency division-frequency division multiple access.” EX1004, p.1737 (referring to scheme as a “OFDM-FDMA multiple access scheme”); EX1002, ¶186.

Thus, Galda discloses and renders obvious claim 10.

B. Ground 3: Claims 11, 12, 16, 17, 20-22, 26, 27, and 30 would have been obvious over Galda in view of Dowling

1. Overview of the combination; motivation to combine; expectation of success

Ground 3 relies on Galda in view of Dowling and addresses claims 11, 12, 16, 17, 20, 21, 22, 26, 27, and 30. Claims 11, 12, 16, 17, and 20 require “*at least one processor*” [11A] and “*a non-transitory computer-readable memory communicatively coupled to the at least one processor, the non-transitory computer-readable memory including a set of instructions stored thereon and executable by*

the at least one processor” [11B]. Similarly, claims 21, 22, 26, 27, and 30 require “a non-transitory computer readable storage device having computer readable program code stored therein, said program code containing instructions executable by one or more processors of a computer system” [21Pre]. Otherwise, these claims correspond to claims 1, 2, 6, 7, and 10.

While these claims require computer instructions stored in memory, Galda does not explicitly state whether the disclosed system is implemented in hardware or a combination of hardware and software. EX1002, ¶¶188-89. Nevertheless, a POSITA would have understood that Galda would have needed to be implemented using at least one of these technologies. *Id.* A POSITA would have found it obvious to implement Galda in software stored in memory coupled to a processor such that the software is executed by the processor. *Id.*

A POSITA knew that transmitters could be implemented in hardware or software. For example, Dowling explains that various aspects of an OFDM transmitter including its modulation techniques “may be implemented as software modules which execute on a programmable processor architecture.” EX1042, 3:46-50; *see id.* at 5:66-6:1 (disclosing that the transmitter, receiver, and precoder may be implemented in hardware or software”); 21:62-64 (disclosing that the “present invention” is applicable to FFT based multicarrier modulation and OFDM systems). In a software implementation, software is stored in some form of memory, and is

provided from memory to a processor for execution as was well known to a POSITA. EX1002, ¶¶190-91. Indeed, those skilled in the art were aware of “software radios” that used code in memory and processors to execute that code to provide flexibility in design and updating, as opposed to hardware which was significantly more difficult to upgrade because it is fixed in silicon. EX1002, ¶191; EX1008 (describing OFDM-CDMA software radio); EX1011, ¶¶[0124]-[0125] (noting that modulation “and other techniques” can be implemented in “hardware, software, or a combination thereof”).

A POSITA would have been motivated to implement Galda’s spreading, mapping, modulation, and cyclic prefix appending functions (among others) in a software radio (including code in memory and a processor coupled to memory to execute the code) rather than in specialized hardware because doing so would have involved (a) the simple substitution of one known element (a software-based transmitter) for another (hardware implementation of same) to obtain predictable results (the same functionality performed in software rather than hardware), (b) the predictable use of prior art elements (software-based transmitter components) according to their established functions (i.e., performing the same functions taught by Galda), and (c) applying a known technique (software implementation) to a known device (Galda’s transmitter) ready for improvement—e.g., in need of implementation details—to yield predictable results (a transmitter performing

Galda's operations in software). EX1002, ¶¶192-93.

A POSITA also would have expected to succeed in making this combination. Galda discloses an OFDM transmitter and defines the various mathematical operations for each of the components. Implementing these mathematical operations in software would have required only routine knowledge because software is especially well-suited for performing mathematical operations. EX1002, ¶194. Given the number of disclosures indicating that those in the field were aware that various transmitter functions were able to be implemented in either hardware or software—two known alternatives—a POSITA would have reasonably expected in achieving a software implementation using instructions stored on a memory for execution by a processor. *Id.*

2. *Claims 11 and 21*

- a. [11Pre], [11A], [11B], [21Pre]: Apparatus, processor, memory, computer program product

Galda in view of Dowling renders obvious the following aspects of claims 11 and 21:

[11Pre] An apparatus for communication in a wireless communication network, the apparatus comprising: [11A] at least one processor; and [11B] a non-transitory computer-readable memory communicatively coupled to the at least one processor, the non-transitory computer-readable memory including a set of instructions stored

thereon and executable by the at least one processor for:

[21Pre] *A computer program product for communication in a wireless communication network, the computer program product comprising a non-transitory computer readable storage device having computer readable program code stored therein, said program code containing instructions executable by one or more processors of a computer system for*

Galda discloses and renders obvious an apparatus for communication in a wireless network as recited in **[11Pre]** for the reasons explained in connection with **[1Pre]**, above. *Supra* §VIII.A.1.a.

Dowling explains that various aspects of an OFDM transmitter including its modulation techniques “may be implemented as software modules which execute on a programmable processor architecture.” EX1042, 3:46-50; *see id.* at 5:66-6:1 (disclosing that the transmitter, receiver, and precoder may be implemented in hardware or software); 21:62-64 (disclosing that the “present invention” is applicable to FFT based multicarrier modulation and OFDM systems). In a software implementation, software is stored in *memory*, and is provided from memory to a *processor* for execution. EX1002, ¶¶195-98. This software is *computer-readable program code* and the memory is a *computer-readable memory* because it can be read by a *processor* to obtain the software code for execution. A POSITA knew about “software radios” with code in memory and processors to execute that code to

provide flexibility in design and updating, as opposed to hardware which was significantly more difficult to upgrade because it is fixed in silicon. EX1002, ¶197; EX1008 (describing OFDM-CDMA software radio); EX1011, ¶¶[0124]-[0125] (modulation can be implemented in “hardware, software, or a combination thereof”). For the reasons already explained above, a POSITA would have found it obvious to implement Galda in software stored on memory for execution by a processor coupled to the memory as recited in claims 11 and 21. *Supra* §VIII.B.1.

Thus, Galda in view of Dowling discloses and renders obvious elements [13Pre], [13A], [13B], [25Pre].

b. [11Ci], [21A]: encoding data symbols to produce subcarrier values

Limitations [11Ci] and [21A] are the same as Limitation [1A]. *Supra* §VIII.A.1.b; EX1002, ¶199. Limitations [11Ci] and [21A] are disclosed and rendered obvious by Galda for same reasons as Limitation [1A]. *Id.* It would have been obvious to implement the functionality recited in this limitation in software stored in memory for execution by a processor for the reasons provided above based on Galda in view of Dowling. *Supra* §VIII.B.1.

c. [11Cii], [21B]: modulating subcarrier values onto OFDM subcarriers

Limitations [11Cii] and [21B] are the same as Limitation [1B]. *Supra* §VIII.A.1.c; EX1002, ¶200. Limitations [11Cii] and [21B] are obvious for same

reasons as Limitation [1B]. *Id.* It would have been obvious to implement the functionality recited in this limitation in software stored in memory for execution by a processor for the reasons provided above based on Galda in view of Dowling. *Supra* §VIII.B.1.

d. [11Ciii], [21C]: producing time-domain waveform

Limitations [11Ciii] and [21C] are the same as Limitation [1C]. *Supra* §VIII.A.1.d; EX1002, ¶201. Limitations [11Ciii] and [21C] are disclosed and rendered obvious by Galda for same reasons as Limitation [1C]. *Id.* It would have been obvious to implement the functionality recited in this limitation in software stored in memory for execution by a processor for the reasons provided above based on Galda in view of Dowling. *Supra* §VIII.B.1.

e. [11Civ], [21D]: subcarrier values comprise first, second polyphase codes

Limitations [11Civ] and [21D] are the same as Limitation [1D]. *Supra* §VIII.A.1.e; EX1002, ¶202. Limitations [11Civ] and [21D] are disclosed and rendered obvious by Galda for same reasons as Limitation [1D]. *Id.* It would have been obvious to implement the functionality recited in this limitation in software stored in memory for execution by a processor for the reasons provided above based on Galda in view of Dowling. *Supra* §VIII.B.1.

f. [11Cv], [21E]: interference producing periodic pulse waveforms

Limitations [11Cv] and [21E] are the same as Limitation [1E]. *Supra* §VIII.A.1.f; EX1002, ¶¶203-04. Limitations [11Cv] and [21E] are disclosed and rendered obvious by Galda for same reasons as Limitation [1E]. *Id.* It would have been obvious to implement the functionality recited in this limitation in software stored in memory for execution by a processor for the reasons provided above based on Galda in view of Dowling. *Supra* §VIII.B.1.

Thus, Galda in view of Dowling renders obvious claims 11 and 21.

3. *Claims 12 and 22*

Claim 12 is the same as claim 2. *Supra* §VIII.A.2; EX1002, ¶¶205-07. Accordingly, Galda discloses and renders obvious claim 12 for the same reasons provided with respect to claim 2. *Supra* §VIII.A.2. Claim 22 is substantively the same as claim 2 but instead of reciting “*n is an integer that varies to provide incremental phase offsets to the set of N code chips,*” claim 22 states: “*an mth one of the plurality of polyphase codes comprises a set of N code chips corresponding to a set of integers $n=\{0, \dots, N-1\}$.*” This is disclosed by Galda because Galda’s “*L orthogonal code vectors $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,l})$ with $l = 0, \dots, L - 1,$ ” EX1004, p.1738, have *L* code chips that correspond to a set of integers $n=\{0, \dots, N-1\}$ because $l = 0, \dots, L - 1.$ *Id.*; EX1002, ¶206. The only difference is in the variable*

used (i.e., n vs. l and N vs. L), where the variables here are arbitrary. EX1002, ¶206. Galda in view of Dowling thus renders obvious claims 12 and 22.

4. *Claims 16 and 26*

Claims 16 and 26 are the same as claim 6. *Supra* §VIII.A.3; EX1002, ¶¶208-09. Accordingly, Galda discloses and renders obvious claims 16 and 26 for the same reasons provided with respect to claim 6. *Supra* §VIII.A.3. Galda in view of Dowling thus renders obvious claims 16 and 26.

5. *Claims 17, 27*

Claims 17 and 27 are the same as claim 7. *Supra* §VIII.A.4; EX1002, ¶¶210-11. Accordingly, Galda discloses and renders obvious claims 17 and 27 for the same reasons provided with respect to claim 7. *Supra* §VIII.A.4. Galda in view of Dowling thus renders obvious claims 17 and 27.

6. *Claims 20, 30*

Claims 20 and 30 are the same as claim 10. *Supra* §VIII.A.5; EX1002, ¶¶212-13. Accordingly, Galda discloses and renders obvious claims 20 and 30 for the same reasons provided with respect to claim 10. *Supra* §VIII.A.5. Galda in view of Dowling thus renders obvious claims 20 and 30.

C. Ground 4: Claim 9 is obvious over Galda in view of Doufexi;

Ground 5: Claims 19 and 29 are also obvious over Galda in view of Dowling and further in view of Doufexi;

Ground 6: Claim 9 is obvious over Galda in view of Lucent;

Ground 7: Claim 19 and 29 are obvious over Galda in view of Dowling and further in view of Lucent;

Ground 8: Claim 9 is obvious over Galda in view of Ma;

Ground 9: Claims 19 and 29 are obvious over Galda in view of Dowling and further in view of Ma.

1. Overview of the combinations; motivations to combine; expectation of success

Grounds 4, 6, and 8 rely on Galda as applied to claim 1, above. *Supra* §VIII.A. Grounds 5, 7, and 9 rely on the combination of Galda and Dowling as applied to claims 11 and 21, above. *Supra* §VIII.B. These grounds are treated together because they present similar issues. Claims 19 and 29 use the same language as claim 9. And, Doufexi, Lucent, and Ma all describe the benefits of having systems that support variable subcarrier spacings.¹²

Galda explains that “[t]he FDMA multiple access scheme offers not only a

¹² To the extent that the Board determines that the ’285 Patent is entitled to a priority date that removes Ma as a prior art reference, Petitioner relies upon Lucent and Doufexi, which provide similar teachings and qualify as prior art even assuming the earliest priority date for the ’285 Patent.

high flexibility for radio resource management (RRM) but can also increase the bandwidth efficiency of the complete system by avoiding the use of highly attenuated subcarriers for specific users based on the knowledge of the channel transfer function.” EX1004, p.1737. Galda does not explain what its subcarrier spacing is or state whether it is fixed or variable. EX1002, ¶214.

A POSITA knew that there were benefits to using variable sub-carrier spacings in OFDM communications systems. These benefits are revealed in each of Doufexi, Lucent, and Ma.

Doufexi explains that “OFDM is proposed as being a leading candidate for a 4G cellular communications standard.” EX1003, p.192. “[K]ey design considerations and link parameters for a 4G OFDM system are identified” including “subchannel spacing.” *Id.* Doufexi motivates a POSITA to use selectable link parameters: “Since 4G systems will be deployed in a wide range of environments, a fixed set of parameters is not capable of achieving high performance in all cases.” *Id.*; EX1002, ¶¶215-16. “A system capable of dynamically adapting one or more of the above parameters may offer superior performance.” EX1003, p.192; EX1002, ¶216. Thus, Doufexi provides different “parameters and transmission modes” shown in the following table:

Table 2. OFDM Parameters for 4G.

Parameter	Value 1	Value 2
Operating Frequency	2GHz	2GHz
Bandwidth (B)	4096 kHz	4096 kHz
Useful Symbol Duration (T)	62.5 μ s	125 μ s
Guard Interval Duration (T_g)	15.625 μ s ($T/4$)	31.25 μ s ($T/4$)
Total Symbol Duration (T_{symbol})	78.125 μ s (with $GI = T/4$)	156.25 μ s (with $GI = T/4$)
Inner Channel Coding	Punctured 1/2 rate convolution code, Constraint length 7, {133, 171} _{octal}	Punctured 1/2 rate convolution code, Constraint length 7, {133, 171} _{octal}
FFT Size	256	512
Number of data sub-carriers (N_D)	216	432
Sub-carrier spacing (Δ_f)	16 kHz	8 kHz

EX1003, p.193. As shown here, various parameters are adjusted including “sub-carrier spacing (Δ_f).” *Id.*; EX1002, ¶¶217-18. Thus, Doufexi motivates a POSITA to have a system in which the subcarrier spacing can be selected from among a plurality of subcarrier spacings. EX1002, ¶218. Such a capability can provide a system that achieves “high performance” in “a wide range of environments” and “superior performance.” EX1003, pp.192-193; EX1002, ¶218. Thus, a POSITA would have been motivated to allow Galda’s system and method to select one of a plurality of selectable subcarrier spacings based on Doufexi.

Lucent, a submission to 3GPP by Lucent, provides a proposal for a “[b]aseline OFDM [s]ystem[] for [s]tudy.” EX1006, p.1. Lucent provides “three reference configurations” for the proposed “baseline OFDM system.” EX1006, p.5. These are shown in the table below:

System Parameters	Configuration 1	Configuration 2	Configuration 3
Suitable deployment environment	Indoor, Pedestrian A	Vehicular A	Pedestrian B
Symbol per 0.67 msec time slot	12	6	3
Number of FFT points	256	512	1024
Number of sub-carriers	256	512	1024
OFDM Symbol period (usec)	55.6	111	222
Sub-carrier spacing (kHz)	19.2	9.6	4.8
Guard band on each side of the 5MHz band (kHz)	42.4	42.4	42.4
Sampling period (usec)	0.20345025	0.20345025	0.20345025
Guard time $T_g = T_{prefix} + T_{postfix}$ (samples/usec)	17/3.46	34/6.92	68/13.8
Cyclic prefix length (samples/usec)	5/1.017252604	16/3.255204	50/10.17252604
Power amplifier ramp-up and ramp-down period (samples)	6 samples each	9 samples each	9 samples each

EX1006, p.5. Lucent explains that the different configurations are associated with different “suitable deployment environment[s].” *Id.*; *see also id.*, p.7 (“We have suggested an OFDM system with multiple configurations that can be deployed in different environments.”). One difference between the three configurations proposed by Lucent is the subcarrier spacing. There are three options: 19.2 kHz, 9.6 kHz, and 4.8 kHz. *Id.* Lucent thus reflects a similar theme to that found in Doufexi—different use cases call for different subcarrier spacings and other transmission parameters. EX1002, ¶¶230-33. A POSITA knew that a user may have a mobile station (e.g., a UE) that was used in each of the scenarios. EX1002, ¶234. For example, a user may be in a car moving at 100 km/h (configuration 2), stop and get out of the car and

walk across a parking lot (configuration 3), and then enter a building (configuration 1). EX1002, ¶234. Thus, each of these configurations may provide better performance than the other configurations depending on the environment in which the UE is located. *Id.* Thus, a POSITA would have been motivated to allow Galda's system and method to select one of a plurality of selectable subcarrier spacings based on Lucent.

Ma describes systems and methods for implementing variable subcarrier spacings and symbol durations in OFDM systems. EX1033, ¶[0002]. Ma partitions frequency and time planes into "multiple access block" ("MAB") regions where each MAB has a different subcarrier spacing and symbol duration. *Id.*, ¶¶[0004], [0028], [0030]-[0031], Fig. 5. Ma's flexible subcarrier spacings and symbol durations "may aid in mitigating problems associated with fixed subcarrier spacing and fixed symbol duration." EX1033, ¶[0028]. Ma's technique can allow parameters to be "selected to meet performance and efficiency demands" thus providing "higher spectral efficiency, greater flexibility, and shorter latencies than is otherwise provided by static sub-carrier spacing and symbol duration allocation of conventional OFDM schemes." *Id.*, ¶[0036]. Therefore, Ma provides explicit motivation for a POSITA to employ flexible subcarrier spacings in Galda's systems and methods. EX1002, ¶¶246-49.

Based on the foregoing a POSITA would have found it obvious to select *one*

of the plurality of subcarrier spacings when selecting the subcarriers for Galda's user because the prior art provides express motivation to do so. EX1002, ¶¶218, 235, 249. A POSITA would have seen benefits in configuring Galda to select one of a plurality of subcarrier spacings when selecting a user's subcarrier including (1) achieving "high" or "superior" performance in "a wide range of environments" as stated by Doufexi, (2) enabling different configurations for different UE environments as taught by Lucent, and (3) providing for "higher spectral efficiency, greater flexibility, and shorter latencies" in various scenarios as taught by Ma. EX1002, ¶¶218, ¶235, 250.

Additionally, a POSITA would have found it obvious to select from a plurality of subcarrier spacings when selecting a user m 's subcarriers in Galda because doing so was one of two possible choices: either employ a fixed subcarrier spacing or employ a variable or selectable subcarrier spacing. EX1002, ¶¶219, 236, 251. And, there were known benefits of providing for selectable subcarrier spacings as outlined above. *Id.*

Using the selectable subcarrier spacings and permitting Galda to select them as part of selecting the set of subcarriers for a particular user (m) would have merely used a known technique of using selectable subcarrier spacings as in each of Doufexi, Lucent, and Ma to improve Galda by allowing it to be adaptable to different environments and deployment scenarios thus increasing system flexibility. EX1002,

¶¶220, 237, 252. The results of the combination would have been predictable because various system parameters would be adjusted to permit either a larger or smaller subcarrier spacing and symbol duration thus improving performance depending on the channel conditions. *Id.*

A POSITA would have reasonably expected to succeed in making the combination because POSITAs were aware of the benefits of selecting different subcarrier spacings depending on channel conditions, deployment scenarios, and/or environmental conditions. EX1002, ¶¶221, 238, 252. A POSITA was also aware of the mathematical relationships between OFDM symbol duration and subcarrier spacing that are needed to maintain orthogonality. EX1002, ¶¶221, 238, 252; EX1015, p.22 (“[T]he carriers are linearly independent (i.e., orthogonal) if the carrier spacing is a multiple of $1/T$.”). These parameters were commonly considered by a POSITA in OFDM system design and this was textbook knowledge. EX1015, p.33 (“In OFDM systems design, a number of parameters are up for consideration, such as the number of subcarriers, guard time, symbol duration, subcarrier spacing, ...”).

2. Claim 9

Galda in view of (1) Doufexi (Ground 4), (2) Lucent (Ground 6), or (3) Ma (Ground 8) renders obvious *wherein modulating comprises selecting one of a set of subcarrier frequency spacings*. EX1002, ¶¶222-27, 239-43, 253-55. Galda describes

modulating spread data symbols, i.e., “ L complex transmit symbols $S_l^{(m)}$ onto subcarriers and creating a “resulting OFDM time signal of user m ” using an IFFT. EX1004, pp.1738-1730; EX1002, ¶¶223. Galda explains that the subcarriers are orthogonal. Galda says:

Inter symbol interferences (ISI) as well as inter carrier interferences (ICI) can be completely avoided by dividing the total system bandwidth into a large number of spectrally overlapping but mutually orthogonal non-frequency selective narrow-band subchannels and by introducing an additional guard interval into the OFDM symbol. Even at the output of a frequency selective channel this orthogonality of the subcarriers can be maintained.

EX1004, p. 1737. Galda further states:

The subdivision of the transmission bandwidth into a set of orthogonal subcarriers can additionally be exploited by an OFDM-FDMA multiple access scheme.

Id.. A POSITA would have known that orthogonality between subcarriers requires the subcarrier spacing to be a multiple of the symbol duration. EX1002, ¶¶225; EX1015, p.22 (“[T]he carriers are linearly independent (i.e., orthogonal) if the carrier spacing is a multiple of $1/T$.”).

Galda does not say that *modulating comprises selecting one of a set of subcarrier frequency spacings*. Each of Doufexi, Lucent, and Ma describe selectable

sets of subcarrier spacings.

Doufexi: Doufexi describes two OFDM transmission modes with different parameter values including two different subcarrier spacings—i.e., *a set of selectable frequency spacings*—namely subcarrier spacings (Δ_f) of 16 kHz and 8kHz as shown in the table highlighted below:

Table 2. OFDM Parameters for 4G.

Parameter	Value 1	Value 2
Operating Frequency	2GHz	2GHz
Bandwidth (B)	4096 kHz	4096 kHz
Useful Symbol Duration (T)	62.5 μ s	125 μ s
Guard Interval Duration (T_g)	15.625 μ s ($T/4$)	31.25 μ s ($T/4$)
Total Symbol Duration (T_{symbol})	78.125 μ s (with $GI = T/4$)	156.25 μ s (with $GI = T/4$)
Inner Channel Coding	Punctured 1/2 rate convolution code, Constraint length 7, {133, 171} _{octal}	Punctured 1/2 rate convolution code, Constraint length 7, {133, 171} _{octal}
FFT Size	256	512
Number of data sub-carriers (N_D)	216	432
Sub-carrier spacing (Δ_f)	16 kHz	8 kHz

EX1003, p.193; EX1002, ¶¶226-27.

Lucent: Lucent describes three OFDM system configurations that use three different subcarrier spacings—i.e., 19.2 kHz, 9.6 kHz, and 4.8 kHz. EX1006, p.5; EX1002, ¶¶239-43. Thus, Lucent teaches *a set of selectable frequency spacings*. This is shown in the table below:

System Parameters	Configuration 1	Configuration 2	Configuration 3
Suitable deployment environment	Indoor, Pedestrian A	Vehicular A	Pedestrian B
Symbol per 0.67 msec time slot	12	6	3
Number of FFT points	256	512	1024
Number of sub-carriers	256	512	1024
OFDM Symbol period (usec)	55.6	111	222
Sub-carrier spacing (kHz)	19.2	9.6	4.8
Guard band on each side of the 5MHz band (kHz)	42.4	42.4	42.4
Sampling period (usec)	0.20345025	0.20345025	0.20345025
Guard time $T_g = T_{prefix} + T_{postfix}$ (samples/usec)	17/3.46	34/6.92	68/13.8
Cyclic prefix length (samples/usec)	5/1.017252604	16/3.255204	50/10.17252604
Power amplifier ramp-up and ramp-down period (samples)	6 samples each	9 samples each	9 samples each

EX1006, p.5; EX1002, ¶¶240-42.

Ma: Ma describes “methods for supporting variable sub-carrier spacing and symbol duration for transmitting OFDM symbols and associated cyclic prefixes.” EX1033, ¶[0024]. “The flexible sub-carrier spacing and symbol duration allocation (e.g., corresponding to various MAB [multiple access block] types) may be defined by various OFDM parameters (or frequency primitives), such as subcarrier-spacing, useful symbol length, cyclic prefix length, or combinations thereof.” *Id.*, ¶[0031]. In one embodiment, Ma describes subcarrier spacings of Δf , $2\Delta f$, and $4\Delta f$, where Δf is 15kHz. *Id.* Thus, Ma discloses *a set of selectable frequency spacings* (e.g., 15 KHz, 30 kHz, and 60 kHz). EX1002, ¶¶253-55.

During modulation, Galda's OFDM modulator would need to choose the combination of symbol duration and subcarrier spacing to ensure orthogonality. EX1002, ¶254; EX1015, p.22. Thus, it would have been obvious to have Galda's modulation step perform the additional *selecting* function. Based on these teachings and for the reasons explained above, a POSITA would have found it obvious to modify Galda to perform a step of *modulating comprises selecting one of a set of subcarrier frequency spacings* based on Doufexi, Lucent, or Ma. *Supra* §VIII.C.1.

3. *Claims 19 and 29*

Claims 19 and 29 are the same as claim 9. *Supra* §VIII.C.2; EX1002, ¶¶228-29, 244-45, 256-57. Accordingly, Galda in view of Doufexi, Lucent, or Ma renders obvious claims 19 and 29 for the same reasons provided with respect to claim 9. *Supra* §VIII.C.2. Galda in view of Dowling and further in view of Doufexi (Ground 5) or further in view of Lucent (Ground 7) or further in view of Ma (Ground 9) thus renders obvious claims 19 and 29.

X. DISCRETIONARY DENIAL UNWARRANTED¹³

A. *Fintiv* Factors Favor Institution

The *Fintiv* factors—as applied per the March 24, 2025 Guidance on the

¹³ Petitioner presents these arguments without waiving additional briefing under the USPTO's March 26, 2025 "Interim Process for Workload Management."

USPTO rescission of the Interim Procedure (EX1060, “Boalick Memo”) guides against discretionary denial. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (Mar. 20, 2020) (precedential).

1. Petitioner Will Seek a Stay

Factor 1 favors institution. Petitioner will seek a stay of co-pending litigation pending the outcome of this and related IPRs and reexaminations. The Eastern District of Texas has granted stays before claim construction because such cases have “not reached such an advanced stage that it would weigh against a stay.” *Broadphone LLC v. Samsung Elecs. Co., Ltd.*, 2024 WL 3524022, at *2-3 (E.D. Tex. July 24, 2024) (granting stay where “significant amount of discovery remains, the claim construction hearing has not occurred, and trial is currently set for [over six months later]”).

2. Parallel Proceeding Trial Date

Factor 2 is at worst neutral. A jury trial is scheduled for April 20, 2026. EX1046, p.1. With this petition being filed in March 2025, a final written decision may be expected by September 2026, only five months after the scheduled trial date, assuming the trial date holds, which, at present is unlikely. Judge Schroeder has scheduled four patent jury trials scheduled for April 20, 2026. EX1061, p.1; EX1062, p.1; EX1063, p.1; EX1064, p.5 (resetting trial to 4/20/2024). “[T]he Board may consider any evidence that the parties make of record that bears on the

proximity of the district court’s trial date.” EX1060, p.2. Because four patent cases cannot be tried simultaneously which (if any) trial will proceed is speculative. *Boe Tech. Grp. Co. v. Optronix Scis. LLC*, No. IPR2024-01130, Paper 16, at 10 (Jan. 27, 2025) (Fintiv factor 2 “neutral or weigh[s] slightly in favor of not exercising discretion” where district court “set 10 cases for jury selection on the same day”).

Even when the Final Written Decision (“FWD”) may come after the trial date, the Board has instituted trial based on many of factors present here, such as diligence in filing the petition, a stipulation not to pursue the asserted grounds in litigation, minimal investment in litigation, and the merits of the challenge were strong. *Lego Sys., Inc. v. Mq Gaming LLC*, No. IPR2020-01445, Paper 12, at 17 (Feb. 16, 2021) (finding jury trial “five months before a final written decision” outweighed by “low” “investment by the court and parties in the [parallel case] on” common issues, Petitioner’s *Sotera* stipulation, and strong merits to the challenge); *Verizon Business Network Services, Inc. v. Huawei Techs. Co.*, IPR2020-01141, Paper 12, at 17-18 (Jan. 14, 2021). Petitioner diligently filed this petition particularly considering the complexity of the analysis undertaken across eight asserted patents that collectively have (1) 638 pages, (2) 243 claims, (3) a range of effective filing dates, and (4) are part of a patent family that was pending before the Office for about two decades. EX1047, ¶1; EX1065. The way Patent Owner structured its patent families, shifted patent disclosures from one application to the next, and, at times, incorporated

dozens of patents and publications by reference, placed a significant burden on Petitioner to assess its positions. EX1023, pp.233-236, 241; EX1031, pp.24, 26, 29, 32, 36, 44. The complexity presented by this, and the seven other IPR petitions Petitioner is filing, weigh strongly in favor of institution. *Apple, Inc. v. SEVEN Networks, LLC*, IPR2020-00156, Paper 10 at 21-22 (June 15, 2020) (“complexity of multiple patents and issues in the District Court Action” favored institution). Considering these procedural and technical complexities, the Board is uniquely situated to adjudicate patentability because of its expertise in patent law and technological questions.

3. *Investment in Parallel Proceeding*

Factor 3 weighs against discretionary denial. The district court case is in the early stages. Fact discovery is in its early stages: no depositions have occurred; expert discovery is many months away. Fact discovery will likely close December 1, 2025. EX1046, p.3. Expert discovery currently starts that same day. *Id.* A *Markman* hearing is scheduled for Oct. 21, 2025. *Id.* Where, as here, “the district court[s] ha[ve] not issued orders related to the patent at issue in the petition, this fact weighs against exercising discretion to deny institution.” *Fintiv* at 10.

4. *Stipulation Favors Institution*

Factor 4 weighs strongly against discretionary denial. Petitioner hereby stipulates that, if the IPR is instituted, Petitioner will not assert that any of the claims

challenged in this proceeding are invalid on any ground that Petitioner raised or reasonably could have raised during this inter partes review. *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12, at 19 (Dec. 1, 2020) (finding “stipulation here mitigates any concerns of duplicative efforts...as well as concerns of potentially conflicting decisions” and “ensures that an *inter partes* review is a ‘true alternative’ to the district court proceeding”); *Lego*, IPR2020-01445, Paper 12 at 16 (“*Fintiv* factor 4 weighs strongly against discretionary denial” where Petitioner makes *Sotera* stipulation); *Verizon Business Network Servs, Inc. v. Huawei Techs. Co.*, IPR2020-01141, Paper 12 (Jan. 14, 2021) (“[i]nstituting trial here serves overall system efficiency and integrity goals by not duplicating efforts and by resolving materially different patentability issues.”).

5. *Identity of the Parties*

Factor 5 is either neutral or weighs slightly against institution because Petitioner and Patent Owner are the same as in district court, but a “holistic view” favors institution. *Samsung Elecs. Co. Ltd. v. Dynamics Inc.*, IPR2020-00505, Paper 11, at 15 (Aug. 12, 2020).

6. *Merits Heavily Favor Institution*

Factor 6 favors institution. The compelling merits of the challenge presented herein further weigh heavily in favor of institution. As demonstrated by the Petition, the challenged claims are unpatentable the cited prior art, which was not previously

considered despite numerous continuation filings. For example, a single undisclosed reference—Galda—anticipates and/or obviates most challenged claims. The Board’s views on the patentability of the challenged claims will also benefit the public, which is otherwise faced with a thicket of similar and related patents that Patent Owner contends are essential to 4G and 5G wireless standards and which have been asserted against various companies. EX1096. This is the first and only IPR on the ’285 Patent, so a patentability determination by the Board on this Petition would conserve resources.

B. Denial Under §325(d) Unwarranted

The ’285 Patent was not rejected on any prior art, and the prior art in Petitioner’s Grounds was not mentioned or otherwise discussed by the Examiner during prosecution. Therefore, denial under § 325(d) is unwarranted.

XI. MANDATORY NOTICES

A. Real Party-In-Interest

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. are the real parties-in-interest.

B. Related Matters

The ’285 Patent is asserted in the following litigation: *GenghisComm Holdings, LLC v. Samsung Electronics America, Inc. f/k/a Samsung Telecommunications America LLC*, No. 24-cv-00242.

Patents in the same or related patent families and which name the same inventor have been challenged in the following post-grant proceedings:

- **U.S. Patent No. 9,768,842:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00780.
- **U.S. Patent No. 10,200,227:** U.S. Reexamination Control No. 90/019,411; *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00781.
- **U.S. Patent No. 10,389,568:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00788.
- **U.S. Patent No. 11,075,786:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00789; Petitioner also anticipates filing a request for reexamination as to this patent to raise grounds that cannot be raised in this proceeding.
- **U.S. Patent No. 11,223,508:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00790; Petitioner also anticipates filing a request for reexamination as to this patent to raise grounds that cannot be raised in this proceeding.
- **U.S. Patent No. 11,252,005:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00791; Petitioner also anticipates filing a request for reexamination as to this patent to raise

grounds that cannot be raised in this proceeding.

- **U.S. Patent No. 11,424,792:** U.S. Reexamination Control No. 90/019,848; *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00793.

A patent in the same family as the '786 Patent—i.e., U.S. Patent No. 11,431,386—is asserted in *GenghisComm Holdings, LLC v. Samsung Electronics America, Inc.*, No. 2:24-cv-901-RWS-RSP (E.D. Tex.).

C. Lead and Back-Up Counsel

Petitioner designates the following lead and back-up counsel:

Lead Counsel	Back-Up Counsel
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D. Service

Petitioner consents to service by email on the following email addresses: GT-Genghiscomm-IPR@gtlaw.com.

XII. FEES

The required fee is being paid electronically through P-TACTS.

Dated: April 7, 2025

Respectfully Submitted,

/Andrew R. Sommer/

Andrew R. Sommer
Reg. No. 53,932

CERTIFICATE OF COMPLIANCE

This petition complies with the word count limits set forth in 37 C.F.R. § 42.24(a)(i), effective May 2, 2016, because this Petition contains 12,184 words, excluding the parts of the petition exempted by 37 C.F.R. § 42.24(a), as determined using the word count provided by Microsoft Word, which was used to prepare this Petition.

Dated: April 7, 2025

Respectfully Submitted,

/Andrew R. Sommer/

Andrew R. Sommer
Reg. No. 53,932

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e) and 42.105(a), the undersigned certifies that on April 7, 2025 I caused a true and correct copy of **PETITION FOR *INTER PARTES* REVIEW OF CLAIMS 1, 2, 6, 7, 9-12, 16, 17, 19-22, 26, 27, 29, AND 30 OF U.S. PATENT NO. 11,381,285, PETITIONER’S POWER OF ATTORNEY BY SAMSUNG ELECTRONICS CO., LTD., PETITIONER’S POWER OF ATTORNEY BY SAMSUNG ELECTRONICS AMERICA, INC., AND EXHIBIT NOS. 1001-1004, 1006-1017, 1019, 1021-1023, 1030-1034, 1038-1039, 1042, 1046-1047, 1049, 1059-1069, 1074, 1087, 1089, AND 1096** by EXPRESS MAIL on the Patent Owner at the correspondence address of record for U.S. Patent No. 11,381,285 as follows:

Mr. Steven J Shattil
P.O. Box 17355
Boulder, CO 80308-0355
UNITED STATES

I further certify that a courtesy copy of the above-identified materials were served on litigation counsel by electronic means upon the foregoing individuals:

Alison Richards, Esq. – aricahrds@giplg.com

/Andrew R. Sommer/

Andrew R. Sommer
Reg. No. 53,932