

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: IPR2025-00793
U.S. Patent No. 11,424,792

**PETITION FOR *INTER PARTES* REVIEW OF CLAIMS 1-3, 5, 8-10, 12,
15-17, AND 19 OF U.S. PATENT NO. 11,424,792**

Mail Stop Patent Trial and Appeal Board
United States Patent and Trademark Office
PO Box 1450
Alexandria, Virginia 22313-1450
Submitted Electronically via P-TACTS

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LISTING OF CLAIMS

Claim 1. [1Pre] A method of enabling a flexible channel bandwidth for mobile radio communications, comprising:

[1A] provisioning a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for mobile radio communications;

[1B] encoding data symbols with polyphase codes derived from a discrete Fourier transform to produce encoded data symbols; and

[1C] modulating the encoded data symbols onto the OFDM subcarriers to produce a superposition signal that resembles a single-carrier signal and has one of a plurality of different symbol durations;

[1D] wherein provisioning comprises selecting one of a plurality of different selectable subcarrier spacings, to provide for the one of the plurality of different symbol durations.

Claim 2. The method of claim 1, wherein at least one of the plurality of different selectable subcarrier spacings equals at least one other of the plurality of different selectable subcarrier spacings multiplied by a scaling factor that is a power of two.

Claim 3. The method of claim 1, wherein the superposition signal is provided with a cyclic prefix.

Claim 5. The method of claim 1, wherein the provisioning is performed by a user

device or a base station.

Claim 8. [8Pre] An apparatus for providing flexible channel bandwidth in mobile radio communications, comprising:

[8A] at least one processor; and

[8B] at least one non-transitory computer-readable memory in electronic communication with the at least one processor, and instructions stored in the at least one memory, the instructions executable by the at least one processor for:

[8Ci] provisioning a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for mobile radio communications;

[8Cii] encoding data symbols with polyphase codes derived from a discrete Fourier transform to produce encoded data symbols; and

[8Ciii] modulating the encoded data symbols onto the OFDM subcarriers to produce a superposition signal that resembles a single-carrier signal and has one of a plurality of different symbol durations;

[8Civ] wherein provisioning comprises selecting one of a plurality of different selectable subcarrier spacings, to provide for the one of the plurality of different symbol durations.

Claim 9. The apparatus of claim 8, wherein at least one of the plurality of different

selectable subcarrier spacings equals at least one other of the plurality of different selectable subcarrier spacings multiplied by a scaling factor that is a power of two.

Claim 10. The apparatus of claim 8, further comprising instructions stored in the at least one non-transitory computer-readable memory, the instructions executable by the at least one processor for adding a cyclic prefix to the superposition signal.

Claim 12. The apparatus of claim 12, wherein the provisioning is performed in a user device or a base station.

Claim 15. [15Pre] A computer program product, comprising a non-transitory computer-readable memory having computer readable program code stored therein, the program code containing instructions executable by one or more processors of a computer system for:

[15A] provisioning a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for mobile radio communications;

[15B] encoding data symbols with polyphase codes derived from a discrete Fourier transform to produce encoded data symbols; and

[15C] modulating the encoded data symbols onto the OFDM subcarriers to produce a superposition signal that resembles a single-carrier signal and has one of a plurality of different symbol durations;

[15D] wherein provisioning comprises selecting one of a plurality of

different selectable subcarrier spacings, to provide for the one of the plurality of different symbol durations.

Claim 16. The computer program product of claim 15, wherein at least one of the plurality of different selectable subcarrier spacings equals at least one other of the plurality of different selectable subcarrier spacings multiplied by a scaling factor that is a power of two.

Claim 17. The computer program product of claim 15, further comprising instructions stored in the at least one non-transitory computer-readable memory, the instructions executable by the at least one processor for adding a cyclic prefix to the superposition signal.

Claim 19. The computer program product of claim 15, wherein the provisioning is performed in a user device or base station.

PETITIONER’S EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 11,424,792 to Shattil (“’792 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 (Mar. 12, 2001).

Exhibit No.	Description
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	RESERVED
1018	RESERVED
1019	File History of U.S. Patent Application No. 14/967,633 as obtained from Patent Center (excerpts).
1020	RESERVED
1021	RESERVED
1022	RESERVED
1023	File History of U.S. Patent Application No. 10/145,854 as obtained from Patent Center (excerpts).
1024	RESERVED
1025	RESERVED
1026	RESERVED

Exhibit No.	Description
1027	RESERVED
1028	RESERVED
1029	RESERVED
1030	RESERVED
1031	File History of U.S. Patent Application No. 14/276,309 as obtained from Patent Center (excerpts)
1032	RESERVED
1033	RESERVED
1034	Declaration of Craig Bishop
1035	RESERVED
1036	RESERVED
1037	RESERVED
1038	RESERVED
1039	Exhibit 1 to Plaintiff's P.R. 3-1(c) Infringement Contentions (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).

Exhibit No.	Description
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
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

Exhibit No.	Description
	(Sept. 24, 2024).
1066	RESERVED
1067	RESERVED
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
1071	RESERVED
1072	RESERVED
1073	RESERVED
1074	RESERVED
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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

Exhibit No.	Description
	(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)
1090	File History of U.S. Patent Application No. 17/183,114 as obtained from Patent Center (excerpts)
1091	File History of U.S. Patent Application No. 12/328,917 as obtained from Patent Center (excerpts)
1092	File History of U.S. Patent Application No. 13/116,984 as obtained from Patent Center (excerpts)
1093	U.S. Patent No. 10,014,882
1094	U.S. Patent No. 7,430,257 to Shattil (“Shattil-257”)
1095	Search Results for Patent Applications of Steve Shattil
1096	RESERVED
1097	Exhibit 8 to Plaintiff’s P.R. 3-1(c) Infringement Contentions (U.S. Pat. No. 11,424,792)
1098	Results of Docket Navigator Search for ’792 Patent
1099	RESERVED
1100	Request for Certificate of Correction from U.S. Patent No. 10,673,758 (withdrawn after issuance)
1101	Request for Certificate of Correction from U.S. Patent No. 10,389,568
1102	Request for Certificate of Correction from U.S. Patent No. 10,778,492
1103	Request for Certificate of Correction for U.S. Patent No. 11,025,468

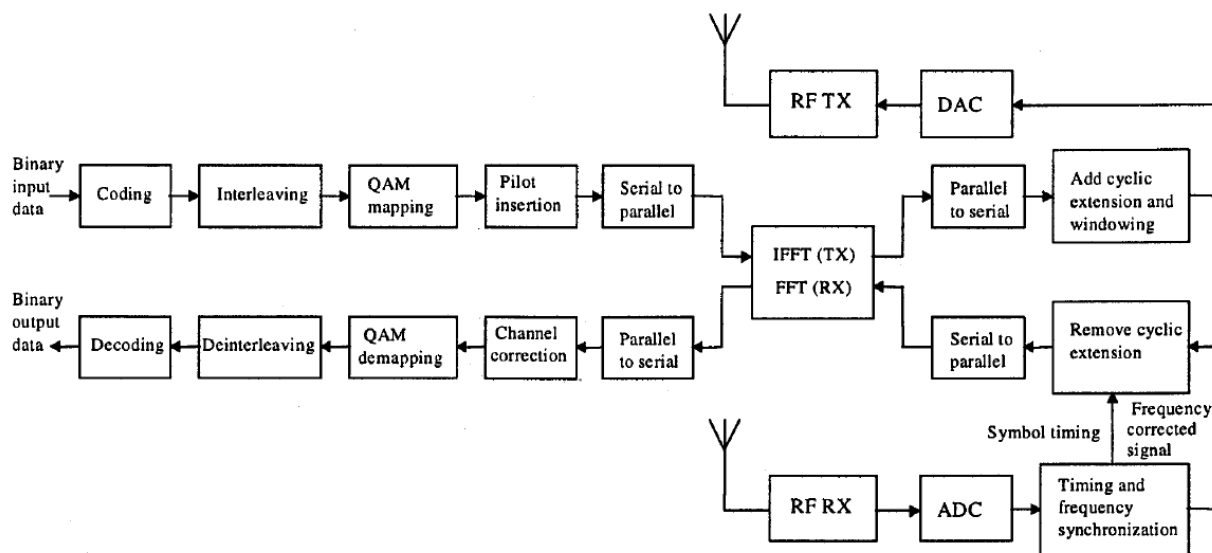
I. GROUNDS FOR STANDING

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 POSITA 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
	10	39062.500
512	12	46875.000
	1.25	2441.406
	1.5	2929.688
	2.5	4882.813
	3	5859.375
	5	9765.625
	6	11718.750
1024	10	19531.250
	12	23437.500
	1.25	1220.703
	1.5	1464.844
	2.5	2441.406
	3	2929.688
	5	4882.813
2048	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 POSITA. EX1002, ¶¶48-

58.

III. THE '792 PATENT

A. Overview of the Patent and Challenged Claims

The '792 Patent states that it describes “[a] flexible channel bandwidth for mobile radio communications” that is provided “by provisioning a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for mobile radio communications.” EX1001, Abstract.

Cooperative network coding can use “various types of linear network codes, including polyphase codes derived from a discrete Fourier transform....” EX1001, 7:53-59. In the uplink, UEs can “produce a transmission signal with low dynamic range (i.e., peak to average power). Thus, the UEs can employ CI coding on OFDM subcarriers to produce CI-OFDM (also known as single-carrier OFDM) signals.” *Id.*, 40:22-28. Symbol values may be “impressed onto the subcarriers” using an IFFT. *Id.*, 40:29-31, 40:37-39.

According to certain examples, “transceiver operating characteristics can be adaptable,” as reflected in Figure 16 (below). EX1001, 42:40-42.

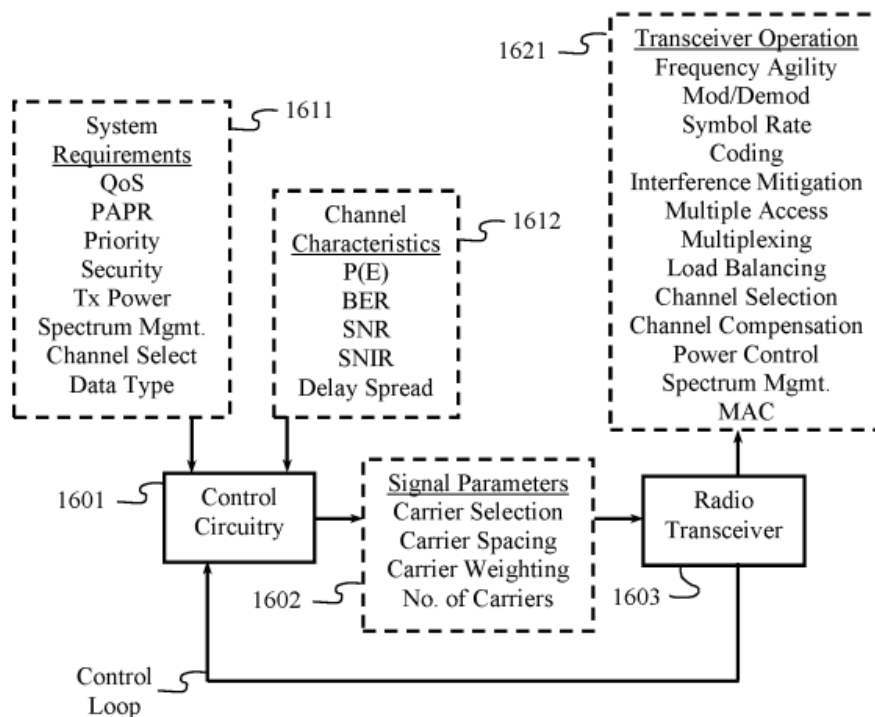


Figure 16

Id., FIG. 16.

Here, control circuitry 1601 receives “one or more system requirements 1611” and then can “adapt one or more signal parameters 1602 employed by a radio transceiver 1603, such as radio transceivers employed by UEs, etc.” *Id.*, 42:45-48. For example, “the control circuitry 1601 may scale a transmitted bit rate by scaling the symbol duration, the number of subcarriers, the subcarrier spacing, and/or the number of bits per symbol per subcarrier.” *Id.*, 42:51-54; EX1002, ¶¶44-47.

B. Prosecution History

Steve Shattil is both the sole inventor and the only patent agent of record in most of the dozens of applications in Patent Owner's portfolio, which Mr. Shattil prosecuted for over 20 years. EX1095, p.1. This section traces the prosecution history leading to the '792 Patent through the applications included in the claim for domestic benefit back to the filing of U.S. Patent Application No. 11/621,014 filed on January 8, 2007. In discussing the prosecution history of the '984 Application, reference is made to the discussion in the preceding section regarding the flawed domestic benefit claim. *Infra* §IV.

1. Application No. 17/183,114 (Challenged Patent)

The application for the '792 Patent was filed on February 23, 2021. EX1090, pp.49, 53-55. The specification included the following description of related applications:

This application is a Continuation of U.S. Pat. Appl. No. 16/575,713, filed on September 19, 2019, now U.S. Pat. No. 10,931,338, which is a Continuation of U.S. Pat. Appl. No. 14/733,013, filed June 8, 2015, now U.S. Pat. No. 10,425,135, which is a Continuation-in-Part of U.S. Pat. Appl. No. 13/116,984, filed May 26, 2011, now U.S. Pat. No. 10,014,882, which is a Continuation-in-Part of U.S. Pat. Appl. No. 12/328,917, filed December 5, 2008, now U.S. Pat. No. 7,965,761, which is a Divisional of U.S.

patent application Ser. No. 11/6212,014 filed January 8, 2007, now U.S. Pat. No. 7,593,449, all of which are expressly incorporated by reference in their entireties.

EX1090, p.97. Insofar as this incorporation by reference is needed to support any claimed subject matter, it bears noting that it was not present in the '984 Application, *see infra* §IV, nor was it present in applications that the '984 Application was altered to refer to, *infra* §IV. Thus, any material that relies on the incorporation by reference in the '792 Patent is new matter added to the chain of applications on or after June 8, 2015.

The first Office Action indicates that the application was “examined under the pre-AIA first to invent provisions.” EX1090, p.32. This was a mistake because of the break in the priority chain discussed below. *Infra* §IV. The Examiner also rejected the claims of the '114 Application on the grounds of obviousness-type double patenting over U.S. Patent No. 11,223,508. EX1090, pp.33-40. A terminal disclaimer was filed. *Id.*, pp.23-24. “No amendment was made” to the claims, *id.*, p.22, and they were allowed, *id.*, pp.11-14.

None of the references raised in this Petition were applied in any rejection by the Office when it decided to issue the '792 Patent.

2. *Application No. 12/328,917*

The '917 Application was filed on December 5, 2008 and included a

preliminary amendment that changed the first paragraph of the specification to read as follows:

This application is a divisional application of U.S. Patent Application No. 11/621,014, filed January 8, 2007, which is a divisional application of U.S. Patent Application No. 10/131,163, filed April 24, 2002, which is a continuation-in-part application of U.S. Patent Application No. 09/022,950, filed February 12, 1998, now U.S. Patent No. 5,955,992.

EX1091, pp.148-155. This priority claim does not incorporate by reference any earlier-filed applications.

In the Notice of Allowance the Examiner entered an Examiner's Amendment, changing the priority claim and omitting the specific reference to U.S. Patent Application No. 11/621,014.¹ *Id.*, p.77. The '917 Application issued as U.S. Patent No. 7,965,761 and included the amended domestic benefit claim that the Applicant's representative had approved. Because of this intentional and applicant-approved amendment, the '917 Application lost copendency with its alleged immediate parent (the '163 Application) because the '163 Application issued in September 2008, and

¹ At all relevant times during the prosecution of the '917 Application the '917 Application was not owned or controlled by the current Patent Owner or Mr. Shattil.

the '917 Application was filed months later in December 2008.

More than a half-decade after the issuance of the '917 Application as the '761 Patent, Mr. Shattil submitted a statement under 37 C.F.R. § 3.73(c) giving himself power of attorney on behalf of putative Patent Owner GenghisComm Holdings, LLC. EX1091, pp.59-60. Mr. Shattil sought a Certificate of Correction on March 20, 2018 and attributed the lack of copendency to a mistake by the Office (rather than a mistake by Applicant's representative who approved the amendment and failed to make any further amendment or object to the Examiner's Amendment before paying the issue fee). *Id.*, pp.49-50 (“[T]he Preliminary Amendment was evidently overlooked by the Patent Owner.... Thus, the incorrect priority information was the fault of the Patent Office.”). The Certificate of Correction was approved and issued on July 24, 2018, *id.*, pp.35, 37.

Nearly two more years passed before Mr. Shattil submitted a Petition for an Unintentionally Delayed Priority Claim. *See* EX1091, pp.28-29. Mr. Shattil claimed that despite knowing of the issues with the priority claim since 2018 when he filed for the Certificate of Correction, that “the entire delay between the date the benefit claim was due and the date the benefit claim was filed was unintentional.” *Id.* It is not clear to Petitioner how Mr. Shattil could have made this representation because

- he was not the assignee or its representative when the Examiner's Amendment was approved,

- he was not the assignee or its representative when the '917 Application issued, and
- almost *nine years* passed between the issuance of the '917 Application as the '761 Patent and the time Mr. Shattil filed the Petition for an Unintentionally Delayed Priority Claim; during this time Mr. Shattil has admitted (in a different patent application) that the owner of the '917 Application “was unresponsive to [Mr. Shattil],” that Mr. Shattil had to pursue “numerous schemes to discover the identity and contact the owner, including ... probing for information from previous assignees ... employing proxies to attempt to contact the owner, and so on.”

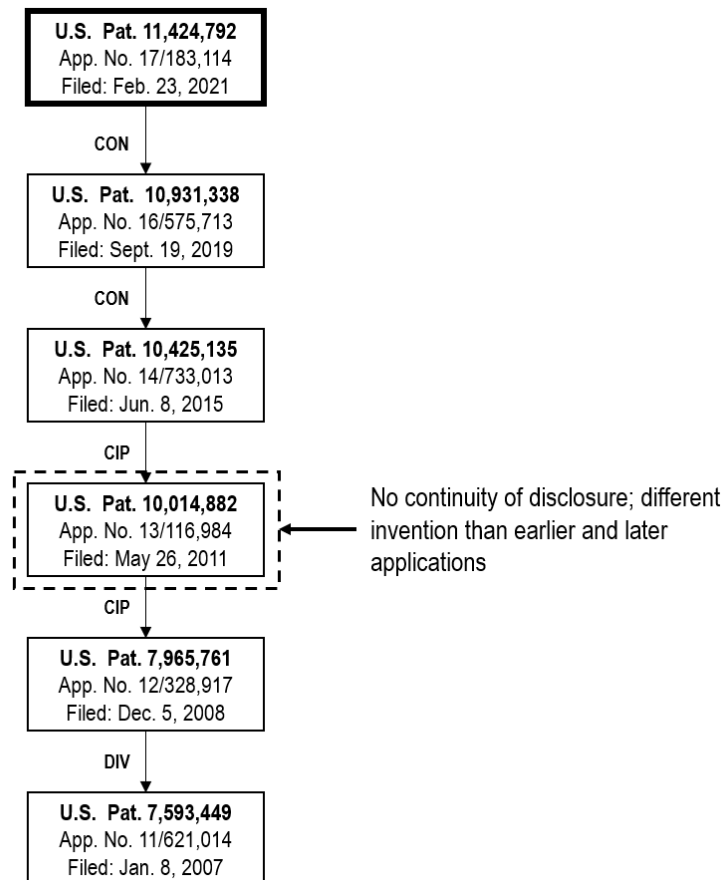
EX1092, p.32.

The first Petition for an Unintentionally Delayed Priority Claim was dismissed because the Office concluded that the Petition (1) did not include the reference required by 35 U.S.C. §120 and 37 C.F.R. §1.78(d)(2) and (2) did not have a statement of unintentional delay. *Id.*, pp.26-27. A request was filed for reconsideration of the Petition, *id.*, pp.21-22, and this time the Petition was granted, *id.*, pp.6-7.

IV. EFFECTIVE FILING DATE; POST-AIA

While the '792 Patent claims the benefit of the filing date of U.S. Patent Application No. 11/621,014, filed on January 8, 2007, it is not entitled to the benefit of that filing date. This is because there is not continuity of disclosure of the claimed

subject matter going back to that application. The following diagram illustrates the priority claim of the '792 Patent.



U.S. Patent Application No. 13/116,984 names three people as inventors: Robi Sen, Steve Shattil,² and Ian Starnes. EX1092, p.465. Neither Messrs. Sen nor Starnes are identified as inventors on any of the other patents or applications in the '792 Patent's priority claim. The '984 Application is unlike any of the specifications

² Mr. Shattil is both a named inventor and a patent agent registered to practice before the Office.

of the other patents in the priority claim. The '984 Application is titled "Method and Apparatus for Fast Prototyping of Wireless Transceivers" and fails to provide any disclosure relevant to the provisioning a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for mobile radio communications as claimed in the '792 Patent. *Id.* Furthermore, as originally filed, the first paragraph of the specification references (but does not incorporate by reference) U.S. Provisional Application No. 61/349,097, filed May 27, 2010. *Id.* No other applications, patents, or patent publications are referred to in the originally filed specification of the '984 Application.³

Unlike the '792 Patent, the '984 Application "relates to rapid prototyping of electronic systems, and in particular, to systems and methods for assembling and

³ A certificate of correction issued on July 14, 2020 in U.S. Patent No. 10,014,882 (the patent that issued from the '984 Application). That certificate changed the first paragraph of the specification to include a priority claim through various applications back to U.S. Patent Application No. 10/131,163 (issued as U.S. Patent No. 7,430,257). *See* EX1092, p.46. None of the referenced applications were incorporated by reference. Nor could they have been without improperly introducing new matter. *See* 35 U.S.C. §132(a) ("No amendments shall introduce new matter into the disclosure of the invention.").

configuring wireless transceiver components.” EX1092, p.466. After describing perceived problems with the prior art, the ’984 Application explains that “the present invention can solve” those problems “by providing an integrated hardware and software component architecture based on principles of Object Oriented Programming to allow system developers and end users to rapidly design, build, and test hardware in an iterative fashion, allowing for faster product life-cycles, greater innovation, and facilitating end-user and third-party development.” EX1092, p.467. The ’984 Application includes no discussion of subcarrier spacings, provisioning subcarriers, or polyphase codes used to encode data symbols.

While irrelevant to the question of whether the disclosure of the ’984 Application includes a disclosure of the subject matter now claimed in the ’792 Patent claims, for the sake of completeness, Petitioner notes that during prosecution of the ’984 Application, Mr. Shattil repeatedly attempted to amend the priority claim and was eventually successful. EX1092, pp.296-316. Starting with a filing titled “Amendment And Petition for Unintentionally Delayed Priority Claim And Request for Corrected Filing Receipt,” Mr. Shattil sought a major change to the priority claim and represented that the delay “between the date the benefit claim was due [in 2011] and the date the benefit claim was filed [on February 13, 2015] was unintentional.” *Id.*, p.297; *see also id.*, p.304. The Application Data Sheet filed with the request to recognize a delayed priority claim indicated that the benefit claim reached back to

U.S. Provisional Application No. 60/286,850 filed on April 26, 2001. *Id.*, p.314. That petition was ultimately dismissed because “application No. 12/328,917 is not a divisional of application No. 11/621,014, as specified in the ADS.” *Id.*, p.102.

On April 7, 2017, Mr. Shattil renewed the petition to correct the domestic benefit claim. This time instead of claiming that the ’917 Application was a divisional of the ’014 Application, the revised ADS indicated that the ’917 Application was a divisional of U.S. Patent Application No. 10/131,163. EX1092, p.91. The Office dismissed the Petition again. This time it was dismissed because while Applicant sought to claim the benefit U.S. Provisional Application 60/286,850 the intervening ’917 Application did not claim the benefit of the ’850 Provisional Application. *Id.*, pp.84-85.

The ’984 Application issued as U.S. Patent No. 10,014,882 without a corrected domestic benefit claim. EX1093, cover. About two years later, Mr. Shattil again tried to correct the benefit claim. After multiple petitions, declarations, and other submissions, the Office corrected the domestic benefit claim. EX1092, pp.2-55; *see supra* fn. 3. None of these changes to the domestic benefit claim can cure a dispositive problem with the domestic benefit claim: the originally filed specification of the ’984 Application fails to describe the subject matter of the claims of the ’792 Patent.

Even with the amended priority claim, a priority claim standing alone is not

an incorporation by reference. *See In re de Seversky*, 474 F.2d 671, 674 (C.C.P.A. 1973) (“[T]he statement that an application is a continuation-in-part, or a continuation, or a division, or in part a continuation of another application is in a broad sense a ‘reference’ to the earlier application, but a mere reference to another application, or patent, or publication is not an incorporation of anything therein into the application containing such reference for the purposes of the disclosure required by 35 U.S.C. § 112.”); MPEP § 608.01(p) (“Mere reference to another application, patent, or publication is not an incorporation of anything therein into the application containing such reference for the purpose of the disclosure required by 35 U.S.C. 112.”). The originally filed ’984 Application shows that there is no disclosure whatsoever of the OFDM systems, methods, and computer readable media claimed in the ’792 Patent. Patent Owner cannot point to anything incorporated by reference into the specification of the ’984 Application to provide written description for the ’792 Patent claims either.

Because the ’984 Application does not describe the subject matter recited in the ’792 Patent claims, there is a break in continuity of disclosure that renders the priority claim improper. In other words, because the ’984 Application does not support the claimed subject matter under 35 U.S.C. § 112(a), there is a break in the chain of earlier-filed applications. Because “continuity of disclosure must have been maintained through a chain of patents from the [earlier] patent leading up to the

[later] patent” and the ’984 Application fails to describe the subject matter of the ’792 Patent claims, the ’792 Patent claims are, at best, entitled to the filing date of U.S. Patent Application No. 14/733,013 on **June 8, 2015**. *Zenon Envt’l, Inc. v. United States Filter Corp.*, 506 F.3d 1370, 1378 (Fed. Cir. 2007). Not only does this open up prior art to the ’792 Patent, it requires the ’792 Patent to be evaluated under post-AIA law.

V. IDENTIFICATION OF THE CHALLENGE

Petitioner challenges the following claims on the following grounds:

Ground	Claims	Challenge	Statute
1	1, 3, 5, 8, 10, 12, 15, 17, 19	Anticipation by Shattil-257	Post-AIA §102(a)(1)
2	1, 3, 5, 8, 10, 12, 15, 17, 19	Obviousness over Shattil-257	Post-AIA §103
3	2, 9, 16	Obviousness over Shattil-257 in view of Lucent	Post-AIA §103
4	1-3	Obviousness over Galda in view of Lucent	Post- or Pre-AIA §103
5	1-3	Obviousness over Galda in view of Doufexi	Post- or Pre-AIA §103
6	8-10, 15-17	Obviousness over Galda in view of Lucent and Dowling	Post- or Pre-AIA §103
7	8-10, 15-17	Obviousness over Galda in view of Doufexi and Dowling	Post- or Pre-AIA §103

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

Based on the ’792 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 January 8, 2007 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, ¶¶61-65. 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.* The level of skill possessed by a POSITA as of June 8, 2015 would not have been materially different. EX1002, ¶66.

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 relied upon in the challenges is analogous prior art. EX1002,

¶¶69-93.

A. Shattil-257

Shattil-257 is U.S. Patent 7,430,257 issued on September 30, 2008—more than one year before the June 8, 2015 effective filing date of the '792 Patent. EX1094, cover; *supra* §IV (demonstrating effective filing date is, at best, June 8, 2015). Shattil-257 is prior art under post-AIA §102(a)(1).

Shattil-257 discloses “the application of a redundantly modulated multicarrier architecture to conventional transmission protocols, such as . . . OFDM” where “CI carrier signals combine to generate a superposition signal having time-domain characteristics that can be controlled via selection of the CI carrier characteristics.” EX1094, 5:55-60.

Shattil-257 is analogous art to the '792 Patent because both relate to wireless communications networks including OFDM wireless communications networks and techniques. EX1001, Abstract, 1:22-23, 18:61-62; EX1094, 5:55-58; EX1002, ¶¶69-72. Indeed, Shattil-257 and the '792 Patent share common figures:

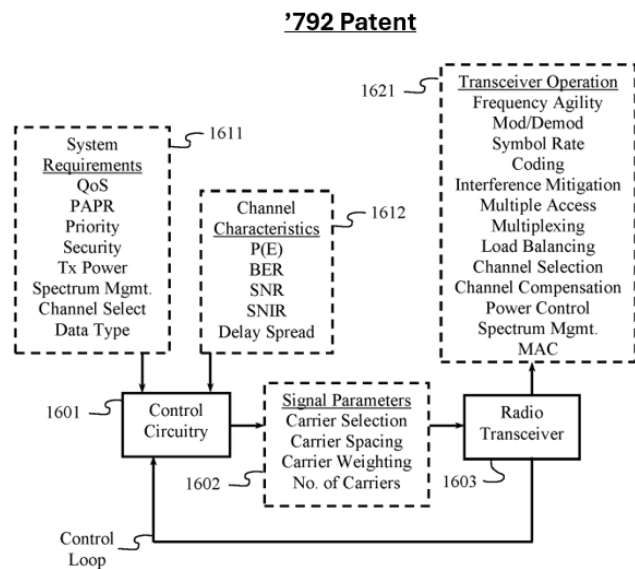
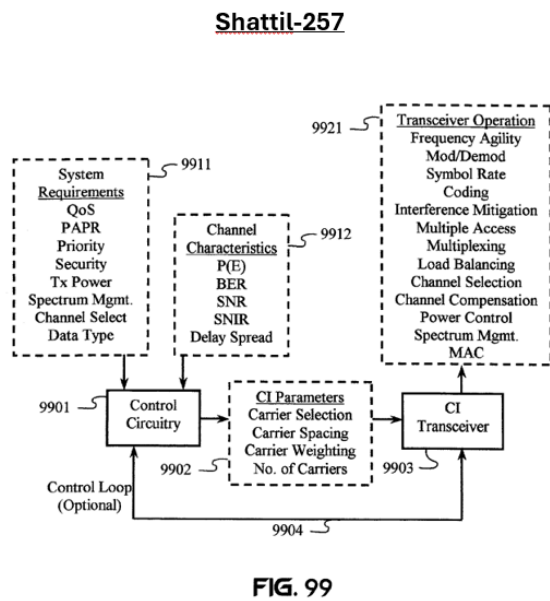


Figure 16

EX1094, FIG. 99; EX1001, FIG. 16.

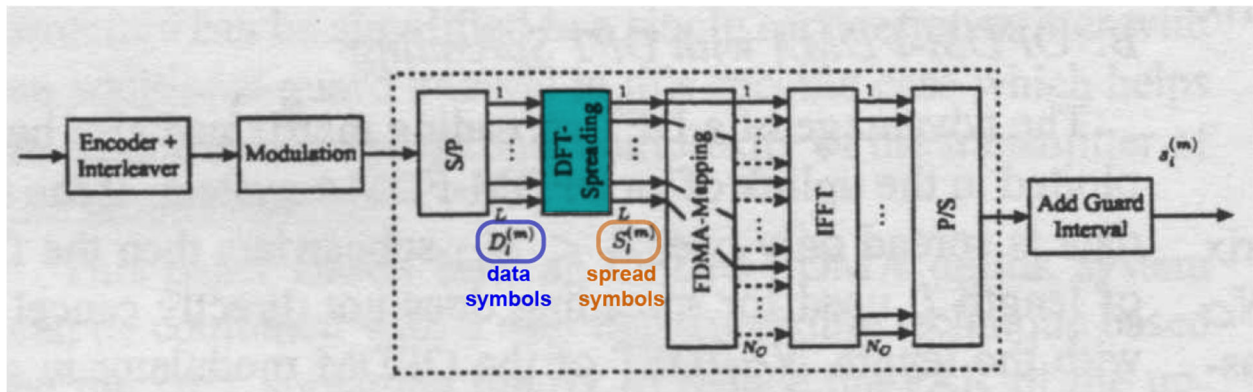
Furthermore, both the '792 Patent and Shattil-257 are directed to a common problem of obtaining bandwidth efficiency including the use of CI-based protocols. EX1094, 104:30-35; EX1001, 33:35-39.

B. 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 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.* CDs 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, ¶73. Galda is thus a prior art printed publication by at least May 6, 2002 and is prior art under pre-AIA §102(b) 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 using “OFDM-FDMA multiple access ... combined with a data spreading technique based on a Discrete Fourier Transform.” EX1004, p.1737. Galda’s transmitter is illustrated below and encodes data symbols “ $D_l^{(m)}$ ” (of which there are L symbols) using DFT spreading block and then modulates the spread (encoded) data symbols “ $S_l^{(m)}$ ” (of which there are also L symbols).



Id., p.1740 (annotated).⁴

Galda is analogous art to the '792 Patent because it relates to “flexible channel bandwidth for mobile radio communications ... by provisioning a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers,” EX1001, Abstract, including “modulating the encoded data symbols onto the OFDM subcarriers.” *Id.*; EX1004, pp.1737, 1740 (Fig. 6(a)); EX1002, ¶¶74-75. Galda is also analogous art because two of the problems facing the inventor were bandwidth limitations and interference, EX1001, 2:45-46, and Galda seeks to solve these problems, EX1004, p.1737; EX1002, ¶76.

C. 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

⁴ Coloring and/or colored text has been added to figures unless otherwise noted.

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, ¶¶77-78. 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 '792 Patent because it relates to wireless communications networks, and especially OFDM wireless communications networks and techniques. EX1001, Abstract; EX1006, p.192 (describing OFDM for 4G networks); EX1002, ¶¶79-80. Doufexi is also reasonably pertinent to a problem faced by the inventor of the '792 Patent, including improvement of OFDM system/spectral efficiency. EX1001, 2:13-15; EX1003, pp.192 (variable guard time can improve efficiency), 193 (“[c]hannel coding also affects bandwidth efficiency”);

EX1002, ¶81.

D. 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, ¶¶82-84. 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. EX1002, ¶85-87. 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 '792 Patent because it is in field of wireless communications networks, and especially OFDM wireless communications networks and techniques. EX1001, Abstract, 1:22-23; EX1006, p.1 (“Proposed Baseline OFDM Systems for Study”); EX1002, ¶¶86-88. And Lucent is reasonably pertinent to a problem to be solved by the '792 Patent inventor, namely efficient use of existing bandwidth. EX1001, 2:10-14 (“using more spectrum” does not “adequately address inter-cell interference”); EX1006, p.1 (“most companies are interested in using the current IMT2000 band instead of some future spectrum or

extra bandwidth”); EX1002, ¶89.

E. 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; EX1002, ¶¶90-91.

Dowling is analogous to the ’792 Patent at least because it relates to wireless communications including OFDM communications. EX1001, Abstract, 18:61-62; 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, ¶¶92-93. Both the ’792 Patent and Dowling are also applicable to multicarrier transmitter and receiver structures and methods which reduce computation, increase transmission bandwidth and reduce transmission power. EX1001, 18:12-16, 35:6-15; EX1042, Abstract.

IX. DETAILED DISCUSSION

A. Grounds 1 and 2: Claims 1, 3, 5, 8, 10, 12, 15, 17, and 19 are (Ground 1) anticipated by or (Ground 2) obvious over Shattil-257

1. Claim 1

a. [1Pre]: Method of enabling flexible channel bandwidth

Assuming the preamble is limiting, Shattil-257 discloses and renders obvious *a method of enabling flexible channel bandwidth for mobile radio communications*. EX1002, ¶¶94-96. Shattil-257 describes *mobile radio communications*: “[a] base station in a mobile wireless network [that] can dynamically create channels depending on the number of mobile units in its coverage area and their service requirements.” EX1094, 101:57-6. Shattil-257 then explains that a *method of enabling flexible channel bandwidth* can be implemented “[w]hen additional units enter the area” because “[b]andwidth can be dynamically allocated to up-stream and down-stream channels depending on network traffic characteristics.” EX1094, 102:8-11; EX1002, ¶95.

Thus, Shattil-257 discloses and renders obvious **[1Pre]**.

b. [1A]: provisioning OFDM subcarriers

Shattil-257 discloses and renders obvious *provisioning a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for mobile radio communications*. EX1002, ¶¶97-102.

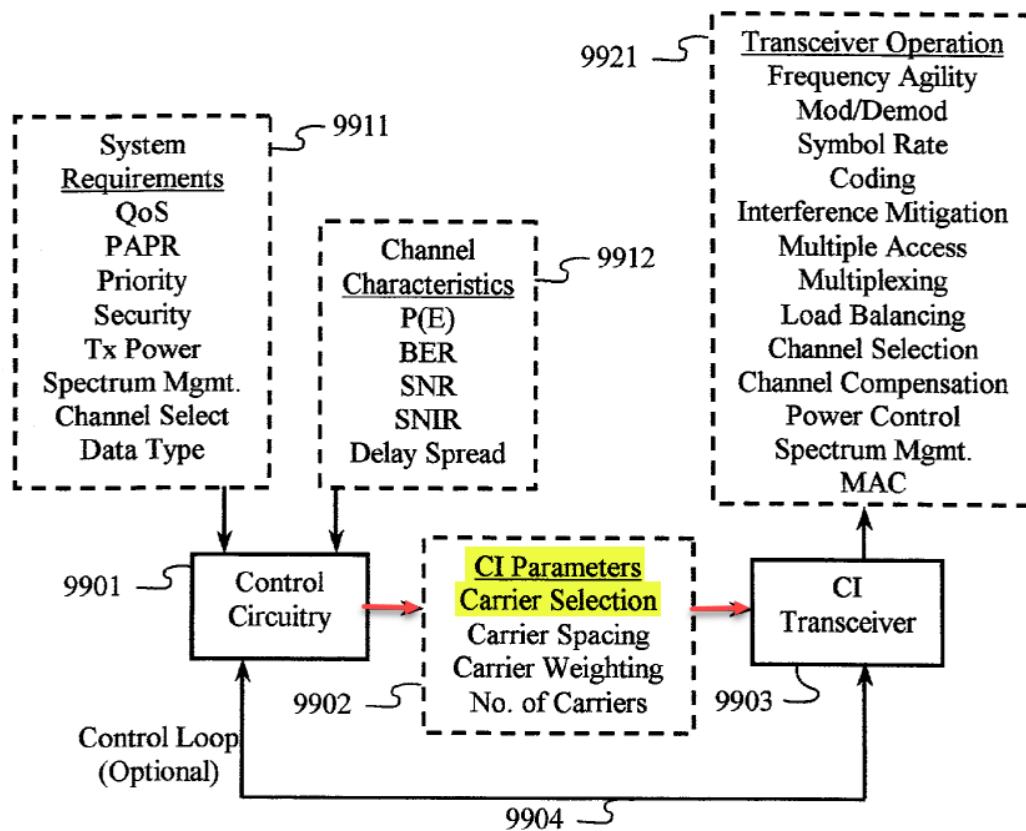
In Shattil-257 a process for *provisioning a set of OFDM subcarriers* includes

“enabl[ing] the application of a redundantly modulated multicarrier architecture to conventional transmission protocols, such as ... OFDM.” EX1094, 5:55-56. Shattil-257 explains that in this extension of OFDM, “[f]requency-domain selectivity enables independent provisioning of CI sub-carrier channels to users who may only need a fraction of the bandwidth of a communication channel.” EX1094, 6:8-11; EX1002, ¶¶98-99. Thus, Shattil-257 allocates some “fraction of the bandwidth” to users in at least certain circumstances.

Shattil-257 further describes *provisioning OFDM subcarriers for mobile communications* because it describes a “scaleable [sic] CI modulation system” that has an “upper limit on the number of carriers” and which can “scale the number of carriers below the upper limit to decrease signal bandwidth.” EX1094, 136:24-30; *see also id.*, 96:38-41 (“A transmission method of the invention provides a transmitter with a multicarrier signal having selected frequency components”), 97:18-20, 102:15-38 (CI network enables “[f]requency agility” including “variable aggregate bandwidth” and “frequency scalability”), 102:47-56; 132:59-133:5 (describing optimizing “CI carrier” “bandwidth(s) and spacing” and “minimize[ing] the number of subbands” and selecting subbands “with respect to channel estimation”), 136:5-23 (describing “control circuitry 9901” that can scale “the number of carriers” and the “carrier spacing”), 140:46-56 (describing adaptation of “[s]ub-carrier bandwidths”); EX1002, ¶100. The various CI protocols can be used

to produce “CI-OFDM,” which includes *OFDM subcarriers*. EX1094, 36:47-37:5 (describing application of CI to OFDM to produce “CI-OFDM”).

Shattil-257 describes a “scaleable [sic] CI modulation system” that has an “upper limit on the number of carriers” and which can “scale the number of carriers below the upper limit to decrease signal bandwidth.” EX1094, 136:24-30; *see also id.*, 96:38-41 (“A transmission method of the invention provides a transmitter with a multicarrier signal having selected frequency components”), 97:18-20, 102:15-38 (CI network enables “[f]requency agility” including “variable aggregate bandwidth” and “frequency scalability”), 102:47-56. Shattil-257’s Figure 99 shows how control circuitry (9901) performs a function of provisioning various “CI Parameters” including “Carrier Selection” to CI Transceiver 9903:



EX1094, FIG. 99; EX1002, ¶101.

Thus, Shattil-257 discloses and renders obvious Limitation [1A].

- c. [1B]: encoding data symbols with polyphase codes from a DFT

Shattil-257 discloses and renders obvious *encoding data symbols* (data symbols $s_n(t)$) *with polyphase codes derived from a discrete Fourier transform to produce encoded data symbols*. EX1002, ¶¶103-09.

Shattil-257 explains that “CI symbols may be values derived from at least one invertible transform function, such as a Fourier transform” and that “CI symbols may include at least one set of polyphase codes.” EX1094, 79:36-40; EX1002,

¶¶104-05. According to Shattil-257, “polyphase channel coding [] may be provided by a CI channel coder” where “one or more data symbols $s_n(t)$ are mapped into a plurality of CI symbols represented by CI carrier weights $w_n(t)$.” EX1094, 68:42-44; *see also id.*, 86:65-87:17. As can be seen from the illustration below, Shattil-257’s polyphase codes are *derived from a discrete Fourier transform* because they take the form $e^{i2\pi mn/N}$ (here m and n range from 0 to $N-1$):⁵

	$s_0()$	$s_1()$	$s_2()$	$s_{N-1}()$
$w_1 = \Sigma():$	$e^{i2\pi(0)(0)/(N-1)}$	$e^{i2\pi(1)(0)/(N-1)}$	$e^{i2\pi(2)(0)/(N-1)}$	$e^{i2\pi(N-1)(0)/(N-1)}$
$w_2 = \Sigma():$	$e^{i2\pi(0)(1)/(N-1)}$	$e^{i2\pi(1)(1)/(N-1)}$	$e^{i2\pi(2)(1)/(N-1)}$	$e^{i2\pi(N-1)(1)/(N-1)}$
$w_3 = \Sigma():$	$e^{i2\pi(0)(2)/(N-1)}$	$e^{i2\pi(1)(2)/(N-1)}$	$e^{i2\pi(2)(2)/(N-1)}$	$e^{i2\pi(N-1)(2)/(N-1)}$
$w_N = \Sigma():$	$e^{i2\pi(0)(N-1)/(N-1)}$	$e^{i2\pi(1)(N-1)/(N-1)}$	$e^{i2\pi(2)(N-1)/(N-1)}$	$e^{i2\pi(N-1)(N-1)/(N-1)}$

4901
4903

⁵ This figure has been corrected in numerous patents by Patent Owner because, according to Patent Owner, it includes a typographical error in the denominator of the exponential term. According to Patent Owner “ $N-1$ ” should be “ N ” to properly represent DFT coefficients. *See* EX1100, p.7; EX1101, p.12; EX 1102, p.14; EX1103, p.3. Given Patent Owner’s representation that the modification of this Figure does not require further examination or add new matter, the figure should be understood in light of the changes Patent Owner has made via Certificate of Correction in other patents.

EX1094, FIG. 49; EX1049, p.2 (using CRC Mathematical Tables and Formulae 30th Ed. (1996) to explain that the “discrete Fourier transform” is defined with a term $(W_N)^{mn}$ where W_N is expressed as $e^{i2\pi/N}$; this can be rewritten as $e^{i2\pi mn/N}$); EX1002, ¶106. As can be seen from the illustration above, each data symbol (e.g., symbol $s_1()$) has a polyphase code (e.g., column vector 4901) applied to it. EX1094, FIG. 49, 26:11-19, 86:65-87:3; EX1002, ¶¶106-08. The result of applying Shattil-257’s polyphase codes is the production of *encoded data symbols* also referred to as “CI symbol values w_n .” EX1094, 86:65-66.

Thus, Shattil-257 discloses and renders obvious Limitation [1B].

d. [1C]: modulating encoded symbols onto OFDM subcarriers

Shattil-257 discloses and renders obvious *modulating the encoded data symbols onto the OFDM subcarriers to produce a superposition signal that resembles a single-carrier signal and has one of a plurality of different symbol durations*. EX1002, ¶¶110-18.

Shattil-257’s FIG. 41A “illustrates general steps of a transmitting method of the present invention.” EX1094, 79:55-56.

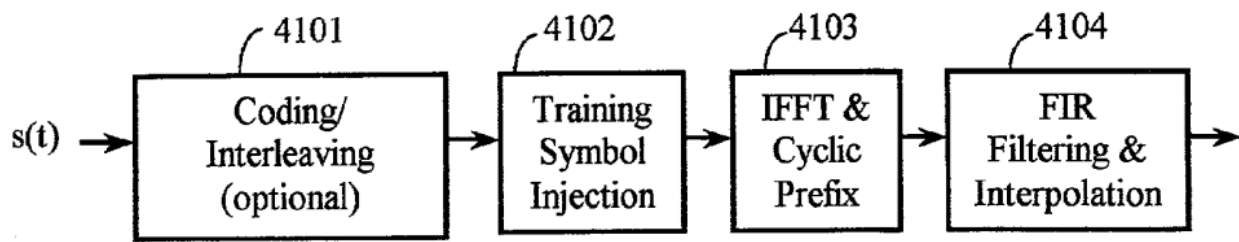


FIG. 41A

EX1094, FIG. 41A. Coding block preferably includes CI coding. *Id.*, 79:58-59. The CI coded data symbols are *encoded data symbols*. EX1002, ¶¶111-12; *supra* §IX.A.1.d. These encoded data symbols are modulated *onto the OFDM subcarriers* because Shattil-257 says “[a]n IFFT 4103 ... impresses the coded data symbols onto a plurality of carriers.” EX1094, 79:65-66; *see also id.*, 80:48-53 (describing “CI transceiver” with “modulator 4221”). This is consistent with the operation of what Shatti-257 describes as “conventional” and “exemplary” “OFDM transceivers.” *Id.*, 3:30-41. Thus, Shattil’s IFFT 4103 performs the step of *modulating the encoded data symbols onto the OFDM subcarriers*. EX1002, ¶112.

Shattil-257’s modulating produces a *superposition signal that resembles a single-carrier signal* because Shattil-257’s IFFT operation creates a superposition time signal. EX1002, ¶113. Patent Owner has admitted as much. EX1039, p.10 (A POSITA “would understand that an OFDM signal is a superposition of subcarriers.”); EX1097, p.8 (“A person of ordinary skill in the art at the time of the invention would understand that an OFDM signal is a superposition of

subcarriers.”). At the very least, based on Patent Owner’s admissions, a POSITA would have found it obvious that Shattil-257’s IFFT produces *a superposition* signal that is OFDM modulated.

A POSITA would have recognized from Shattil-257 that the resulting time-domain signal *resembles a single-carrier signal* as shown below, where superposition signal 110D resembles a single carrier signal that is the superposition of each pulse 105A, 105B, and 105C.

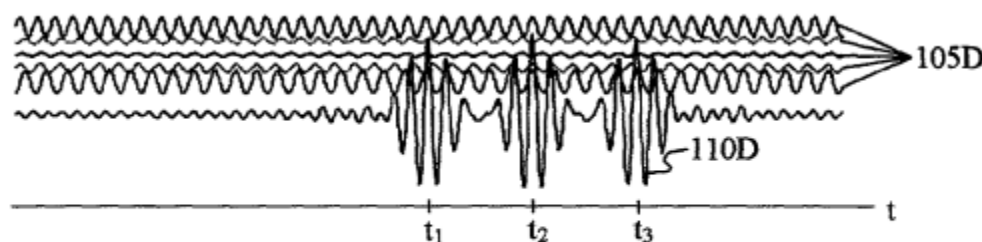


FIG. 1B

EX1094, FIG. 1B; EX1002, ¶114.

At the very least modulating the encoded data symbols onto the OFDM subcarriers to produce a superposition signal that resembles a single-carrier signal would have been obvious because a POSITA knew that DFT spreading data symbols before modulating them onto OFDM subcarriers (as described in Shattil-257) resulted in a signal that resembles a single-carrier signal. EX1002, ¶115; EX1004, p.1740 (“[T]he time signal of the OFDM-FDMA uplink with DFT spreading is identical to a single carrier transmission...”); EX1016, p.2329 (OFDM system using

spreading with “Fourier matrix” “is technically equivalent to a single-carrier system with guard interval”), *id.*, 2330 (“Since the single-carrier system which results from an OFDM-CDM system with Fourier spreading matrix is a special case of an OFDM-CDM system, the same detection algorithms can be applied and the same performance can be expected.”).

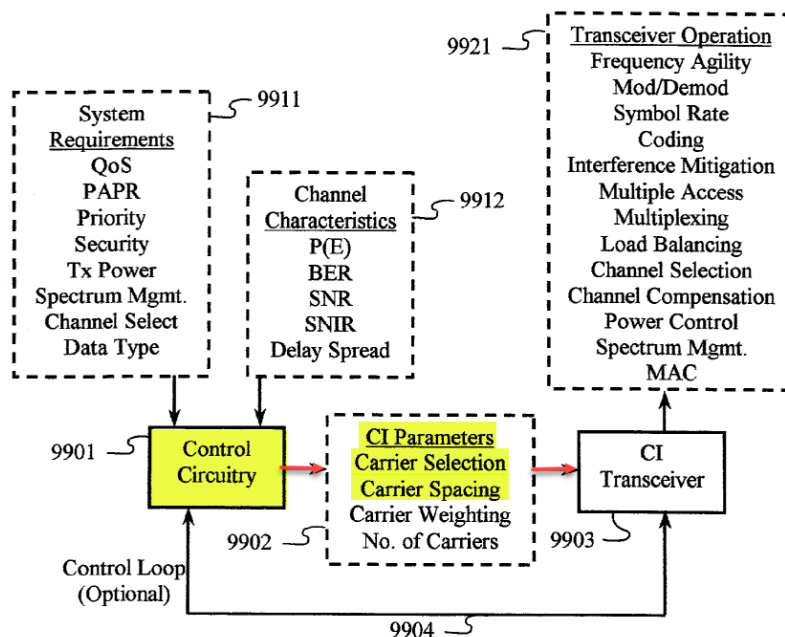
Finally, Shattil-257 also discloses and renders obvious that the superposition signal *has one of a plurality of different symbol durations*. First, and as explained in more detail below, Shattil-257 explains that the subcarrier spacings are selectable. *Infra* §IX(A)(1)(e) (Limitation [1D]). And Shattil-257 teaches that “[c]arrier-frequency spacing in each carrier set may be selected to reduce correlated fading between adjacent carrier frequencies” and “[t]he symbol duration T_s is equal to the inverse of the carrier-frequency spacing f_s .” EX1094, 35:21-24; EX1002, ¶116. Indeed, the relationship between subcarrier spacing any symbol duration was maintained to preserve orthogonality. EX1015, p.22 (“[T]he carriers are linearly independent (i.e., orthogonal) if the carrier spacing is a multiple of $1/T$.”). Thus, when a subcarrier spacing is selected, a symbol duration (T_s) is also chosen in an OFDM system and at the very least the claimed selection of one of a plurality of symbol durations would have been obvious. EX1002, ¶¶117, 122.

Thus, Shattil-257 discloses and renders obvious Limitation [1C].

- e. [1D]: selecting one of multiple different subcarrier spacings provides one of multiple symbol durations

Shattil-257 discloses and renders obvious *wherein provisioning comprises selecting one of a plurality of different selectable subcarrier spacings, to provide for the one of the plurality of different symbol durations*. EX1002, ¶¶119-23.

Shattil-257 discloses control circuitry 9901 that provisions subcarriers by “Carrier Selection.” EX1094, FIG. 99. This *provisioning comprises selecting one of a plurality of different selectable subcarrier spacings* because “[t]he control circuit 9901 provides adjustment to one or more CI parameters 9902” such as “Carrier Spacing”, as highlighted in FIG. 99:



EX1094, 135:5-8, FIG. 99; EX1002, ¶¶120-21. Shattil-257 explains that adjustment

of the carrier spacing parameter can be made by *selecting one of a plurality of different selectable subcarrier spacings* (i.e., “carrier-frequency spacing in each carrier set may be selected to reduce correlated fading”) *to provide for the one of the plurality of different symbol durations* (i.e., “[t]he symbol duration T_s is equal to the inverse of the carrier-frequency spacing f_s .”). *Id.* 35:12-13, 35:22-25. EX1002, ¶122. At the very least, a POSITA would have found it obvious that when the subcarrier spacing is selected, a symbol duration will also be selected to maintain orthogonality of the carriers in OFDM. EX1002, ¶122 (citing EX1015, p.22).

Thus, Shattil-257 discloses and renders obvious Limitation **[1D]** and claim 1.

2. *Claims 8 and 15*

Claims 8 and 15 recite a system and a computer program product, respectively, with identical *provisioning* ([8Ci], [15A]), *encoding* ([8Cii], [15B]), *modulating* ([8Ciii], [15C]), and *subcarrier spacing selection* ([8Civ], [15D]) limitations as claim 1. EX1001, cls. 1, 8, 15; EX1002, ¶¶128-32. The discussion that follows focuses only on the differences between claim 1 on the one hand and claims 8 and 15 on the other.

Shattil-257 discloses and renders obvious *an apparatus for providing flexible channel bandwidth in mobile radio communications, comprising [8Pre], at least one processor [8A], and at least one non-transitory computer-readable memory in electronic communication with the at least one processor, and instructions stored in*

the at least one memory, the instructions executable by the at least one processor [8B] as recited in claim 8. Similarly, Shattil-257 discloses a computer program product, comprising a non-transitory computer-readable memory having computer readable program code stored therein, the program code containing instructions executable by one or more processors of a computing system [15Pre] as recited in claim 15. EX1002, ¶¶124-27.

Shattil-257 discloses a software radio that includes processors, a storage medium, and a computer program for performing subcarrier modulation. *See* EX1094, 103:29-33 (“a software implementation of a CI-based transceiver may include ... one or more CI-based signal processing software components 6601.1 to 6601.i.”), 103:44-46 (“[t]he software components 6601.1 to 6601.i may include at least one local and/or remote computer program adapted to process signals received from the hardware components”), 103:55-58 (“the hardware component(s) 6603.1 to 6603.j typically include a transmitter and/or receiver system, and a storage medium ... for storing application programs”), 103:60-64 (“[i]n some applications, modulation and/or demodulation may be performed digitally with any combination of software 6601.1 to 6601.i and hardware 6603.1 to 6603.j components.”). EX1002, ¶125.

The “hardware components” in the “software-defined radio” include “storage medium” (e.g., “flash memory”) which is “for storing application programs and

data.” EX1094, 103:55-59. Thus, Shattil-257 describes the various functionality of the “CI-based transceiver” being implemented in software (*computer readable program code*) stored in memory and executable by a processor, which a POSITA would have understood to be part of the hardware on which computer code is executed; at the very least processors were so ubiquitous that a POSITA would have found it obvious to execute software using a processor to perform various tasks such as those disclosed by Shattil-257 as of January 2007. EX1002, ¶126; *see also* EX1094, 102:65-66 (a benefit of implementing CI in “software-based processing” included simplification of the “required microprocessor architecture”).

Thus, Shattil-257 discloses and renders obvious limitations [8Pre], [8A], [8B], and [15B].

3. Claims 3, 10, and 17

Shattil-257 discloses and renders obvious *wherein the superposition signal is provided with a cyclic prefix* as recited in each of claims 3, 10, and 17. EX1002, ¶133-36.

Shattil-257 discloses and renders obvious *wherein the superposition signal is provided with a cyclic prefix*, as recited in claim 3 (“[m]odulated signals may include guard bands, cyclic prefixes, codes, and the like, which are well-known in the art”). EX1094, 18:45-47; EX1002, ¶134-35. Shattil-257 also discloses and renders obvious *adding a cyclic prefix to the superposition signal*, as recited in claims 10

and 17 (“[a] cyclic prefix may be added to the coded data symbols”) EX1094, 79:66-67; EX1002, ¶136.

Thus, Shattil-257 discloses and renders obvious claims 3, 10, and 17.

4. *Claims 5, 12, and 19*

Shattil-257 discloses and renders obvious *wherein the provisioning is performed in a user device or base station* as recited in claims 5, 12, and 19. EX1002, ¶137-39.

Shattil-257 discloses and renders obvious *wherein the provisioning is performed by or in a base station* in explaining that “a base station in a mobile wireless network can dynamically create channels depending on the number of mobile units in its coverage area and their service requirements” and mobile units can serve as base stations. EX1094, 101:57-58, 149:15-17 (“The method described in FIG. 108A may be performed by a subscriber unit acting as a base station in a CI network.”), 149:29-31; EX1002, ¶138.

Thus, Shattil-257 discloses and renders obvious claims 5, 12, and 19.

B. Ground 3: Claims 2, 9, and 16 are rendered obvious by Shattil-257 in view of Lucent

1. *Overview of the Combination; motivation to combine; expectation of success*

Shattil-257 describes a CI system that “increases flexibility and adaptability by providing scaling of operating parameters and/or signal characteristics in a CI

system.” EX1094, 135:62-65. Shattil-257 also describes control circuitry that “may scale a transmitted bit rate by scaling . . . the carrier spacing,” and “this permits the scaleable CI system to operate in various communications environments requiring various operating parameters and/or characteristics.” EX1094, 136:5-23. But Shattil-257 does not provide specific examples of how the sub-carrier spacing is scaled for different environments.

A POSITA would have been familiar with systems and methods that used known subcarrier spacings to address different deployment scenarios or environments in wireless communications networks. EX1002, ¶143. Lucent provides one such example of a system in which subcarrier spacing changes depending on the environment in which the mobile station is being used. *Id.*, ¶¶140-44. For instance, Lucent is a proposal for a “[b]aseline OFDM [s]ystem[] for [s]tudy.” EX1006, p.1. In Lucent, there are “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.* A POSITA knew that a user may have a mobile station (e.g., a UE) that was used in each of the scenarios. EX1002, ¶¶144-45. 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,

¶146. Thus, each of these configurations may provide better performance than the others depending on the environment in which the UE is located. *Id.*

A POSITA would have also recognized that the subcarrier spacings and other system parameters (e.g., guard intervals, number of subcarriers, symbols per frame (time slot), etc.) were calculated specifically for each of Lucent’s “Configurations.” EX1002, ¶147. Lucent proposed using subcarrier spacings which reflected another subcarrier spacing multiplied by a power of two as shown below:

Smallest Subcarrier spacing	Scaling Factor	Selectable Subcarrier Spacing
4.8 kHz	1 (2^0)	4.8 kHz
4.8 kHz	2 (2^1)	9.6 kHz
4.8 kHz	4 (2^2)	19.2 kHz

Because of the known interrelationship of the various system parameters, it would have been obvious to implement predetermined “configurations” like those shown in Lucent in connection with Shattil-257 to ensure proper operation of the OFDM system and to minimize having to recalculate all the various system parameters each time a change in, for example, subcarrier allocations or spacings would have been beneficial to the system. EX1002, ¶148; 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, ...”).

A POSITA would have found it obvious to use predetermined subcarrier

spacings (which are the lowest spacing and then increment by a scaling factor that is a power of two) such as those taught by Lucent when selecting the subcarriers for Shattil-257 users because it would have enabled selecting subcarrier spacings with reduced complexity and calculation time (e.g., the system would provision different “Configurations” depending on the scenario). EX1002, ¶149.

Using a plurality of different selectable subcarrier spacings where at least one spacing equals at least one other spacing multiplied by a scaling factor that is a power of two as taught by Lucent would have merely combined Lucent’s known subcarrier spacings and other system configurations with Shattil’s known system for encoding and transmitting OFDM signals according to known methods (i.e., providing different system configurations to address different environmental conditions). EX1002, ¶150.

Lucent’s different selectable subcarrier spacings reflects a known techniques of defining different system configurations including a subcarrier spacing that equals at least one of the other subcarrier spacings multiplied by a scaling factor that is a power of two. Using Lucent’s technique would have improved Shattil-257’s known OFDM transmitter and transmission techniques by enabling it to select pre-defined configurations thus reducing computational load on the transmitter to adjust a range of system parameter by simply applying preset configurations depending on environmental conditions. EX1002, ¶151. The results of the combination would

have been predictable because various system parameters would be adjusted according to predefined configurations thereby permitting, for example, a larger or smaller subcarrier spacing and symbol duration thus improving performance depending on the channel conditions. *Id.*, ¶¶151-52.

A POSITA would have reasonably expected to succeed in making the combination. A POSITA knew that predefined configurations were one way to enable OFDM systems to select different subcarrier spacings as shown by Lucent. Having different selectable subcarrier spacings where at least one spacing equals at least one other of the plurality of different selectable subcarrier spacings multiplied by a scaling factor that is a power of two was a known way to configure OFDM systems as also shown by Lucent. EX1002, ¶153. A POSITA also would have known how to consider various system parameters including subcarrier spacings and symbol durations to define different OFDM system configurations (as reflected in Lucent) because such parameters were evaluated by a POSITA in OFDM system design. 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. *Claims 2, 9, and 16*

Shattil-257 in view of Lucent renders obvious *wherein at least one of the plurality of different selectable subcarrier spacings equals at least one other of the*

plurality of different selectable subcarrier spacings multiplied by a scaling factor that is a power of two. EX1002, ¶¶154-57.

Lucent shows a plurality of three subcarrier spacings, where *at least one of the plurality of different selectable subcarrier spacings* (e.g., 19.2 kHz in Configuration 1) *equals at least one other of the plurality of different selectable subcarrier spacings* (e.g., 9.6 kHz in Configuration 2) *multiplied by a scaling factor that is a power of two* (e.g., the scaling factor of 2 from Configuration 2 to Configuration 1 is a 2^1):

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, pp.5-7. EX1002, ¶¶155-56. This describes *at least one of the plurality of subcarrier spacings* (e.g., 19.2 kHz) that *equals at least one other of the plurality of*

different selectable subcarrier spacings (e.g., 9.6 kHz or 4.8 kHz) multiplied by a scaling factor that is a power of two (e.g., 4.8 kHz times 2^2 or 9.6 kHz times 2^1).

EX1002, ¶156. It would have been obvious to implement these configurations in Shattil-257 for the reasons discussed above. *Supra* §IX.B.1.

Thus, Shattil-257 in view of Lucent renders obvious claim 2.

C. Grounds 4 and 5: Claims 1-3 and 5 are rendered obvious by (Ground 4) Galda in view of Lucent and (Ground 5) Galda in view of Doufexi

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

Grounds 3 and 4 address claims 1-3 and 5 and rely on Galda in view of Lucent and Doufexi, respectively. These grounds are treated together because they present similar issues.

Galda explains that “[t]he FDMA multiple access scheme offers not only a 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, ¶¶158-59, 207-08.

A POSITA knew that there were benefits to using variable sub-carrier spacings in OFDM communications systems. These benefits are revealed in both

Lucent and Doufexi.

Lucent is summarized above in connection with Ground 3. *Supra* §§VIII.D, IX.B; *see* EX1002, ¶¶160-63. As explained in more detail below, a POSITA would have been motivated to enable Galda’s system and method to provision subcarriers by including the ability to select from among multiple subcarrier spacings where at least one of the subcarrier spacings is equal to another spacing multiplied by a scaling factor that is a power of two based on Lucent.

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, ¶¶209. “A system capable of dynamically adapting one or more of the above parameters may offer superior performance.” EX1003, p.192; EX1002, ¶209. 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_p)	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, ¶¶210-11. 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, ¶211. 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, ¶211.

Additionally, at least one of Doufexi’s selectable subcarrier spacings equals the other selectable subcarrier spacings multiplied by a scaling factor that is a power of two. Specifically, Doufexi’s subcarrier spacings are 16kHz and 8kHz each providing a different symbol period, where 16kHz is equal to 8kHz multiplied by 2^1 . EX1002, ¶¶210-12. 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 and to implement different OFDM system “values” or configurations to simplify processing of the various system parameters when the environmental conditions change as explained in further detail below. EX1002, ¶213.

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 m because the prior art provides express motivation to do so. EX1002, ¶¶164, 213. A POSITA would have seen benefits in configuring Galda to select one of a plurality of subcarrier spacings when selecting a user's subcarriers using the predefined configurations taught by Lucent or Doufexi including (1) achieving "high" or "superior" performance in "a wide range of environments" as stated by Doufexi, and (2) enabling different configurations for different UE environments as taught by Lucent. EX1002, ¶¶164, 213.

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, ¶¶165, 214. And there were known benefits of providing for selectable subcarrier spacings including permitting system adaptability. EX1002, ¶¶165, 214. Employing the configurations defined by Lucent or the "values" defined by Doufexi would have enabled Galda's system to apply variable OFDM system parameters depending on the environment or deployment conditions under which the mobile station is operating. This includes using the predefined subcarriers in which one subcarrier spacing is equal to another subcarrier spacing that is multiplied by a scaling factor that is a power of two as

shown by both Lucent and Doufexi. EX1002, ¶¶166, 215. Implementing the known configurations provided by Lucent and Doufexi in Galda would have reduced the computational complexity of adapting the OFDM system to different conditions. EX1002, ¶¶167, 216. The rationale for why a POSITA would have found applying known configurations as disclosed by Lucent in connection with OFDM transmission systems are applicable to the combination of Galda and Lucent or Galda and Doufexi. *Supra* §IX.B.1.

Using 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 or Lucent to improve Galda by allowing it to be adaptable to different environments and deployment scenarios thus increasing system flexibility. EX1002, ¶¶167, 216. 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. EX1002, ¶168, 216. Moreover, the resulting combination would have provided predictable results because various system parameters would be adjusted according to predefined configurations thereby permitting, for example, a larger or smaller subcarrier spacing and symbol duration thus improving performance depending on the channel conditions. EX1002, ¶¶167-68, 216.

A POSITA would have reasonably expected to succeed in implementing the predefined OFDM configurations taught by Lucent and Doufexi in Galda's OFDM system because POSITAs were aware of the benefits of selecting different subcarrier spacings (including predefined spacings that equal other spacings multiplied by a scaling factor that is a power of two) depending on channel conditions, deployment scenarios, and/or environmental conditions. EX1002, ¶¶169, 217. A POSITA was also aware of the mathematical relationships between OFDM symbol duration and subcarrier spacing that are needed to maintain orthogonality. EX1002, ¶¶170, 217; EX1015, p.22 (“[T]he carriers are linearly independent (i.e., orthogonal) if the carrier spacing is a multiple of $1/T$.”). A POSITA also would have known how to consider various system parameters including subcarrier spacings and symbol durations to define different OFDM system configurations because such 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 1*

a. [1Pre]: Method of enabling flexible channel bandwidth

Assuming the preamble is limiting, Galda in view of Lucent (Ground 4) and Galda in view of Doufexi (Ground 5) renders obvious *a method of enabling flexible*

channel bandwidth for mobile radio communications. EX1002, ¶¶171-74, 218.

Galda discusses “an OFDM access scheme” that is *a method of flexible channel bandwidth for radio communications* because the scheme “offers not only a high flexibility for the 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; *see also id.* (“By allocating distinct sets of subcarriers to different users the available bandwidth can be flexibly shared between different mobile terminals while avoiding any multiple access interferences (MAI) between different users.”); EX1002, ¶¶172, 218.

Indeed, Galda’s Abstract states that OFDM “has a high system inherent flexibility for designing a multiple access scheme by combining conventional TDMA, FDMA, and CDMA approaches with the OFDM modulation scheme.” EX1004, p.1737. Moreover, the combination of Galda and Lucent and Galda and Doufexi would further increase flexibility in channel bandwidth by allowing for different conditions to be addressed by, for example, different system parameters including subcarrier allocations, guard intervals, symbol durations, and subcarrier spacings. EX1002, ¶¶173, 218.

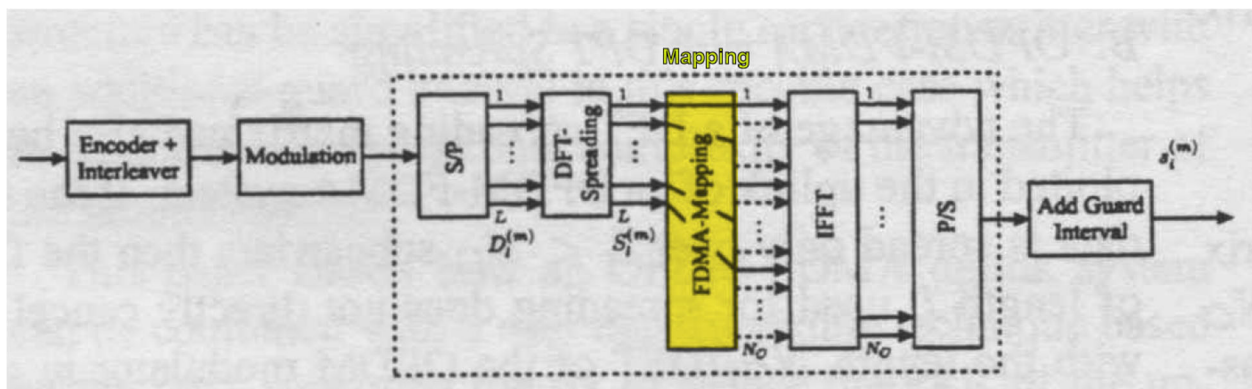
Thus, Galda in view of Lucent and Galda in view of Doufexi render obvious [1Pre].

b. [1A]: provisioning OFDM subcarriers

Galda in view of Lucent (Ground 4) and Galda in view of Doufexi (Ground 5) renders obvious *provisioning a set of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for mobile radio communications*. EX1002, ¶¶175-80, 218.

In Galda, “the subdivision of the transmission bandwidth into a set of orthogonal subcarriers can additionally be exploited by an OFDM-FDMA scheme[] [b]y allocating distinct sets of subcarriers to different users.” EX1004, p.1737. Galda’s subcarriers are OFDM subcarriers because Galda describes an OFDM-FDMA scheme. EX1004, pp.1737, 1739, 1741; EX1002, ¶¶176-77, 218.

Galda discloses “FDMA-Mapping” block, which would have been understood to perform *provisioning OFDM subcarriers for mobile radio communications* as shown below:



EX1004, p.1740; EX1002, ¶¶178, 218. “FDMA-Mapping” maps “ L complex transmit symbols $S_t^{(m)}$ onto L of the available N_C subcarrier[s] which are exclusively

allocated to user m .” EX1004, p.1738. This provisioning acts on the allocation of subcarriers to user m and thus allows the IFFT to generate the resulting “OFDM time signal of user m ” called $s_i^{(m)}$. EX1004, p.1738; EX1002, ¶¶179, 218. By this provisioning, FDMA-Mapping provides spread (encoded) data symbols to provisioned inputs of the IFFT. EX1002, ¶¶179, 218. In the combined Galda-Lucent and Galda-Doufexi systems, a POSITA would have understood that this mapper operates on, among other things, different “Values” or “Configuration.” EX1002, ¶¶179, 218. Thus, Galda describes a step of provisioning OFDM subcarriers.

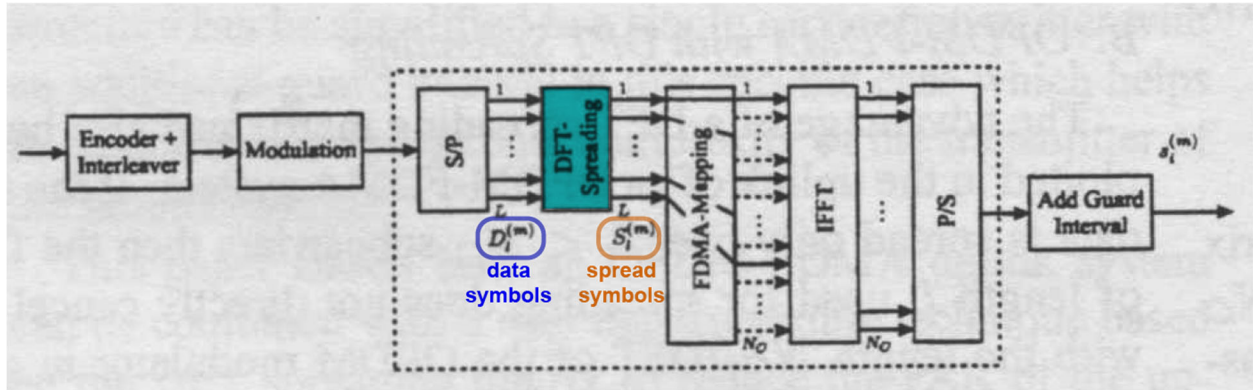
Thus, Galda in view Lucent or Galda in view of Doufexi render obvious Limitation [1A].

c. [1B]: encoding data symbols with polyphase codes from a DFT

Galda in view of Lucent (Ground 4) and Galda in view of Doufexi (Ground 5) renders obvious *encoding data symbols with polyphase codes derived from a discrete Fourier transform to produce encoded data symbols*. EX1002, ¶¶181-88, 218.

Galda describes performing *encoding the data symbols with polyphase codes* because the vector of “complex modulation symbols” (i.e., data symbols “ $\vec{D}^{(m)}$ ”) is multiplied by codes from complex-valued code matrix “[C]” to produce *encoded data symbols* (i.e., “complex transmit symbols” “ $\vec{S}^{(m)}$ ”). EX1004, p.1738; EX1002,

¶¶182-83, 218. The encoding is performed in Galda's "DFT-Spreading" block:



EX1004, p.1738 (Fig. 6(a)).

Galda performs *encoding data symbols with polyphase codes derived from a discrete Fourier transform* because it explains that “ L complex modulation symbols $D_l^{(m)}$, $l = 0, \dots, L - 1 \dots$ are spread over the L user specifically allocated subcarrier with a[] unitary spreading matrix $[C]$ resulting in L complex transmit symbols $S_l^{(m)}$.” EX1004, p.1738. Galda's spreading matrix $[C]$ defines a number of *polyphase codes* described 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. The encoded data symbols $S_l^{(m)}$ (for $l=0$ to $l=L-1$) are mathematically represented as follows:

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

EX1004, p.1738; EX1002, ¶¶184-85, 218. Thus, the data symbols $D_l^{(m)}$, $l = 0, \dots, L - 1$ (expressed as vector $D_v^{(m)}$ in the equation above) are encoded with *polyphase*

codes. EX1002, ¶¶185, 218.

Galda's polyphase codes are *derived from a discrete Fourier transform* because they take the form:

$$C_{i,j} = \left(\frac{1}{\sqrt{L}} \right) \cdot e^{j2\pi i j / L}$$

EX1004, p.1739; EX1002, ¶¶186, 218. Galda's *polyphase codes derived from a discrete Fourier transform* are thus expressed as L orthogonal code vectors $\vec{C}_l = (C_{l,0}, C_{l,1}, \dots, C_{l,L})$ with $l = 0, \dots, L - 1$ " and each code in the code vector are obtained from "the elements of the Fourier matrix." EX1004, pp.1738, 1739; EX1002, ¶¶186, 218.

When *data symbols* $D_l^{(m)}$, $l = 0, \dots, L - 1$ are multiplied by the elements of the Fourier matrix, it encodes the data symbols to be transmitted by spreading them *to produce encoded data symbols* which are defined by the summation of products of the polyphase codes and data symbol vectors. EX1002, ¶¶187, 218.

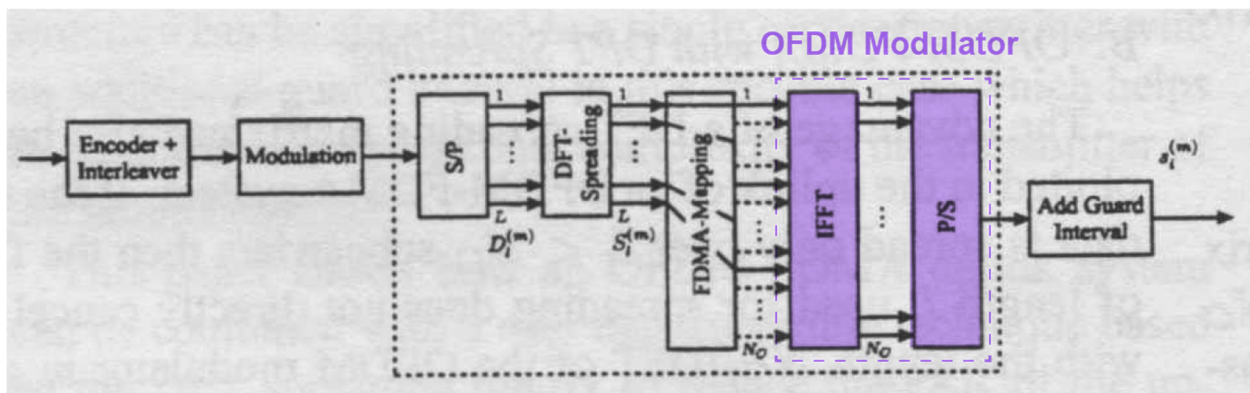
Thus, Galda in view Lucent or Galda in view of Doufexi render obvious Limitation [1B].

d. [1C]: modulating encoded symbols onto OFDM subcarriers

Galda in view of Lucent (Ground 4) and Galda in view of Doufexi (Ground 5) renders obvious *modulating the encoded data symbols onto the OFDM*

subcarriers to produce a superposition signal that resembles a single-carrier signal and has one of a plurality of different symbol durations [1C]. EX1002, ¶¶189-95, 219-23.

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



EX1004, p.1740 (Fig. 6(a)); *see also id.*, 1738 (Fig. 1). 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*”). EX1002, ¶¶190-91, 220-21.

Galda’s IFFT block *produce a superposition signal* because Galda’s time-domain waveform (“the resulting OFDM time signal of user *m*” $s_t^{(m)}$) is the sum (superposition) of the individual spread symbols on the subcarriers, as is reflected in the following mathematical expression:

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

$$\text{for } i = -N_G, \dots, 0, \dots, N_C,$$

where the summation of subcarriers from $l = 0$ to L represents a *superposition signal* of the subcarriers, and corresponding data symbols, modulated by the set of subcarrier values $S_l^{(m)}$. EX1004, pp.1738-1739; *see also id.*, p.1737 (“the superposition signal results from a large number of independent data symbols”); EX1002, ¶¶192, 221.

To the extent the Board determines that Galda does not expressly disclose production of a *superposition signal*, it would have been obvious to a POSITA that Galda’s “OFDM time signal” is a superposition signal, 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 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, ¶¶192, 221.

Galda produces a *superposition signal that resembles a single-carrier signal*

because “[t]he time signal of the OFDM-FDMA uplink with DFT spreading is identical to a single carrier transmission.” EX1004, p.1740.

Galda’s OFDM signal will have a symbol duration because Galda explains that there are a “number of periods inside a single OFDM symbol,” which is “equal to the spacing M of the subcarriers allocated to user m .” EX1004, p.1740. Galda does not explicitly mention a *plurality of different symbol durations* but, as explained in connection with Limitation [1D], below, both Lucent and Doufexi disclose superposition signals with one of several different symbol durations (tied to different subcarrier spacings). It would have been obvious to modify Galda to include a plurality of different symbol durations for the reasons discussed above and based on the knowledge that a symbol period is the inverse of the subcarrier spacing in order to maintain orthogonality. *Supra* §IX.C.1; EX1002, ¶¶193-94, 222; EX1015, p.22 (“[T]he carriers are linearly independent (i.e., orthogonal) if the carrier spacing is a multiple of $1/T$.”).

Thus, Galda in view of Lucent and Galda in view of Doufexi render obvious Limitation [1C].

- e. [1D]: selecting one of multiple different subcarrier spacings provides one of multiple symbol durations

Galda in view of Lucent (Ground 4) and Galda in view of Doufexi (Ground 5) renders obvious *wherein provisioning comprises selecting one of a plurality of*

different selectable subcarrier spacings, to provide for the one of the plurality of different symbol durations. EX1002, ¶¶196-99, 224-28.

Galda does not describe selecting *one of a plurality of different selectable subcarrier spacings, to provide for the one of the plurality of different symbol durations.* This limitation would have been obvious over Galda in view of Lucent or Galda in view of Doufexi because each of Lucent and Doufexi disclose provisioning subcarriers that includes selecting one of a plurality of different selectable subcarrier spacings to provide for the one of the plurality of different symbol durations.

Doufexi: Doufexi describes *provisioning* “the key link parameters of OFDM for a potential 4G cellular standard” where “[t]hese include the number of carriers [and] the subcarrier spacing.” EX1003, p.192. Doufexi discloses “[a] system capable of dynamically adapting one or more of the above parameters may offer superior performance” and shows two different sets of dynamically adaptable “proposed OFDM parameters” in Table 2:

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.192-193 (Table 2). Doufexi discloses *selecting one of a plurality of different subcarrier spacings* by showing two options for adaptable subcarrier spacing (16 kHz and 8 kHz) *to provide for one of the plurality of different symbol durations* (“[t]he subcarrier spacing is $\Delta_f = 1/T$ ”, where T is Useful Symbol Duration, so selecting Δ_f of 16 kHz will provide for T of 62.5 μ s and selecting 8 kHz will provide for T of 125 μ s). EX1003, p.193; EX1002, ¶¶225-27.

Lucent: Lucent describes *selecting one of a plurality of different selectable subcarrier spacings* in describing “an OFDM system with multiple configurations that can be deployed in different environments” where Configuration 1 includes a sub-carrier spacing of 19.2 kHz, Configuration 2 includes a sub-carrier spacing of 9.6 kHz, and Configuration 3 includes a sub-carrier spacing of 4.8 kHz:

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, pp.5-7. EX1002, ¶¶197. Lucent's three configurations also show an inverse relationship between sub-carrier spacing and symbol period, such that selecting a subcarrier spacing *provides for the one of the plurality of different symbol durations*. EX1002, ¶¶197-98. For example, a subcarrier spacing of 4.8 kHz provides for a symbol period of 222 microseconds, whereas a subcarrier spacing of 9.6 kHz provides for a symbol duration of 111 microseconds.

Based on these teachings and for the reasons explained above, Galda in view of Lucent and Galda in view of Doufexi renders obvious Limitation [1D] and claim 1. *Supra* §IX.C.1.

3. *Claim 2*

Galda in view of Lucent (Ground 4) and Galda in view of Doufexi (Ground 5) renders obvious *wherein at least one of the plurality of different selectable subcarrier spacings equals at least one other of the plurality of different selectable subcarrier spacings multiplied by a scaling factor that is a power of two*. EX1002, ¶¶200-203, 229-32.

Doufexi: Doufexi provides *a plurality of different selectable subcarrier spacings* where *one of the plurality* (associated with Value 1) is 16 kHz and another (Value 2) is 8 kHz:

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, Table 3. Thus, *at least one of the plurality of different selectable subcarrier spacings* (i.e., 16 kHz) *equals at least one other of the plurality of different selectable subcarrier spacings* (i.e., 8 kHz) *multiplied by a scaling factor that is a power of two* (i.e., a scaling factor of 2, which 2^1). EX1002, ¶¶230-31.

Lucent: Lucent shows a plurality of three subcarrier spacings, where *at least one of the plurality of different selectable subcarrier spacings* (19.2 kHz in

Configuration 1) *equals at least one other of the plurality of different selectable subcarrier spacings* (9.6 kHz in Configuration 2) *multiplied by a scaling factor that is a power of two* (the scaling factor of 2 from Configuration 2 to Configuration 1 is a 2^1).

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, pp.5-7. EX1002, ¶201-02. In fact, each of Lucent's configurations represent powers of 2 when it comes to the subcarrier spacings:

Smallest Subcarrier spacing	Scaling Factor	Selectable Subcarrier Spacing
4.8 kHz	0 (2^0)	4.8 kHz
4.8 kHz	2 (2^1)	9.6 kHz
4.8 kHz	4 (2^2)	19.2 kHz

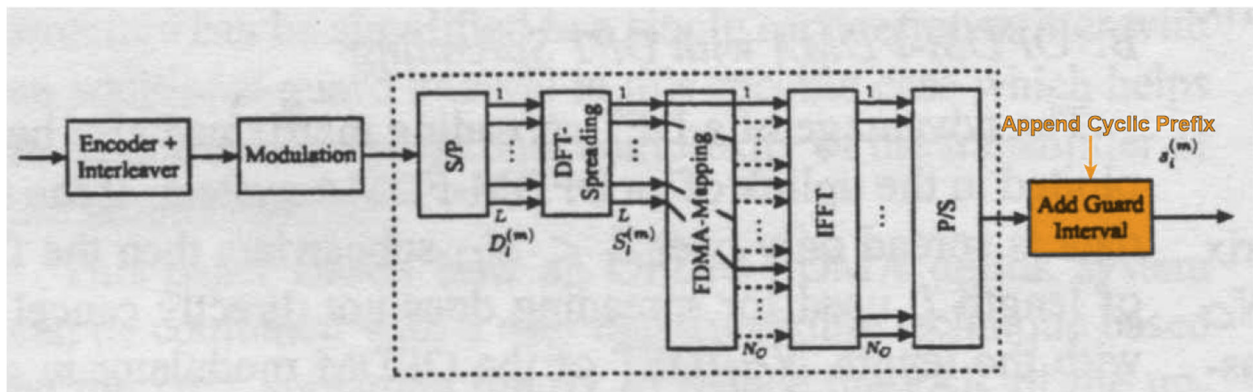
EX1002, ¶202.

For the reasons explained above, Galda in view of Lucent and Galda in view of Doufexi render claim 2 obvious. *Supra* §IX.C.1.

4. Claim 3

Galda in view of Lucent (Ground 4) and Galda in view of Doufexi (Ground 5) renders obvious *wherein the superposition signal is provided with a cyclic prefix*. EX1002, ¶¶204-06, 233-35.

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)); *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, ¶¶205, 234. As seen here, the cyclic prefix is added after spreading and before transmission. EX1004, p.1740 (Fig. 6(a)).

Thus, Galda in view of Lucent and Galda in view of Doufexi render obvious

claim 3.

D. Grounds 6 and 7: Claims 8-10, 12, 15-17, and 19 are rendered obvious by (Ground 6) Galda in view of Lucent and Dowling and (Ground 7) Galda in view of Doufexi

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

Grounds 6 and 7 address claims 8-10, 12, 15-17, and 19. Independent claim 8 recites an apparatus that comprises **[8A]** *at least one processor* and **[8B]** *at least one non-transitory computer-readable memory in electronic communication with the at least one processor, and instructions stored in the at least one memory, the instructions executable by the at least one processor*. EX1001, cl. 8. Independent claim 15 recites **[15Pre]** *A computer program product, comprising a non-transitory computer-readable memory having computer readable program code stored therein, the program code containing instructions executable by one or more processors of a computer system*. Claims 8-10, 12, 15-17, and 19 otherwise correspond to claims 1-3 and 5. The reasons to combine Galda and Lucent and Galda and Doufexi are already provided in connection with Grounds 4 and 5 and are equally applicable to Grounds 6 and 7. *Supra* §IX.C.1. Thus, this analysis focuses on the additional combination of Galda-Lucent and Galda-Doufexi with Dowling.

While the claims challenged in these Grounds require computer instructions stored in memory which are executable by a processor, Galda, Lucent, and Doufexi

do not explicitly state whether the disclosed systems are implemented in hardware or a combination of hardware and software. EX1002, ¶¶236-39. Nevertheless, a POSITA would have understood that Galda in view of Lucent and Galda in view of Doufexi would have needed to be implemented using at least one of these technologies. *Id.* A POSITA would have found it obvious to implement the Galda-Lucent combination and the Galda-Doufexi combination in software stored in memory coupled to a processor such that the software is executed by the processor. *Id.*, 239

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, ¶¶240-41. 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, ¶241; 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 the combined Galda-Lucent and the combined Galda-Doufexi functions (as explained in connection with Grounds 4 and 5, above) 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 as the Galda-Lucent and Galda-Doufexi combinations), 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, ¶¶242-43.

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, ¶244. 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 8 and 15*

a. [8Pre], [8A], [8B], [15Pre]: Apparatus, processor, memory, computer program product

Galda in view of Lucent and Dowling (Ground 6) and Galda in view of Doufexi and Dowling (Ground 7) render obvious the following aspects of claims 8 and 15:

[8Pre] *An apparatus for providing flexible channel bandwidth in mobile radio communications, [8A] at least one processor and [8B] at least one non-transitory computer-readable memory in electronic communication with the at least one processor, and instructions stored in the at least one memory, the instructions executable by the at least one processor;*

[15Pre] *A computer program product, comprising a non-*

transitory computer-readable memory having computer readable program code stored therein, the program code containing instructions executable by one or more processors of a computer system

EX1002, ¶¶245-49.

Galda in view of Lucent and Galda in view of Doufexi render obvious *an apparatus for providing flexible channel bandwidth in mobile radio communications* as recited in [8Pre] because it describes a method that is for providing flexible channel bandwidth in mobile radio communications as explained in connection with [1Pre], above, and the method is performed using an apparatus. *Supra* §§IX.C.2.a; IX.D.1.

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, ¶¶246-47. Dowling further discloses that its transmitter may be implemented as “a computer program which executes on a

processor.” EX1042, 19:14-15. A POSITA would have understood that “software radios” with code in memory and processors to execute that code to provide flexibility in design and updating and were significantly easier to upgrade than hardware whose implementation would have been fixed in silicon. EX1002, ¶248; EX1008 (describing OFDM-CDMA software radio); EX1011, ¶¶[0124]-[0125] (modulation can be implemented in “hardware, software, or a combination thereof”). These references have similar disclosures to the ’792 Patent, which states that various aspects “may be implemented in hardware or special purpose circuits, software.” EX1001, 62:52-53. For the reasons explained above, a POSITA would have found it obvious to implement Galda’s transmitter in software stored on memory for execution by a processor coupled to the memory as recited in claims 8 and 15. *Supra* §IX.D.1.

Thus, Galda in view of (1) Dowling and Doufexi or (2) Dowling and Lucent renders obvious [8Pre], [15Pre], [8A], and [8B]. EX1002, ¶¶245-49.

b. [8Ci]-[8Civ], and 15[A]-15[D]

Limitations [8Ci]-[8Civ] and 15[A]-15[D] are the same as Limitations [1A]-[1D]. The analysis of those limitations is equally applicable to these limitations. *Supra* §§IX.C.2.b-e.

Limitations [8Ci]-[8Civ] and 15[A]-15[D] are obvious over Galda in view of Lucent and Dowling (Ground 6) and Galda in view of Doufexi and Dowling (Ground

7) for the reasons explained above. *Supra* §§IX.C.1 (combination of Galda with Lucent and Doufexi), IX.D.1 (addition of Dowling); EX1002, ¶¶250-54.

3. *Claims 9 and 16*

Claims 9 and 16 are the same as claim 2. *Supra* §IX.C.3; EX1002, ¶255. Accordingly, Galda in view of Lucent and Dowling and Galda in view of Doufexi and Dowling render obvious claims 9 and 16 based on the analysis presented respect to claim 2. *Supra* §IX.C.3. It would have been obvious to implement the functionality recited in claims 9 and 16 in software stored in memory for execution by a processor for the same reasons provided above based on Galda in view of Lucent and Dowling and Galda in view of Doufexi and Dowling. *Supra* §IX.D.1; EX1002, ¶255.

4. *Claims 10 and 17*

Claims 10 and 17 are similar to claim 3. Claim 3 recites that “the superposition signal is provided with a cyclic prefix” and claims 10 and 17 reciting “adding a cyclic prefix to the superposition signal.” *Supra* §IX.C.4.

Claims 10 and 17 are rendered obvious by Galda in view of Lucent and Dowling and Galda in view of Doufexi and Dowling for at least the same reasons as claim 3 and because Galda discloses “a guard interval is added in the time domain as a cyclic prefix.” EX1004, p.1739; EX1002, ¶256; *supra* §IX.C.4. It would have been obvious to implement the functionality recited in claims 10 and 17 in software

stored in memory for execution by a processor for the same reasons provided above based on Galda in view of Lucent and Dowling and Galda in view of Doufexi and Dowling. *Supra* §IX.D.1; EX1002, ¶256.

X. DISCRETIONARY DENIAL UNWARRANTED

A. *Fintiv* Factors Favor Institution

The *Fintiv* factors—as applied per the March 24, 2025 Guidance on the USPTO rescission of the Interim Procedure (EX1060, “Boalick Memo”) guides against discretionary denial. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (precedential).

1. Petitioners 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 April 2025, a final written decision may be expected by October 2026, only six 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, 2025 WL 305477, at *4 (P.T.A.B. 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, 2021 WL 606917, at *8 (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 (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.*, No. IPR2020-01019, at 19 (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*, 2021 WL 606917, at *6 (“[F]actor 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. EX1098. This is the first and only IPR on the ’792 Patent, so a patentability determination by the Board on this Petition would conserve resources.

B. Denial Under §325(d) Unwarranted

The ’792 Patent was not rejected on any prior art, and the prior art in Petitioner’s Grounds was never relied upon by the Examiner during prosecution for a rejection. 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 '792 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:** U.S. Reexamination Control No. 90/019,847; *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00791.
- **U.S. Patent No. 11,381,285:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00792; Petitioner also anticipates filing a request for reexamination as to this patent to raise grounds that cannot be raised in this proceeding.

A patent with similar subject matter and common inventorship and alleged ownership as the '792 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 address:

GT-Genghiscomm-IPR@gtlaw.com

XII. FEES

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

Dated: April 10, 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 13,986 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 10, 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 10, 2025, I caused a true and correct copy of **PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 11,424,792, 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, 1006-1016, 1019, 1023, 1031, 1034, 1039, 1042, 1046, 1047, 1049, 1059-1065, 1068-1069, 1087, 1089-1095, 1097-1098, AND 1100-1103** by EXPRESS MAIL on the Patent Owner at the correspondence address of record for U.S. Patent No. 11,424,792 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. – arichards@giplg.com; kfrisby@giplg.com

/Andrew R. Sommer/

Andrew R. Sommer
Reg. No. 53,932