

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: IPR2025-00790
U.S. Patent No. 11,223,508

**PETITION FOR *INTER PARTES* REVIEW OF CLAIMS 1-6, 9-14, and
17-22 OF U.S. PATENT NO. 11,223,508**

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

I.	FOUNDATIONS FOR STANDING	1
II.	TECHNICAL OVERVIEW	1
III.	THE ’508 PATENT	6
	A. Overview of the Patent and Challenged Claims	6
	B. Prosecution History	7
	1. Application No. 16/916,901 (Challenged Patent)	9
	2. Application No. 16/426,240	9
	3. Application No. 15/786,270	10
	4. Application No. 15/489,644	10
	5. Application No. 15/149,382	11
	6. Application No. 14/727,769	11
IV.	EFFECTIVE FILING DATE; POST-AIA	12
V.	THE PERSON OF ORDINARY SKILL IN THE ART (“POSITA”)	13
VI.	IDENTIFICATION OF THE CHALLENGE	13
VII.	CLAIM CONSTRUCTION	14
VIII.	PRIOR ART STATUS OF THE REFERENCES; ANALOGOUS ART	14
	A. Shattil-537	14
	B. Doufexi	16
	C. Lucent	18
IX.	DETAILED DISCUSSION	20
	A. Grounds 1 and 2: Claims 1, 3, 5, 9, 11, 13, 17, 19, and 21 are (Ground 1) anticipated by or (Ground 2) obvious over Shattil-537	20
	1. Claim 1	20
	a. [1Pre]: Method for communicating	20
	b. [1A]: provisioning a consecutive series of OFDM subcarriers	22
	c. [1B]: provisioning selectable subcarrier spacings	24
	d. [1C]: performing DFT coding to produce coded symbols	25

e.	[1D]: performing an inverse-DFT to produce an SC-FDMA signal.....	27
f.	[1E]: transmitting the SC-FDMA signal	29
g.	[1F]: providing symbol period by selecting subcarrier spacing	30
2.	Claim 9.....	32
a.	[9Pre], [9A], [9B], [9C]: An apparatus for communicating	32
b.	[9Ci]: provisioning a consecutive series of OFDM subcarriers	34
c.	[9Cii]: provisioning selectable subcarrier spacings.....	34
d.	[9Ciii]: performing DFT coding to produce DFT coded symbols.....	35
e.	[9Civ]: performing an inverse-DFT to produce an SC-FDMA signal.....	35
f.	[9Cv]: transmitting the SC-FDMA signal	35
g.	[9D]: providing symbol period by selection of subcarrier spacing	35
3.	Claim 17	36
a.	[17Pre]: An apparatus for communicating.....	36
b.	[17A]: a transceiver-control circuitry	37
c.	[17Ai]: provisioning a consecutive series of OFDM subcarriers	39
d.	[17Aii]: provisioning selectable subcarrier spacings	44
e.	[17Aiii] performing DFT coding to produce DFT coded symbols.....	45
f.	[17B]: an OFDM transceiver	47
g.	[17Bi] performing an inverse-DFT to produce an SC-FDMA signal.....	49
h.	[17Bii]: transmitting the SC-FDMA signal.....	51
i.	[17C]: providing symbol period by selection of subcarrier spacing	52

4.	Claims 3, 11, and 19	54
5.	Claims 5, 13, and 21	55
B.	Grounds 3 and 4: Claims 2, 4-6, 10, 12-14, 18, and 20-22 would have been obvious over (Ground 3) Shattil-537 in view of Doufexi and (Ground 4) Shattil-537 in view of Lucent.....	57
1.	Overview of the combination; motivation to combine; expectation of success.....	57
2.	Claims 2, 10, and 18.....	63
3.	Claims 4, 12, and 20.....	65
4.	Claims 5, 13, and 21	67
5.	Claims 6, 14, and 22.....	70
X.	DISCRETIONARY DENIAL UNWARRANTED.....	72
A.	<i>Fintiv</i> Factors Favor Institution	72
1.	Petitioner Will Seek a Stay	72
2.	Parallel Proceeding Trial Date	73
3.	Investment in Parallel Proceeding	75
4.	Stipulation Favors Institution.....	75
5.	Identity of the Parties	76
6.	Merits Heavily Favor Institution.....	76
B.	Denial Under §325(d) Unwarranted.....	77
XI.	MANDATORY NOTICES.....	77
A.	Real Party-In-Interest.....	77
B.	Related Matters.....	77
C.	Lead and Back-Up Counsel.....	79
D.	Service.....	79
XII.	FEES.....	80

LISTING OF CLAIMS

Claim 1. [1Pre] A method of communicating in a mobile radio communications network, comprising:

[1A] provisioning a consecutive series of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for uplink or downlink communications;

[1B] provisioning a plurality of different selectable subcarrier spacings for the consecutive series of OFDM subcarriers;

[1C] performing discrete Fourier transform (DFT) coding on a plurality of data symbols to produce coded symbols;

[1D] performing an inverse-DFT on the coded symbols to produce a single-carrier frequency division multiple access signal that comprises a sum of the consecutive series of OFDM subcarriers; and

[1E] transmitting the single-carrier frequency division multiple access signal in the mobile radio communications network;

[1F] wherein provisioning the plurality of different selectable subcarrier spacings comprises providing the single-carrier frequency division multiple access signal with a particular one of a set of different symbol periods by selecting one of the plurality of different selectable subcarrier spacings.

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, further comprising adding a cyclic prefix to the single-carrier frequency division multiple access signal prior to transmitting.

Claim 4. The method of claim 1, wherein the plurality of different selectable subcarrier spacings are integer multiples of a first subcarrier spacing.

Claim 5. The method of claim 1, wherein the provisioning the plurality of different selectable subcarrier spacings is configured for different deployment scenarios comprising different system requirements or different channel conditions.

Claim 6. The method of claim 1, wherein each of the plurality of different subcarrier spacings provides a different number of symbols per frame.

Claim 9. [9Pre] An apparatus for communicating in a mobile radio communications network, comprising:

[9A] a non-transitory computer-readable memory storing one or more instructions; and

[9B] at least one processor in communication with the non-transitory computer-readable memory;

[9C] wherein the one or more instructions, when executed by the at least one processor, cause the at least one processor to:

[9Ci] provision a consecutive series of Orthogonal Frequency Division

Multiplexing (OFDM) subcarriers for uplink or downlink communications;

[9Cii] provision a plurality of different selectable subcarrier spacings for the consecutive series of OFDM subcarriers;

[9Ciii] perform discrete Fourier transform (DFT) coding on a plurality of data symbols to produce DFT coded symbols;

[9Civ] perform an inverse-DFT on the coded symbols to produce a single-carrier frequency division multiple access signal that comprises a sum of the consecutive series of OFDM subcarriers; and

[9Cv] transmit the single-carrier frequency division multiple access signal in the mobile radio communications network;

[9D] wherein the one or more instructions cause the at least one processor to provide the single-carrier frequency division multiple access signal with one of a set of different selectable symbol periods by selecting one of the plurality of different selectable subcarrier spacings.

Claim 10. The apparatus of claim 9, 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 11. The apparatus of claim 9, further comprising one or more instructions, when executed by the at least one processor, cause the at least one processor to add a cyclic prefix to the single-carrier frequency division multiple access signal.

Claim 12. The apparatus of claim 9, wherein the plurality of different selectable subcarrier spacings are integer multiples of a first subcarrier spacing.

Claim 13. The apparatus of claim 9, wherein each of the plurality of different selectable subcarrier spacings is configured for one of a plurality of different deployment scenarios, the plurality of different deployment scenarios comprising different system requirements or different channel conditions.

Claim 14. The apparatus of claim 9, wherein each of the plurality of different selectable subcarrier spacings provides a different number of symbols per frame.

Claim 17. [17Pre] An apparatus for communicating in a mobile radio communications network, comprising:

[17A] a transceiver-control circuitry configured for:

[17Ai] provisioning a consecutive series of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for uplink or downlink communications;

[17Aii] provisioning a plurality of different selectable subcarrier spacings for the consecutive series of OFDM subcarriers; and

[17Aiii] performing discrete Fourier transform (DFT) coding on a plurality of data symbols to produce DFT coded symbols; and

[17B] an OFDM transceiver communicatively coupled to the transceiver-control circuitry and configured for:

[17Bi] performing an inverse-DFT on the coded symbols to produce a single-carrier frequency division multiple access signal that comprises a sum of the consecutive series of OFDM subcarriers; and

[17Bii] transmitting the single-carrier frequency division multiple access signal in the mobile radio communications network;

[17C] wherein provisioning the plurality of different selectable subcarrier spacings comprises providing the single-carrier frequency division multiple access signal with a particular one of a set of different symbol periods by selecting one of the plurality of different selectable subcarrier spacings.

Claim 18. The apparatus of claim 17, 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 19. The apparatus of claim 17, wherein the OFDM transceiver is further configured to add a cyclic prefix to the single-carrier frequency division multiple access signal.

Claim 20. The apparatus of claim 17, wherein the plurality of different selectable subcarrier spacings comprise integer multiples of a first subcarrier spacing.

Claim 21. The apparatus of claim 17, wherein each of the plurality of different selectable subcarrier spacings is configured for one of a plurality of different deployment scenarios, the plurality of different deployment scenarios comprising

different system requirements or different channel characteristics.

Claim 22. The apparatus of claim 17, wherein each of the plurality of different selectable subcarrier spacings produces a different number of symbols per frame.

PETITIONER’S EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 11,223,508 (“’508 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	RESERVED
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	RESERVED
1020	RESERVED
1021	File History of U.S. Patent Application No. 11/187,107 as obtained from Patent Center (excerpts).
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
1027	RESERVED

Exhibit No.	Description
1028	File History of U.S. Patent Application No. 15/786,270 as obtained from Patent Center (excerpts)
1029	RESERVED
1030	File History of U.S. Patent Application No. 14/727,769 as obtained from Patent Center (excerpts)
1031	File History of U.S. Patent Application No. 14/276,309 as obtained from Patent Center (excerpts)
1032	File History of U.S. Patent Application No. 12/545,572 as obtained from Patent Center (excerpts)
1033	RESERVED
1034	Declaration of Craig Bishop
1035	RESERVED
1036	File History of U.S. Patent Application No. 15/489,644 as obtained from Patent Center (excerpts)
1037	File History of U.S. Patent Application No. 15/149,382 as obtained from Patent Center (excerpts)
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	RESERVED
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.

Exhibit No.	Description
	24, 2024).
1047	Complaint, <i>Genghiscomm Holdings, LLC v. Samsung Elecs., Am., Inc.</i> , No. 2:24-cv-0242-RWS-RSP, Dkt. 1 (Apr. 12, 2024).
1048	RESERVED
1049	RESERVED
1050	RESERVED
1051	RESERVED
1052	RESERVED
1053	RESERVED
1054	RESERVED
1055	RESERVED
1056	RESERVED
1057	RESERVED
1058	RESERVED
1059	RESERVED
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).

Exhibit No.	Description
1065	Combined asserted patents in <i>Genghiscomm Holdings, LLC v. Samsung Elecs., Am., Inc.</i> , No. 2:24-cv-0242-RWS-RSP, Dkt. 25 (Sept. 24, 2024).
1066	RESERVED
1067	RESERVED
1068	RESERVED
1069	RESERVED
1070	RESERVED
1071	RESERVED
1072	RESERVED
1073	RESERVED
1074	RESERVED
1075	RESERVED
1076	RESERVED
1077	RESERVED
1078	RESERVED
1079	RESERVED
1080	RESERVED
1081	RESERVED
1082	RESERVED
1083	RESERVED
1084	RESERVED
1085	RESERVED
1086	RESERVED
1087	Exhibit 6 to Plaintiff's P.R. 3-1(c) Infringement Contentions

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	RESERVED
1091	RESERVED
1092	RESERVED
1093	RESERVED
1094	RESERVED
1095	RESERVED
1096	RESERVED
1097	RESERVED
1098	RESERVED
1099	International Application Publication No. WO 02/054537 to Shattil (“Shattil-537”).
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
1104	File History of U.S. Patent Application No. 16/916,901 as obtained from Patent Center
1105	File History of U.S. Patent Application No. 16/426,240 as obtained from Patent Center

Exhibit No.	Description
1106	Results of Docket Navigator Search for '508 Patent

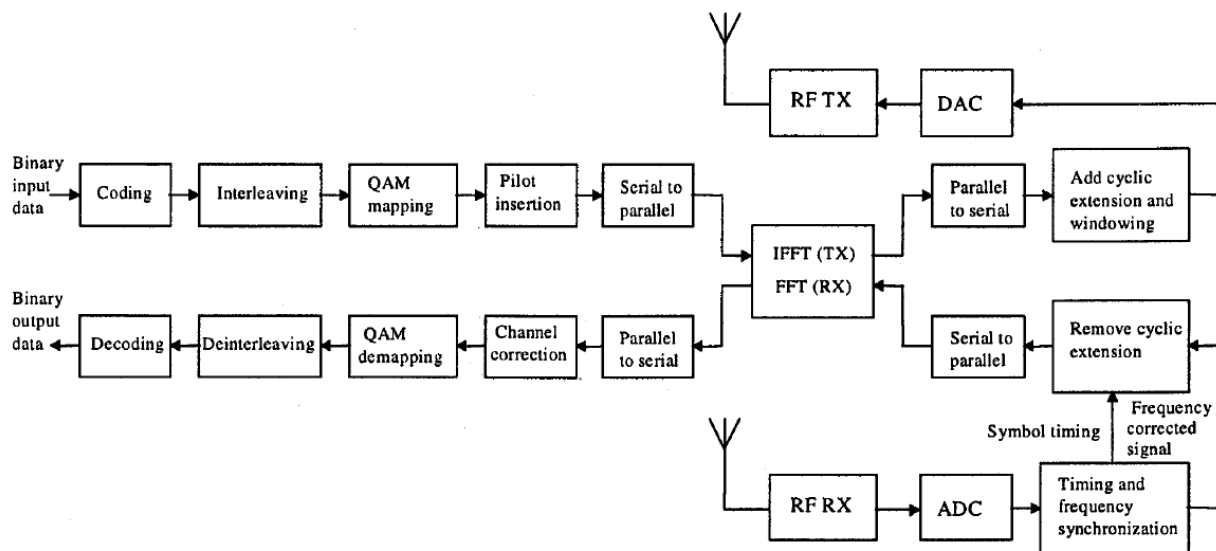
I. GROUNDS FOR STANDING

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

II. TECHNICAL OVERVIEW

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

A textbook example of an OFDM transceiver is shown below.



EX1015, p.48. An OFDM signal is formed at the transmitter using an inverse Fourier transform, typically implemented using an inverse fast Fourier transform (“IFFT”). *Id.*, pp.42, 47-48. A guard interval including a cyclic prefix is added to minimize

intersymbol interference (“ISI”) and intercarrier interference (“ICI”). *Id.*, pp.39-40.

OFDM systems can exhibit high peak-to-average power ratios (“PAPR” or “PAR”). EX1013, p.1780; EX1014, pp.31-32. The Challenged Patent purports to reduce PAPR in OFDM systems by spreading input data using complex-valued codes obtained from a discrete Fourier transform (“DFT”). EX1001, Abstract, 8:64-9:1.

This technique for reducing PAPR in OFDM was not new. Various publications—including some used in the grounds presented herein—described using DFT spreading codes to reduce PAPR in OFDM systems before the earliest claimed effective filing date. For example, Brüninghaus (1998) 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. Bury (2000) 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. Galda (2002) “shows how an OFDM-FDMA uplink system can be combined with a user data spreading technique based on the DFT spreading matrix to reduce the PAR of the uplink signal without increasing the computational complexity of the transmitter.” EX1004, p.1738.

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

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

Table 5: Example of numerical values for the OFDM parameters

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

EX1009, p.11.

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

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

Table 3.5 Parameters and Values Defining Operating Modes for MC Systems

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

Table 3.6 Guidelines for Subsidiary Parameters In MC Systems

FFT Size N	Sample Rate R (MSam/sec)	Subcarrier Spacing (Hz)
256	1.25	4882.813
	1.5	5859.375
	2.5	9765.625
	3	11718.750
	5	19531.250
	6	23437.500
	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, ¶¶44-

58.

III. THE '508 PATENT

A. Overview of the Patent and Challenged Claims

The '508 Patent relates to “transmitting and receiving multicarrier signals.” EX1001, 1:33-35. One of the disclosed techniques relates to reducing the peak-to-average power ratio of an OFDM transmission by spreading the data symbols before they are input into an IDFT. *Id.*, 4:11-17. “FIG. 4A is a block diagram of a spread-OFDM transmitter in accordance with an aspect of the disclosure.” *Id.*, 7:13-14.

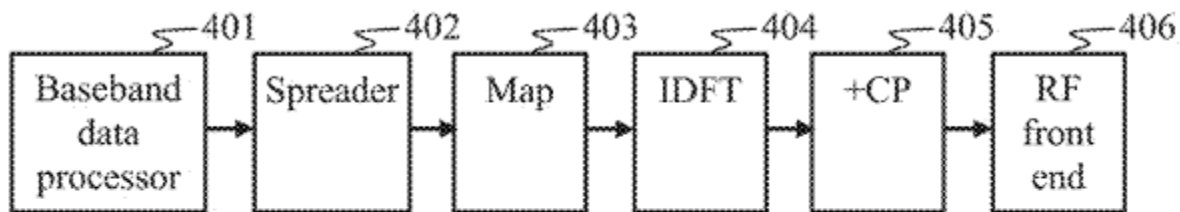


Figure 4A

EX1001, FIG. 4A. “FIG. 4B is a block diagram of a spread-OFDM spreader (such as spreader 402) in accordance with some aspects of the disclosure.” EX1001, 20:13-15.

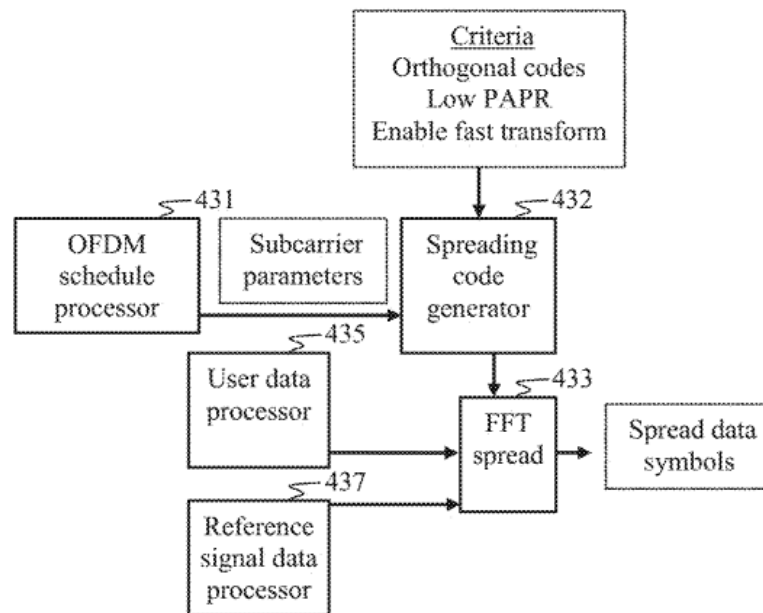
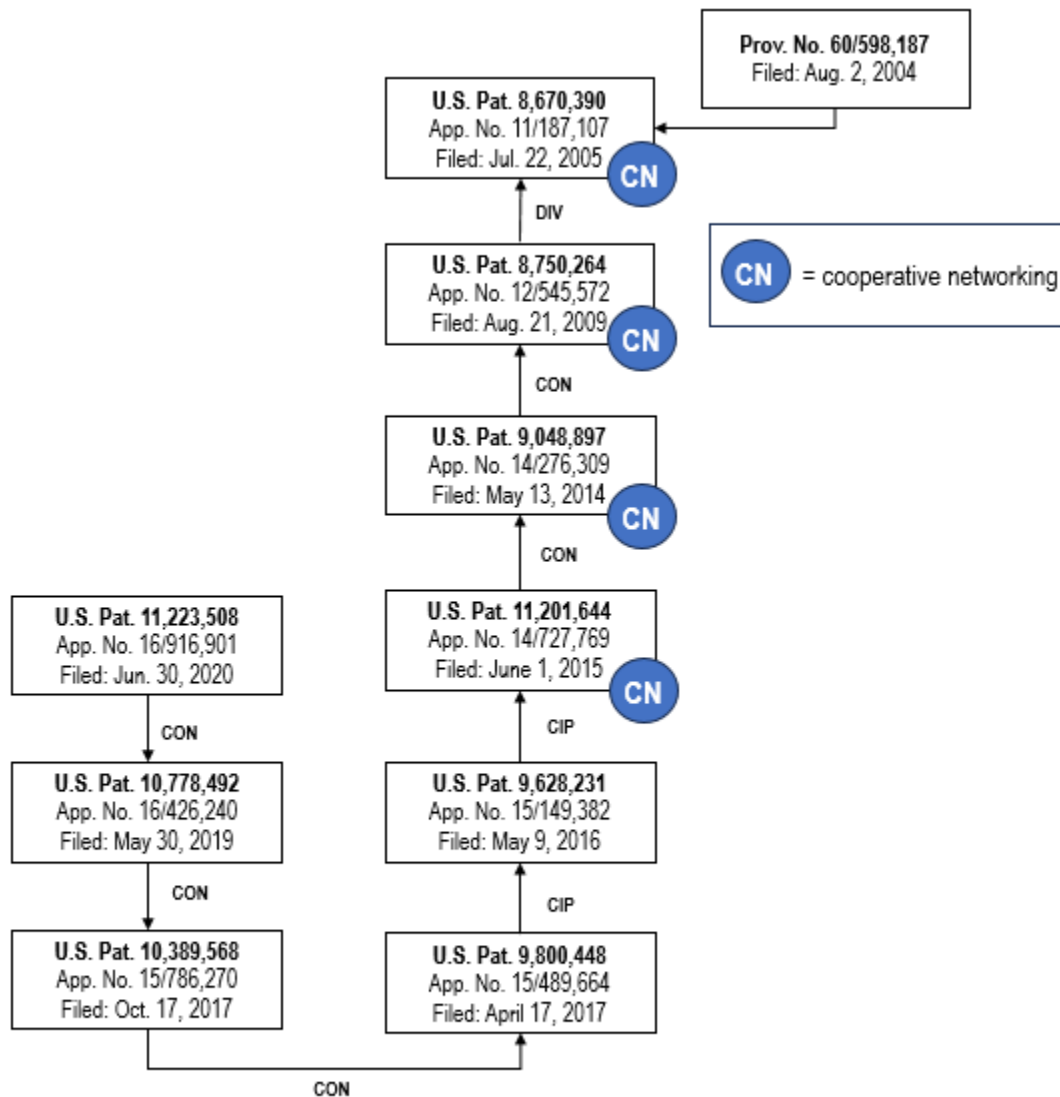


Figure 4B

EX1001, FIG. 4B. The “OFDM schedule processor” receives “subcarrier parameters (e.g., number of subcarriers N, subcarrier spacing, and the like) which are conveyed to a spreading code generator 432.” *Id.*, 20:20-23. Data symbols are provided by user data processor 435 to the spreader 433 for spreading. *Id.*, 20:50-53. The spreading codes can be DFT-based complex spreading codes. EX1001, 21:34-37.

B. Prosecution History

The '508 Patent claims the benefit of an effective filing date of August 2, 2004 through eight non-provisional applications and one provisional application. EX1001, cover. The family of applications in the priority chain is reflected in the illustration below.



'508 Pat. Related U.S. Application Data

In the sections that follow, certain applications (identified with “CN” above) are omitted because they pertain to materially different inventions from that of the '508 Patent. They claim using multiple wireless terminals to cooperatively process or generate signals. *E.g.*, EX1021, p.76 (claiming “cooperative beam-forming in the at least one group of wireless terminals”); EX1032, p.2 (claiming “a plurality of the

mobile wireless terminals to perform cooperative subspace processing”).

1. Application No. 16/916,901 (Challenged Patent)

The '901 Application was filed on June 30, 2020. EX1001, cover. The '901 Application was allowed without rejection. EX1104, pp.10-12. The reasons for allowance called out the “provisioning a plurality of different selectable subcarrier spacings” and “wherein provisioning the plurality of different selectable subcarrier spacings comprises providing the single-carrier frequency division multiple access signal with a particular one of a set of different symbol periods by selecting one of the plurality of different selectable subcarrier spacings”—along with “all disclosed steps of [sic] functions or all disclosed structures performing corresponding functions in claims 1, 9, and 17.” *Id.*, 11.

No prior art is mentioned as being particularly relevant to the '508 Patent claims. And, despite Mr. Shattil being the named inventor on the Shattil-537 publication relied upon in this Petition, he failed to even cite it to the Office. EX1001, “References Cited.”

2. Application No. 16/426,240

The '240 Application was filed on May 30, 2019 with a preliminary amendment indicating that the amended claims included subject matter that was indicated as being allowable in parent Application No. 15/786,270. EX1105, p.137. One of the claims was rejected under 35 U.S.C. §101 as being directed to “software

per se” and all claims were rejected for obviousness-type double patenting over U.S. Patent No. 10,015,034. EX1105, pp.44-46. The claims were indicated as being allowable because “[t]he approved terminal disclaimer overcomes the double patenting rejection.” *Id.*, p.21.

No prior art is mentioned as being particularly relevant to the ’508 Patent claims.

3. *Application No. 15/786,270*

The ’270 Application received one Office Action and in it some claims were indicated as including allowable subject matter. EX1028, pp.37-44. Applicant amended the claims to add: “wherein the transform precoding generates a plurality of orthogonal spreading codes to provide a superposition of the plurality of OFDM subcarriers with a reduced peak-to-average power ratio.” *Id.*, pp.20, 26, 32. The claims were then allowed. *Id.*, p.17.

4. *Application No. 15/489,644*

The ’644 Application was filed on April 17, 2017. EX1036, p.18. A preliminary amendment canceled all claims and rewrote many of the claims to copy expressions from the 4G LTE standards. For example, claim 28 provided the following expression for a “spread symbol”:

$$z(l \cdot M_{SC}^{PUSCH} + k) = \frac{1}{\sqrt{M_{SC}^{PUSCH}}} \sum_{i=0}^{M_{SC}^{PUSCH}-1} d(l \cdot M_{SC}^{PUSCH} + i) e^{-j \frac{2\pi i k}{M_{SC}^{PUSCH}}}$$

EX1036, p.32. This expression is found nowhere in the '644 Application (or any earlier-filed application). The Examiner indicated this (and other) claims were allowable. *Id.*, pp.6, 9, 20.

5. *Application No. 15/149,382*

The '382 Application was filed on May 9, 2016. There were two office actions rejecting claims using references to Kim, Larioa, and Baum. EX1037, pp.33-39, 57-63. Applicant argued that Baum was not prior art because the claims were supported by the '854 Application. *Id.*, pp.22-28. Applicant did not address continuity of disclosure nor did the Examiner seem to appreciate the fact that the '854 Application's text is not found in or incorporated by reference into the '107 Application. The Examiner focused on the "DFT spreader" and "subcarrier mapper" limitations of the claims when the '382 Application was allowed. EX1037, p.9.

6. *Application No. 14/727,769*

The '769 Application was filed on July 1, 2015. Its claims and prosecution history focus on embodiments related to cooperative networking including things like "a cooperative antenna array" and "a plurality of geographically distributed wireless terminals." *E.g.*, EX1030, pp.148-149, 304.

The '769 Application was examined under post-AIA law. EX1030, p.89. Even after Applicant disagreed the Examiner continued to apply post-AIA law because the Examiner concluded certain claimed features were not supported by the '572 Application, and instead had support on or after May 13, 2014. EX1030, pp.17, 30, 45, 50-53, 83. Despite removal of these features from the claims by amendment, the application continued to be examined under post-AIA law because it had included claims that were not entitled to an effective filing date before March 16, 2013.

IV. EFFECTIVE FILING DATE; POST-AIA

The '508 Patent is not entitled to its claimed effective filing date of August 2, 2004. The '508 Patent is also not a pre-AIA patent. Petitioner has taken these positions in litigation. Nevertheless, for the challenges presented herein all references qualify as prior art under 35 U.S.C. §§102(b) or 102(a)(1), and as such they cannot be antedated. Thus, the correct effective filing date of the claimed subject matter is not material to the outcome of this proceeding and Petitioner does not elaborate further on the matter in this Petition while reserving its right to do if necessary during trial.¹

¹ For completeness, Petitioner has explained why a parent to the '508 Patent is a post-AIA application and not entitled to its claimed effective filing date in IPR2025-00788.

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

Based on the ’508 Patent, the prior art and other documentation cited herein, and on Dr. Bims’s testimony a POSITA as of the earliest claimed effective filing date of August 2, 2004 would have had “either a Master’s degree in electrical engineering or a related field, or a Bachelor’s degree in electrical engineering or a related field with three years of experience in wireless communication systems, signal processing, and related technologies.” EX1002, ¶¶69-72. A POSITA would have known that DFT spreading would reduce PAPR in OFDM systems and would have been familiar with hardware and software implementations of mobile device transmitters. *Id.*

VI. IDENTIFICATION OF THE CHALLENGE

Petitioner challenges the following claims on the following grounds:

Ground	Claims	Challenge	Statute
1	1, 3, 5, 9, 11, 13, 17, 19, 21	Anticipation by Shattil-537	pre-AIA §102(b); post-AIA §102(a)(1)
2	1, 3, 5, 9, 11, 13, 17, 19, 21	Obviousness over Shattil-537	Pre- or post-AIA §103
3	2, 4-6, 10, 12-14, 18, 20-22	Obviousness over Shattil-537 in view of Doufexi	Pre- or post-AIA §103
4	2, 4-6, 10, 12-14, 18, 20-22	Obviousness over Shattil-537 in view of Lucent	Pre- or post-AIA §103

VII. CLAIM CONSTRUCTION

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

VIII. PRIOR ART STATUS OF THE REFERENCES; ANALOGOUS ART

Each reference discussed below and relied upon in the challenges is analogous prior art and in the same field of endeavor as the '508 Patent. EX1002, ¶¶75-93.

A. Shattil-537

Shattil-537 is an International Application Publication that was published on July 11, 2002. EX1099, cover. That makes it prior art under pre-AIA 35 U.S.C. §102(b) or post-AIA §102(a)(1).

Shattil-537 discloses a system and method for performing carrier interferometry using CI codes that “include families of orthogonal polyphase codes.” EX1099, Abstract; 1:6-8 (“The present invention relates to Carrier Interferometry (CI). More specifically, the invention relates to applications of CI to multicarrier processing, such as Fourier transforms and coding.”). CI symbols can include codes derived from a Fourier transform. *Id.*, 24:15-20. Weights (also referred to as CI

symbol values) can be applied to data symbols as shown in FIG. 22:²

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

2201
2203

EX1099, FIG. 22.

Shattil-537 also describes applying various “CI Parameters” including “Carrier Selection,” and “Carrier Spacing” to the CI transceiver to adapt the operation of the transceiver. *Id.*, 19:20-24, 20:8-9. Shattil-537 speaks to the reasons

² This figure, which was present in at least some of the parent applications to the Challenged Patent has an error in the denominator of the exponent term. Namely, “N-1” should be “N.” This was corrected in various issued patents, including the immediate parent to the ’508 Patent by certificate of correction. EX 1102, p.14; see also EX1100, p.7; EX1101, p.12; EX1103, p.3. Given Patent Owner’s representation that the changes are typographical and do not add new matter, this Figure should be interpreted as illustrating DFT coefficients (i.e., denominator “N” instead of “N-1”).

for allowance as well by not only describing adjustable “Carrier Spacing,” but also explaining that carrier spacing relates to symbol duration. EX1099, 8:20, 10:8-10; *see also id.*, 8:12-14 (“A process for separating a received signal into orthogonal waveforms may utilize knowledge of carrier separations f_s (and, thus, $T_s = 1/f_s$) of a transmitted multicarrier signal.”), 11:15 (“the sampling period is $T_s = 1/f_s$.”), 14:29-30 (“In this case, the selector/accumulator 1004 may control symbol duration T_s (i.e., carrier separation f_s)”), cls. 1 (“ $T_s = 1/f_s$ ”), 9 (“ $T_s = 1/f_s$ ”), FIG. 14.

Shattil-537 is analogous to the ’508 Patent because both relate to “wireless communication” including “transmitting and receiving multicarrier signals.” EX1001, 1:33-35; EX1099, 1:6-8 (describing the “present invention” as relating to “applications of CI to multicarrier processing”), 2:20-23 (describing use of invention in “wireless applications” including “cellular communications); EX1002, ¶¶73-80. Shattil-537 and the ’508 Patent also describe “CI coding” which can be provided via a “DFT” (discrete Fourier transform). EX1001, 28:13-14; EX1099, 24:15-20.

B. Doufexi

Doufexi is a paper from *The 13th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*. EX1003. Exhibit 1003 was obtained from the Linda Hall Library by Dr. Hall-Ellis. EX1012, ¶65. Doufexi was cataloged into that library on December 30, 2002. EX1012, ¶¶68-69. Additionally, Doufexi was added to the IEEE online database by December 10, 2002. *Id.*, ¶66. Doufexi

would have been reasonably accessible to a POSITA because it was cataloged by subject matter including “Wireless communication systems; Mobile Communications systems” as reflected by the Library of Congress classification system, among other indices. *Id.*, ¶70; EX1002, ¶¶81-82. 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 ’508 Patent because it is in the field of wireless communications networks, and especially multicarrier OFDM wireless communications networks and techniques. EX1001, 1:33-35 (the disclosure relates to “wireless communication, and more specifically, ... transmitting and receiving multicarrier signals”); EX1006, p.192 (describing OFDM for 4G networks); EX1002, ¶¶83-84. Doufexi is also reasonably pertinent to a problem faced by the inventor of the ’508 Patent, including improvement of bandwidth efficiency. EX1001, 13:66-14:7 (describing solution to “elegantly circumvent the data bandwidth limitation of aforementioned multi-user MIMO system[s]”); EX1003,

pp.192 (variable guard time can improve efficiency), 193 (“[c]hannel coding also affects bandwidth efficiency”); EX1002, ¶85.

C. 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, ¶¶86-88. Lucent is therefore a prior art printed publication under pre-AIA §102(b) or post-AIA §102(a)(1).

Lucent describes different configurations for a proposed OFDM baseline system in which the different configurations are associated with different “suitable deployment environment[s].” *Id.*; *see also id.*, p.7 (“We have suggested an OFDM system with multiple configurations that can be deployed in different environments.”). One difference between the three configurations proposed by

Lucent is the subcarrier spacing. There are three options: 19.2 kHz, 9.6 kHz, and 4.8 kHz as shown in the table below.

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

Id.

Lucent is analogous to the '508 Patent because it is in field of wireless communications networks, and especially OFDM wireless communications networks and techniques. EX1001, 1:33-35 (the disclosure relates to “wireless communication, and more specifically, ... transmitting and receiving multicarrier signals”); EX1006, p.1 (“Proposed Baseline OFDM Systems for Study”); EX1002, ¶¶89-92. And Lucent is reasonably pertinent to a problem to be solved by the '508 Patent inventor, namely subcarrier allocation including subcarrier frequency spacing

to address channel conditions and/or interference. EX1001, 24:39-58 (describing allocating subcarriers based on “favorable channel conditions”); EX1006, pp.3-5 (“Some benefit[s] of having multiple configurations are:” allowing shorter symbol durations “when the multipath is less severe, this would result in wider subcarrier spacing which would make the system more immune to frequency offset,” using a shorter symbol duration to make the “system less susceptible to high Doppler and hence reduces ICI [inter-carrier interference].”); EX1002, ¶93.

IX. DETAILED DISCUSSION

A. Grounds 1 and 2: Claims 1, 3, 5, 9, 11, 13, 17, 19, and 21 are (Ground 1) anticipated by or (Ground 2) obvious over Shattil-537

1. Claim 1

a. [1Pre]: Method for communicating

Assuming the preamble is a limitation, Shattil-537 discloses and renders obvious *[a] method of communicating in a mobile radio communications network*. EX1002, ¶¶94-98.

For example, Shattil-537 discloses the “general steps of a transmitting method,” as shown in FIG. 27A:

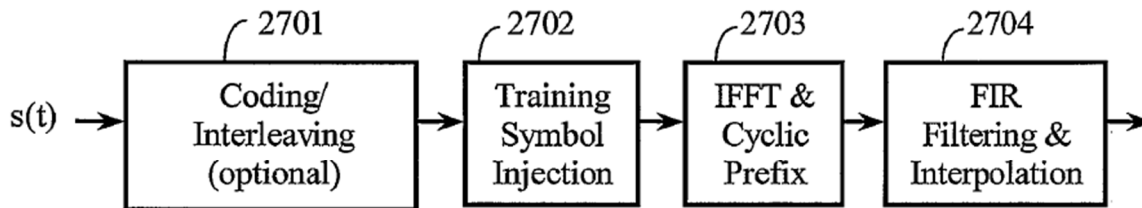


FIG. 27A

EX1099, 31:33 (FIG. 27A). Shattil-537 further explains that, while not explicitly shown in FIG. 27A, “various signal-processing steps that are typically performed in transmission systems may be included herein.” *Id.*, 32:10-11. Shattil-537 provides examples of such signal-processing steps, which include “signal-processing functions typically applied to information-bearing baseband or IF signals prior to coupling into a communication channel” such as “predistortion, A/D conversion, D/A conversion, mixing, modulation, multiplexing, multiple-access processing, frequency conversion, spreading, amplification, filtering, coding, and/or array processing.” *Id.*, 6:25-29.

Shattil-537 describes various systems for performing its disclosed transmitting methods including “a software-controlled CI transceiver” having “an Encoder/Interleaver software module 1810 that generates weights provided to an IFFT processor 1811.” EX1099, 19:20-22. “The IFFT may be adaptable with respect to control signals provided by other software modules, such as the Encoder 1810.” *Id.*, 19:23-24. Shattil-537’s transceiver physical layer properties can be controlled

by “a software defined-controller 1901 that processes one or more system requirements 1911 and/or one or more channel characteristics 1912 to control one or more CI parameters 1902 in a radio transceiver 1903.” *Id.*, 20:3-5, FIG. 19.

Shattil-537’s methods are *for communicating in a mobile radio communications network* because Shattil-537 explains that the invention has “many wireless applications” including “cellular communications.” EX1099, 2:20-21; EX1002, ¶¶95-97.

Thus, Shattil-537 discloses and renders obvious [1Pre].

b. [1A]: provisioning a consecutive series of OFDM subcarriers

Shattil-537 discloses and renders obvious *provisioning a consecutive series of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for uplink or downlink communications*. EX1002, ¶¶99-105.

Shattil-537 discloses providing “Carrier Selection” and “No. of Carriers” to a transceiver. *See* EX1099, FIG. 19. “Carrier selection may include either or both transmit-side carrier selection with respect to one or more CI carrier parameters to generate at least one transmit signal and receive-side carrier selection to decompose at least one signal into CI components.” EX1099, 5:8-10. Thus, by providing carrier selection to the transceiver 1903, a POSITA would have understood that Shattil-537 is provisioning the subcarriers that are used for generating the “at least one transmit

signal.” *Id.*; EX1002, ¶¶100-01. A POSITA would have understood that the transmit signal was either in the *uplink* (mobile device to base station) or *downlink* (base station to mobile device) because these are the available options in the disclosed “cellular communications” “wireless applications” described in Shattil-537. EX1099, 2:20-21; EX1002, ¶101.

In Shattil-537, the carriers provisioned by CI software to the CI transceiver are *OFDM subcarriers* because Shattil-537 explains that “CI codes may be applied to ... OFDM” EX1099, 21:20-21; *see also id.*, 1:29-30 (“CI may also be applied to orthogonal frequency division multiplexing (OFDM), N-point transforms used in OFDM,”). Thus, the subcarriers would have been understood to include *OFDM subcarriers*. EX1002, ¶102.

Shattil-537 explains that the carriers provisioned to the transceiver are *a consecutive series* of carriers. First, Shattil illustrates “N modulated orthogonal carrier components,” which include f_n “overlapping frequencies” as shown in Figures 14A and 14B:

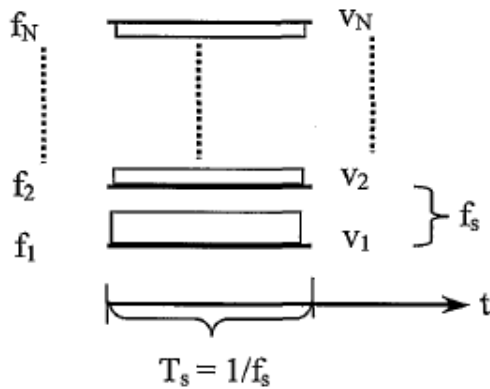


FIG. 14A

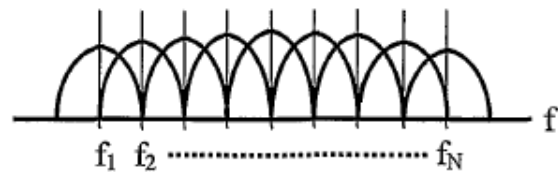


FIG. 14B

EX1099, FIGS. 14A, 14B, 16:2-28. These overlapping frequencies have “incremental frequency spacing f_s .” *Id.*, 16:27-28. This incremental frequency spacing is the subcarrier spacing. EX1002, ¶¶103-04. Because these carriers are “overlapping narrow band carrier signals” obtained from a “single-carrier signal” generated at a transmitter, the transmitted signal includes *a consecutive series of subcarriers* (numbered $f_1, f_2, \dots, f_n$) separated by subcarrier spacing f_s . EX1002, ¶104.

Thus, Shattil-537 discloses and renders obvious Limitation [1A].

c. **[1B]: provisioning selectable subcarrier spacings**

Shattil-537 discloses and renders obvious *provisioning a plurality of different selectable subcarrier spacings for the consecutive series of OFDM subcarriers*. EX1002, ¶¶106-08.

Shattil-537 discloses that its “CI software” provisions “CI Parameters,”

including “Carrier Spacing.” EX1099, FIG. 19, 5:14-15 (“CI carrier parameters may include ... carrier frequency spacing(s)....”). The carrier spacings “are selected, at least in part, with respect to the channel estimates.” EX1099, 17:18-19. This shows that the subcarrier spacings are *selectable*. EX1002, ¶107. And, because the subcarrier spacings are selectable, a POSITA would have understood that there are multiple subcarrier spacings to select from. EX1002, ¶107. This is further confirmed because Shattil-537 explains that (1) symbol duration is the inverse of the subcarrier spacing and the subcarrier spacing is adaptable, EX1099, 10:8-10 (“symbol interval T_s is provided with respect to the relationship $T_s=1/f_s$ ”), 20:8-9; and (2) “CI parameter adjustments and selections” to “physical-layer processes” include “Carrier Spacing,” *id.*, 20:5-6. EX1002, ¶107.

Thus, Shattil-537 discloses and renders obvious Limitation [1B].

d. [1C]: performing DFT coding to produce coded symbols

Shattil-537 discloses and renders obvious *performing discrete Fourier transform (DFT) coding on a plurality of data symbols to produce coded symbols*. EX1002, ¶¶109-15.

Shattil-537 discloses that “Encoder/Interleaver 1810” “generates weights.” EX1099, 19:20-21. Shattil-537 equates “weights” with “CI symbol values.” *Id.*, 5:16-18 (“CI symbol values are complex values (or weights) for the plurality of CI carriers.”) Therefore, Shattil-537 teaches that the “Encoder/Interleaver 1810”

generates CI symbol values (“weights”). EX1002, ¶¶110-11. CI symbol values “may be values derived from at least one invertible transform function such as a Fourier transform....” EX1099, 24:18-20. “FIG. 22 illustrates a relationship between CI symbol values w_n and data symbols s_n ” and shows that CI symbols (weights w_n) are the combination of a CI code (e.g., “values derived from ... a Fourier transform”) and the data symbol s_n .

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

EX1099, FIG. 22. Thus, Shattil-537 discloses and renders obvious *performing discrete Fourier transform (DFT) coding* (i.e., applying “CI code[s]” which are “values derived from ... a Fourier transform”) *on a plurality of data symbols* (symbols $s_0, s_1, \dots, s_{N-1}$) *to produce coded symbols* (to produce “weights” or “CI symbol values”). EX1002, ¶¶112-13.

Thus, Shattil-537 discloses and renders obvious Limitation [1C].

e. [1D]: performing an inverse-DFT to produce an SC-FDMA signal

Shattil-537 discloses and renders obvious *performing an inverse-DFT on the coded symbols to produce a single-carrier frequency division multiple access signal that comprises a sum of the consecutive series of OFDM subcarriers*. EX1002, ¶¶115-23.

Shattil's OFDM transceiver performs an "inverse-DFT," namely an IFFT,³ on the coded symbols ("weights" or "CI symbol values") that are provided to the IFFT. EX1099, 19:20-24, FIGS. 18 & 27A. The result of the IFFT operation is the generation of a "single-carrier signal," which is received and decomposed into its individual carrier components at a receiver. EX1099, 16:23-25, 17:2-4 ("Desirable spectral ranges ... can support CI carriers that combine in a CI receiver to produce a conventional single-carrier receiver."), 18:4-7. A POSITA would have reasonably expected, and found it obvious that DFT coding the data symbols results in the production of *a single carrier frequency division multiple access signal* because that was the known consequence of using DFT spreading in OFDM systems, including multiple access systems. *See* EX1004, p.1740 ("[T]he time signal of the OFDM-

³ The '508 Patent indicates an IFFT is a type of IDFT. EX1001, 34:45-46 ("[A]n IDFT can be implemented as an IFFT").

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.”); EX1002, ¶¶116-18. The single carrier signal is a multiple access signal because Shattil-537 describes allocating frequencies among various users. EX1099, 16:33-36 (describing avoiding “certain spectral ranges” including those “allocated to another user”); EX1002, ¶¶118-19. In Shattil-537 the single-carrier signal *comprises a sum of the consecutive series of OFDM subcarriers* because Shattil-537 explains that “[a] superposition of” the CI carriers “produces a CI waveform bearing the data symbol value s_n , such as at a particular pulse position.” EX1099, 25:25-26. A POSITA would have recognized that the single carrier waveform *comprises a sum of the consecutive series of OFDM subcarriers* because the creation of the single carrier from the CI components can be reversed at the receiver. EX1099, 16:23-25, 17:31-32, 18:13-14.

At the very least, a POSITA would have found it obvious that *performing an inverse-DFT on the coded symbols* would have produced a SC-FDMA signal that *comprises a sum of the consecutive series of OFDM subcarriers* because a POSITA

knew that DFT spreading data symbols before modulating them onto OFDM subcarriers (as described in Shattil-537) results in a signal that resembles a single-carrier signal. EX1002, ¶¶120-21; 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.”).

A POSITA would also have found it obvious that the resulting signal is a sum of the consecutive subcarriers 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; EX1087, p.8; EX1089, p.6; EX1002, ¶122.

Thus, Shattil-537 discloses and renders obvious Limitation [1D].

f. [1E]: transmitting the SC-FDMA signal

Shattil-537 discloses or renders obvious *transmitting the single-carrier frequency division multiple access signal in the mobile radio communications*

network. EX1002, ¶¶124-26.

Shattil-537 explains that “[a] transmit data stream” is processed by the “Encoder/Interleaver” 1810. EX1099, 19:20-21. Shattil-537’s transceiver would have been understood to perform a step of *transmitting* and that, after the generation of the *single carrier frequency division multiple access signal*, the signal is transmitted over the air in the wireless communication network as this is the point of Shattil-537’s transmitting method. EX1002, ¶125; EX1099, 2:20-23 (referring to “many wireless applications” including “cellular communications”), 31:33, FIG. 27A.

Thus, Shattil-537 discloses and renders obvious Limitation [1E].

g. [1F]: providing symbol period by selecting subcarrier spacing

Shattil-537 discloses and renders obvious *wherein provisioning the plurality of different selectable subcarrier spacings comprises providing the single-carrier frequency division multiple access signal with a particular one of a set of different symbol periods by selecting one of the plurality of different selectable subcarrier spacings*. EX1002, ¶¶127-30.

Shattil-537 explains that “a desired waveform’s period T_s ” is equal to “ $1/f_s$ ” and explains that “[t]he symbol interval T_s is provided with respect to the relationship $T_s = 1/f_s$ such that at least one data symbol on at least one carrier can

be separated from interfering data symbols on one or more carriers that are orthogonal to the desired carrier(s).” EX1099, 8:20, 10:8-10; *see also id.*, 8:12-14 (“A process for separating a received signal into orthogonal waveforms may utilize knowledge of carrier separations f_s (and, thus, $T_s = 1/f_s$) of a transmitted multicarrier signal.”), 11:15 (“the sampling period is $T_s = 1/f_s$.”), 14:29-30 (“In this case, the selector/accumulator 1004 may control symbol duration T_s (i.e., carrier separation f_s)”), cls. 1 (“ $T_s = 1/f_s$ ”), 9 (“ $T_s = 1/f_s$ ”), FIG. 14.

A POSITA would have recognized the relationship $T_s = 1/f_s$, defined by Shattil-537, as a widely recognized principle in OFDM system design for maintaining orthogonality between subcarriers. EX1002, ¶¶128-29; EX1015, p.22 (“[T]he carriers are linearly independent (i.e., orthogonal) if the carrier spacing is a multiple of $1/T$.”). 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,”).

Therefore, because Shattil-537 describes *provisioning the plurality of different selectable subcarrier spacings* and selecting one of the different subcarrier spacings as explained in connection with Limitation [1B], Shattil-537 also describes *providing the single-carrier frequency division multiple access signal with a particular one of a set of different symbol periods by selecting* because of the

disclosed inverse relationship between subcarrier spacing and symbol duration. EX1002, ¶129. This means that the selection of the subcarrier spacing would have provided the SC-FDMA signal with a symbol period specific for that subcarrier spacing. EX1002, ¶129. In other words, changing the subcarrier spacing will result in a change in the symbol duration. *Id.*

Thus, Shattil-537 explicitly demonstrates that the selection of subcarrier spacing f_s determines the symbol period T_s through the inverse relationship $T_s = 1/f_s$. This means that the selection of a different subcarrier spacing provides for a corresponding different symbol period. EX1002, ¶129.

Thus, Shattil-537 discloses and renders obvious Limitation **[1F]**.

2. *Claim 9*

- a. **[9Pre]**, **[9A]**, **[9B]**, **[9C]**: An apparatus for communicating

Shattil-537 discloses and renders obvious the following aspects of claim 9:

[9Pre] [a]n apparatus for communicating in a mobile radio communications network, comprising: **[9A]** a non-transitory computer-readable memory storing one or more instructions; and **[9B]** at least one processor in communication with the non-transitory computer-readable memory; **[9C]** wherein the one or more instructions, when executed by the at least one processor, cause the at least one processor

EX1002, ¶¶131-35.

Shattil-537 describes a “software-controlled” transceiver apparatus that includes “an Encoder/Interleaver software module 1810 that generates weights provided to an IFFT processor 1811.” EX1099, 19:20-22, FIGS. 18 & 19. “The IFFT may be adaptable with respect to control signals provided by other software modules, such as the Encoder 1810.” *Id.*, 19:23-24. In addition, Shattil-537 explains that “The IFFT 1811 may include a signal processing software module.” *Id.*, 19:22. Shattil-537 further discloses that physical layer properties of the transceiver can be controlled by “a software defined-controller 1901 that processes one or more system requirements 1911 and/or one or more channel characteristics 1912 to control one or more CI parameters 1902 in a radio transceiver 1903.” *Id.*, 20:3-5, FIG. 19.

Shattil-537 reveals that “physical-layer functions” are “performed via software-controlled processes, such as application programs residing in one or more memory spaces of one or more processing units.” EX1099, 19:11-19. Shattil-537’s “processing unit” refers to “a computer processing unit, such as a microprocessor device, a main frame, a work station, a computer network, and/or a stand-alone computer.” *Id.*, 6:30-31. Likewise, Shattil-537’s reference to a “Memory space” means “a disk drive, tap drive, VD, DVD, flash memory, or any other data storage media or device.” *Id.*, 6:23-24. Thus, software instructions stored in memory spaces and executed by processors like Shattil-537’s “software-controlled transceiver”

illustrated in Figure 18 and 19 is an *apparatus*. That apparatus is *for communicating in a mobile radio communications network* because Shattil-537 explains that the invention has “many wireless applications” including “cellular communications.” EX1099, 2:20-21; EX1002, ¶¶132-34. And, that apparatus comprises *a non-transitory computer-readable memory storing one or more instructions* (e.g., Shattil-537’s application programs/software stored in memory spaces). EX1002, ¶133. As detailed below, the software-controlled transceiver comprises *at least one processor in communication with the non-transitory computer-readable memory wherein the one or more instructions, when executed by the at least one processor, cause the at least one processor to perform Limitations [9Ci]-[9Cv] and [9D]*, discussed below. EX1002, ¶134.

b. [9Ci]: provisioning a consecutive series of OFDM subcarriers

Limitation [9Ci] is the same as Limitation [1A], and thus is disclosed and rendered obvious for the same reasons as Limitation [1A]. *Supra* §IX.A.1.b; EX1002, ¶136.

c. [9Cii]: provisioning selectable subcarrier spacings

Limitation [9Cii] is the same as Limitation [1B], and thus is disclosed and rendered obvious for the same reasons as Limitation [1B]. *Supra* §IX.A.1.c; EX1002, ¶137.

d. [9Ciii]: performing DFT coding to produce DFT coded symbols

Limitation [9Ciii] is substantively the same as Limitation [1C] (i.e., there is no substantive difference between “performing discrete Fourier transform (DFT) coding on a plurality of data symbols to produce coded symbols” and “perform[ing] discrete Fourier transform (DFT) coding on a plurality of data symbols to produce DFT coded symbols”), and thus Limitation [9Ciii] is disclosed and rendered obvious for the same reasons as Limitation [1C]. *Supra* §IX.A.1.d; EX1002, ¶138.

e. [9Civ]: performing an inverse-DFT to produce an SC-FDMA signal

Limitation [9Civ] is the same as Limitation [1D], and thus is disclosed and rendered obvious for the same reasons as Limitation [1D]. *Supra* §IX.A.1.e; EX1002, ¶139.

f. [9Cv]: transmitting the SC-FDMA signal

Limitation [9Cv] is the same as Limitation [1E], and thus is disclosed and rendered obvious for the same reasons as Limitation [1E]. *Supra* §IX.A.1.f; EX1002, ¶140.

g. [9D]: providing symbol period by selection of subcarrier spacing

Limitation [9D] is substantively the same as Limitation [1F], with the substantive difference being that Limitation [1F] includes the term “selectable” before “symbol periods” in *provid[ing] . . . different selectable symbol periods by*

selecting one of the plurality of different selectable subcarrier spacings. EX1002, ¶¶141-42. As explained above, *supra* §IX.A.1.g, Shattil-537 teaches and renders obvious that subcarrier spacing (f_s) and symbol period (T_s) are inversely related (i.e., $T_s = \frac{1}{f_s}$), such that the selection of one of a plurality of different selectable subcarrier spacings in Shattil-537 causes a corresponding one of a set of different symbol periods to be selectable for a single-carrier frequency division multiple access signal. EX1099, 8:12-14, 8:19-20, 10:8-10, 11:15, 14:29-30, cls. 1, 9, FIG. 14. Accordingly, because Shattil-537 discloses the selections of different subcarrier spacings, Shattil-537 also discloses that these selections cause the corresponding different symbol periods to be selectable. EX1002, ¶141. Thus Limitation [9D] is disclosed and rendered obvious for the same reasons as Limitation [1F]. *Supra* §IX.A.1.g; EX1002, ¶¶141-42.

3. *Claim 17*

a. [17Pre]: An apparatus for communicating

Assuming the preamble is a limitation, Shattil-537 discloses and renders obvious *[a]n apparatus for communicating in a mobile radio communications network.* EX1002, ¶¶143-47.

For example, Shattil-537 discloses “a software-controlled CI transceiver” that includes “an Encoder/Interleaver software module 1810 that generates weights provided to an IFFT processor 1811.” EX1099, 19:20-22. “The IFFT may be

adaptable with respect to control signals provided by other software modules, such as the Encoder 1810.” *Id.*, 19:23-24. A POSITA would have understood that the “software-controlled CI transceiver” including the IFFT is an apparatus operating on circuitry including, for example, processors and memory. EX1002, ¶¶144-45. Indeed, Shattil-537 reveals that “physical-layer functions” are “performed via software-controlled processes, such as application programs residing in one or more memory spaces of one or more processing units.” EX1099, 19:11-19. As used in Shattil-537, “processing unit” means “a computer processing unit, such as a microprocessor device, a main frame, a work station, a computer network, and/or a stand-alone computer.” *Id.*, 6:30-31. “Memory space” means “a disk drive, tap drive, VD, DVD, flash memory, or any other data storage media or device.” *Id.*, 6:23-24. Thus, software stored in memory spaces and executed by processors like Shattil-537’s “software-controlled transceiver” illustrated in Figure 18 is an *apparatus*.

Shattil-537’s apparatus is *for communicating in a mobile radio communications network* because Shattil-537 explains that the invention has “many wireless applications” including “cellular communications.” EX1099, 2:20-21; EX1002, ¶146.

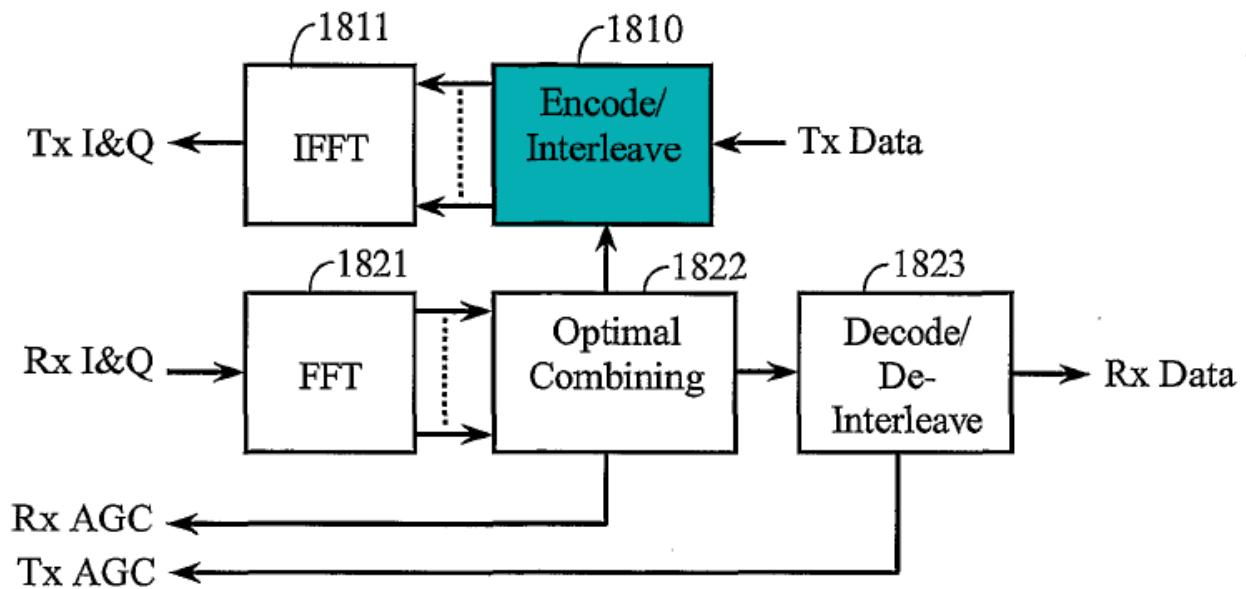
Thus, Shattil-537 discloses and renders obvious [17Pre].

b. [17A]: a transceiver-control circuitry

Shattil-537 discloses and renders obvious *a transceiver-control circuitry*.

EX1002, ¶¶148-53.

Shattil-537's *transceiver-control circuitry* includes the circuitry such as “memory space” and “processing unit” that is configured to store and execute the “Encoder/Interleaver software module 1810.” EX1099, 19:20-22, 41:10-19 (“at least one processing unit having at least one memory space” and an application that is able to “provide weighting for one or more of the CI carriers”). Shattil-537's *transceiver-control circuitry* is shown below:



EX1099, FIG. 18; EX1002, ¶¶149-50.

Shattil-537's “Encoder/Interleaver” is used for *transceiver control* because (1) it “generates weights provided to an IFFT processor 1811,” and (2) it provides “control signals’ to the “IFFT” to allow for the IFFT to be “adaptable with respect to [those] control signals.” EX1099, 19:20-24.

A POSITA would have understood that Shattil-537's "Encoder/Interleaver software module 1810" is *transceiver-control circuitry* because it is software executing on circuitry that executes the instructions of the software module. EX1002, ¶¶151-52. At the very least, it would have been obvious to implement Shattil-537's "Encoder/Interleaver software module 1810" in circuitry because a POSITA would have appreciated that circuitry is needed to store and execute the "software module" and thus would have implemented Shattil-537's "Encoder/Interleaver" accordingly. EX1002, ¶152.

Thus, Shattil-537 discloses and renders obvious Limitation [17A].

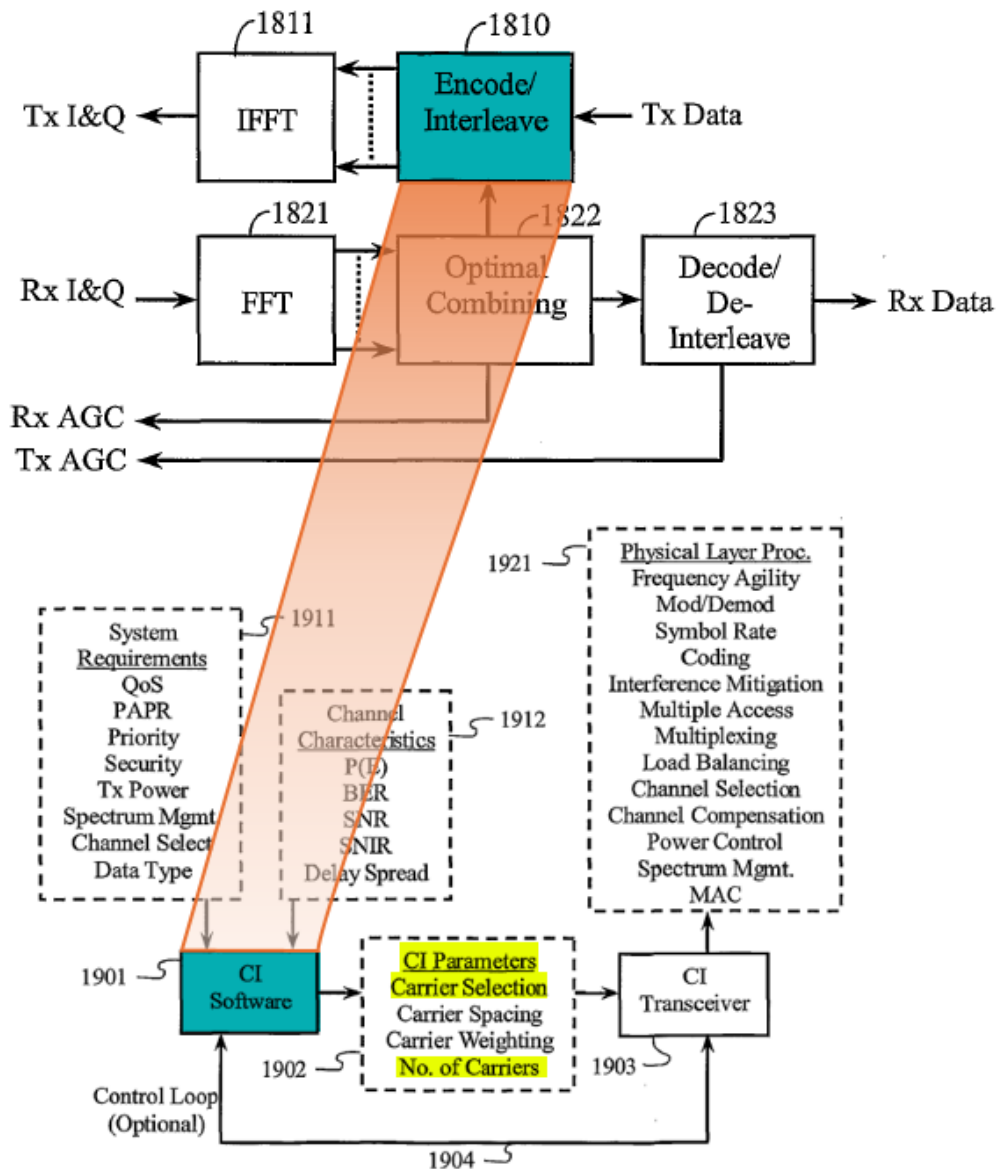
c. [17Ai]: provisioning a consecutive series of OFDM subcarriers

Shattil-537 discloses or renders obvious *transceiver-control circuitry configured for: provisioning a consecutive series of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for uplink or downlink communications*. EX1002, ¶¶154-67.

The functions illustrated in Shattil-537's Figure 19 include *provisioning a consecutive series of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for uplink or downlink communications* as recited in Limitation [17Ai]. First, a discussion about how a POSITA would have understood Figure 19 in the context of Figure 18. Shattil-537's "Encoder/Interleaver software module 1810" is

configured for transceiver control. EX1002, ¶¶155-56. Shattil-537 explains that the IFFT module 1811 is “adaptable with respect to control signals provided by other software modules, such as Encoder 1810.” EX1099, 19:23-24. In other words, “Encoder 1810” can output control signals to the “IFFT module 1811” to adapt its operation. EX1002, ¶156.

Shattil-537 discloses that the physical layer properties of the transceiver can be controlled by “a software defined-controller 1901 that processes one or more system requirements 1911 and/or one or more channel characteristics 1912 to control one or more CI parameters 1902 in a radio transceiver 1903.” EX1099, 20:3-5. Thus, a POSITA would have understood that Shattil-537’s “Encoder 1810” includes a software module that provides control signals to the transceiver’s IFFT module and that the control signals include the exemplary information shown in Shattil-537’s Figure 19. EX1002, ¶157. This is illustrated in the combination of Shattil-537’s Figures 18 and 19, below:



EX1099, FIGS. 18 & 19. A POSITA would have understood that the control signals such as carrier selection, carrier spacing, and number of carriers would have allowed for the IFFT to adapt to different conditions by, for example, determining which inputs to the IFFT would be zeroed out (e.g., no data on the particular subcarrier). EX1002, ¶158.

At the very least, a POSITA would have found it obvious to incorporate

Shattil-537's "CI Software" into the "Encoder/Interleaver 1810." EX1002, ¶¶158-60. This would have permitted "Encoder/Interleaver 1810" to provide control signals including information on the selection of subcarriers, carrier spacing, and number of carriers to control and adapt the IFFT. EX1002, ¶160. This arrangement is suggested by Shattil-537 itself because the reference describes "control signals" from the "Encoder 1810" to adapt the IFFT and explains that the "software-defined controller 1901" is used to "control one or more CI parameters 1902 in a radio transceiver 1903." EX1099, 19:23-24, 20:3-5; EX1002, ¶160. Indeed, Shattil-537 indicates that "alternative operational embodiments and system architectures will be apparent to persons skilled in the relevant art(s) because on the discussion contained herein," and combining control functionality with a module that provides control signals would have been a readily apparent implementation detail that would have enabled Encoder 1810 to perform the IFFT control functionality suggested by Shattil-537 itself. EX1002, ¶161; EX1099, 19:23-24, 20:3-5, 33:6-9.

Based on the foregoing, Shattil-537 discloses or renders obvious *transceiver-control circuitry* that provisions *subcarriers for uplink or downlink communications* because the circuitry, under control of software, provides "Carrier Selection" and "No. of Carriers" to the transceiver. *See* EX1099, FIG. 19. "Carrier selection may include either or both transmit-side carrier selection with respect to one or more CI carrier parameters to generate at least one transmit signal and receive-side carrier

selection to decompose at least one signal into CI components.” EX1099, 5:8-10. Thus, by providing carrier selection to the transceiver 1903, a POSITA would have understood that Shattil-537 is provisioning the subcarriers that are used for generating the “at least one transmit signal.” *Id.*; EX1002, ¶¶162-63. A POSITA would have understood that the transmit signal was either in the *uplink* (mobile device to base station) or *downlink* (base station to mobile device) because these are the available options in the disclosed “cellular communications” “wireless applications” described in Shattil-537. EX1099, 2:20-21.

In Shattil-537, the carriers provisioned by CI software to the CI transceiver are *OFDM subcarriers* because Shattil-537 explains that “CI codes may be applied to ... OFDM” EX1099, 21:20-21; *see also id.*, 1:29-30 (“CI may also be applied to orthogonal frequency division multiplexing (OFDM), N-point transforms used in OFDM,”). Thus, the subcarriers would have been understood to include *OFDM subcarriers*. EX1002, ¶164.

Shattil-537 explains that the carriers provisioned by the CI software to the CI transceiver are *a consecutive series* of carriers. First, Shattil illustrates “N modulated orthogonal carrier components,” which include f_n “overlapping frequencies” as shown in Figures 14A and 14B:

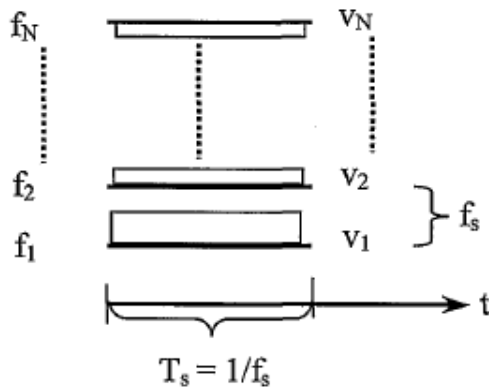


FIG. 14A

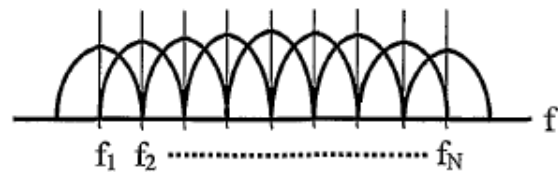


FIG. 14B

EX1099, FIGS. 14A, 14B, 16:2-28. These overlapping frequencies have “incremental frequency spacing f_s .” *Id.*, 16:27-28. This incremental frequency spacing is the subcarrier spacing. EX1002, ¶¶165-66. Because these carriers are “overlapping narrow band carrier signals” obtained from a “single-carrier signal” generated at a transmitter, the transmitted signal includes *a consecutive series of subcarriers* (numbered $f_1, f_2, \dots, f_n$) separated by subcarrier spacing f_s . EX1002, ¶166.

Thus, Shattil-537 discloses and renders obvious Limitation [17Ai].

d. [17Aii]: provisioning selectable subcarrier spacings

Shattil-537 discloses and renders obvious *a transceiver-control circuitry configured for provisioning a plurality of different selectable subcarrier spacings for the consecutive series of OFDM subcarriers*. EX1002, ¶¶168-71.

A discussion of why Shattil-537 discloses or renders obvious the

“Encoder/Interleaver” 1810 including “CI software” 1901 is provided in connection with Limitation [17Pre]-[17Ai]. *Supra* §§IX.A.3.a, IX.A.3.b, IX.A.3.c. One of the “CI Parameters” provisioned by the “CI software” is “Carrier Spacing.” EX1099, FIG. 19, 5:14-15 (“CI carrier parameters may include ... carrier frequency spacing(s)...”). The carrier spacings “are selected, at least in part, with respect to the channel estimates.” EX1099, 17:18-19. This shows that the subcarrier spacings are *selectable*. EX1002, ¶¶169-70. And, because the subcarrier spacings are selectable, a POSITA would have understood that there are multiple subcarrier spacings to select from. EX1002, ¶170. This is further confirmed because Shattil-537 explains that (1) symbol duration is the inverse of the subcarrier spacing and the subcarrier spacing is adaptable, EX1099, 10:8-10 (“symbol interval T_s is provided with respect to the relationship $T_s=1/f_s$ ”), 20:8-9; and (2) “CI parameter adjustments and selections” to “physical-layer processes” include “Carrier Spacing,” *id.*, 20:5-6. EX1002, ¶170.

Thus, Shattil-537 discloses and renders obvious Limitation [17Aii].

- e. [17Aiii] performing DFT coding to produce DFT coded symbols

Shattil-537 discloses or renders obvious *a transceiver-control circuitry configured for performing discrete Fourier transform (DFT) coding on a plurality of data symbols to produce DFT coded symbols*. EX1002, ¶¶172-76.

A discussion of why Shattil-537 discloses or renders obvious that the “Encoder/Interleaver” 1810 includes “CI software” 1901 is provided in connection with Limitations [17Pre]-[17Ai]. *Supra* §§IX.A.3.a, IX.A.3.b, IX.A.3.c.

One thing that “Encoder/Interleaver 1810” does is “generates weights.” EX1099, 19:20-21. Shattil-537 equates “weights” with “CI symbol values.” *Id.*, 5:16-18 (“CI symbol values are complex values (or weights) for the plurality of CI carriers.”) Therefore, Shattil-537 teaches that the “Encoder/Interleaver 1810” generates CI symbol values (“weights”). EX1002, ¶174. CI symbol values “may be values derived from at least one invertible transform function such as a Fourier transform....” EX1099, 24:18-20. “FIG. 22 illustrates a relationship between CI symbol values w_n and data symbols s_n ” and shows that CI symbols (weights w_n) are the combination of a CI code (e.g., “values derived from ... a Fourier transform”) and the data symbol s_n .

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

2201

2203

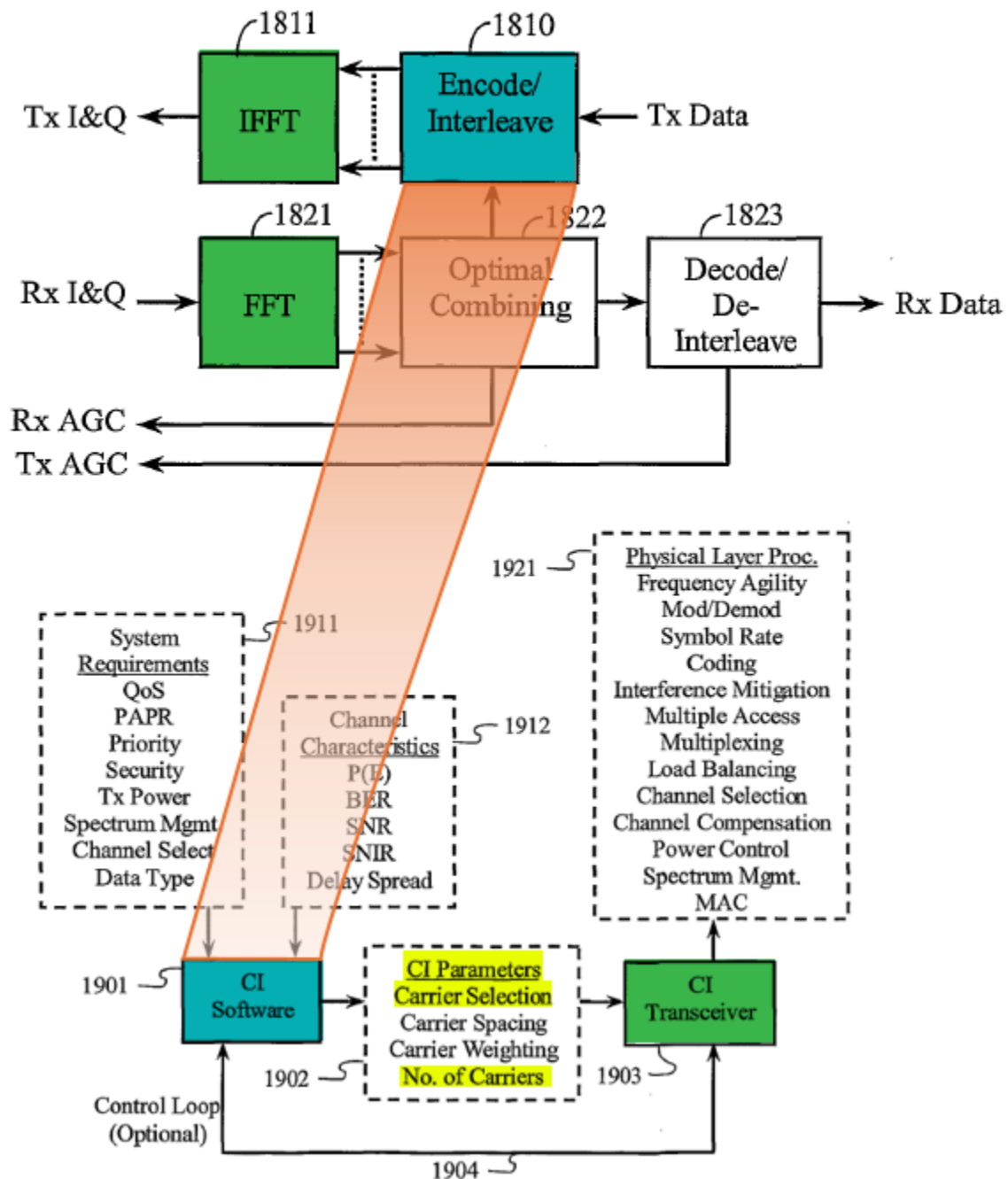
EX1099, FIG. 22. Thus, Shattil-537 discloses and renders obvious *a transceiver-control circuitry configured for performing discrete Fourier transform (DFT) coding* (i.e., applying “CI code[s]” which are ““values derived from ... a Fourier transform”) *on a plurality of data symbols* (symbols $s_0, s_1, \dots, s_{N-1}$) *to produce DFT coded symbols* (to produce “weights” or “CI symbol values”). EX1002, ¶175.

Thus, Shattil-537 discloses and renders obvious Limitation [17Aiii].

f. [17B]: an OFDM transceiver

Shattil-537 discloses or renders obvious *an OFDM transceiver communicatively coupled to the transceiver-control circuitry*. EX1002, ¶¶177-80.

The OFDM transceiver is shown, for example, in Figures 18 and 19 and is highlighted in green below.



EX1099, FIGS. 18 & 19; EX1002, ¶178. The transceiver is described as being “software-controlled.” EX1099, 19:20. A POSITA would have understood that Shattil-537’s *OFDM transceiver* would have been *communicatively coupled to the transceiver-control circuitry* because it needs to receive the “CI parameters” and

weights from the “Encoder/Interleaver 1810” and the “CI software.” EX1002, ¶179. Indeed, the CI software permits adaptation of the IFFT, which is used to modulate the OFDM subcarriers as would have been understood by a POSITA. *Id.*; EX1099, 1:29-35, 32:4-5.

Thus, Shattil-537 discloses and renders obvious Limitation [17B].

g. [17Bi] performing an inverse-DFT to produce an SC-FDMA signal

Shattil-537 discloses or renders obvious *an OFDM transceiver configured for performing an inverse-DFT on the coded symbols to produce a single-carrier frequency division multiple access signal that comprises a sum of the consecutive series of OFDM subcarriers*. EX1002, ¶¶181-88.

Shattil’s OFDM transceiver performs an “inverse-DFT,” namely an IFFT,⁴ on the coded symbols (“weights” or “CI symbol values”) that are provided to the IFFT. EX1099, 19:20-24, FIG. 18. The result of the IFFT operation is the generation of a “single-carrier signal,” which is received and decomposed into its individual carrier components at a receiver. EX1099, 16:23-25, 17:2-4 (“Desirable spectral ranges ... can support CI carriers that combine in a CI receiver to produce a conventional

⁴ The ’508 Patent indicates an IFFT is a type of IDFT. EX1001, 34:45-46 (“[A]n IDFT can be implemented as an IFFT”).

single-carrier receiver.”), 18:4-7. The single carrier signal is a multiple access signal because Shattil-537 describes allocating frequencies among various users. EX1099, 16:33-36 (describing avoiding “certain spectral ranges” including those “allocated to another user”); EX1002, ¶185.

In Shattil-537 the single-carrier signal *comprises a sum of the consecutive series of OFDM subcarriers* because Shattil-537 explains that “[a] superposition of” the CI carriers “produces a CI waveform bearing the data symbol value s_n , such as at a particular pulse position.” EX1099, 25:25-26. A POSITA would have recognized that the single carrier waveform *comprises a sum of the consecutive series of OFDM subcarriers* because the creation of the single carrier from the CI components can be reversed at the receiver. EX1099, 16:23-25, 17:31-32, 18:13-14; EX1002, ¶185.

At the very least, a POSITA would have found it obvious that *performing an inverse-DFT on the coded symbols* would have produced a SC-FDMA signal that *comprises a sum of the consecutive series of OFDM subcarriers* because a POSITA knew that DFT spreading data symbols before modulating them onto OFDM subcarriers (as described in Shattil-537) results in a signal that resembles a single-carrier signal. EX1002, ¶186; 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.”).

A POSITA would also have at least found it obvious that the resulting signal is a sum of the consecutive subcarriers 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; EX1087, p.8 (same); EX1089, p.6 (same); EX1002, ¶187.

Thus, Shattil-537 discloses and renders obvious Limitation [17Bi].

h. [17Bii]: transmitting the SC-FDMA signal

Shattil-537 discloses and renders obvious *an OFDM transceiver configured for transmitting the single-carrier frequency division multiple access signal in the mobile radio communications network*. EX1002, ¶¶189-91.

Shattil-537 explains that “[a] transmit data stream” is processed by the “Encoder/Interleaver” 1810. EX1099, 19:20-21. Shattil-537’s transceiver would have been understood to perform a step of *transmitting* and that after the generation of the *single carrier frequency division multiple access signal* the signal is transmitted over the air in the wireless communication network as this is the point

of Shattil-537's transmitter circuitry in the transceiver. EX1002, ¶190; EX1099, 2:20-23 (referring to “many wireless applications” including “cellular communications”).

Thus, Shattil-537 discloses and renders obvious Limitation **[17Bii]**.

- i. **[17C]: providing symbol period by selection of subcarrier spacing**

Shattil-537 discloses or renders obvious *wherein provisioning the plurality of different selectable subcarrier spacings comprises providing the single-carrier frequency division multiple access signal with a particular one of a set of different symbol periods by selecting one of the plurality of different selectable subcarrier spacings*. EX1002, ¶¶192-97.

Shattil-537 explains that “a desired waveform’s period T_s ” is equal to “ $1/f_s$ ” and explains that “[t]he symbol interval T_s is provided with respect to the relationship $T_s = 1/f_s$ such that at least one data symbol on at least one carrier can be separated from interfering data symbols on one or more carriers that are orthogonal to the desired carrier(s).” EX1099, 8:20, 10:8-10; *see also id.*, 8:12-14 (“A process for separating a received signal into orthogonal waveforms may utilize knowledge of carrier separations f_s (and, thus, $T_s = 1/f_s$) of a transmitted multicarrier signal.”), 11:15 (“the sampling period is $T_s = 1/f_s$.”), 14:29-30 (“In this case, the selector/accumulator 1004 may control symbol duration T_s (i.e., carrier separation f_s)”), cls. 1 (“ $T_s = 1/f_s$ ”), 9 (“ $T_s = 1/f_s$ ”), FIG. 14.

A POSITA would have recognized the relationship $T_s = 1/f_s$, defined by Shattil-537, as a widely recognized principle in OFDM system design for maintaining orthogonality between subcarriers. EX1002, ¶194; EX1015, p.22 (“[T]he carriers are linearly independent (i.e., orthogonal) if the carrier spacing is a multiple of $1/T$.”). 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,”).

Therefore, because Shattil-537 describes *provisioning the plurality of different selectable subcarrier spacings* and selecting one of the different subcarrier spacings as explained in connection with Limitation [1B], Shattil-537 also describes *providing the single-carrier frequency division multiple access signal with a particular one of a set of different symbol periods by selecting* because of the disclosed inverse relationship between subcarrier spacing and symbol duration. EX1002, ¶195. This means that the selection of the subcarrier spacing would have provided the SC-FDMA signal with a symbol period specific for that subcarrier spacing. EX1002, ¶195. In other words, changing the subcarrier spacing will result in a change in the symbol duration. *Id.*

Thus, Shattil-537 explicitly demonstrates that the selection of subcarrier spacing f_s determines the symbol period T_s through the inverse relationship $T_s =$

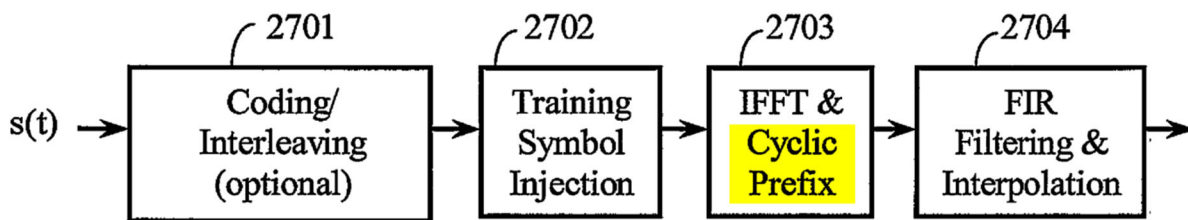
$1/f_s$. This means that the selection of a different subcarrier spacing provides for a corresponding different symbol period. EX1002, ¶¶195-196.

Thus, Shattil-537 discloses and renders obvious Limitation [17C].

4. *Claims 3, 11, and 19*

Shattil-537 discloses *adding a cyclic prefix to the single-carrier frequency division multiple access signal prior to transmitting*. EX1002, ¶¶198-200.

Shattil explains that after “IFFT 2703 or equivalent process [(e.g., the process performed by the IFFT processor in FIG. 18 or the transceiver in FIG. 19)] impresses the coded data symbols onto a plurality of carriers” “a cyclic prefix may be added to the coded data symbols,” as shown in FIG. 27A:



EX1099, 32:4-6 (FIG. 27A). In addition, Shattil explains that “guard intervals and/or cyclic prefixes [] are well known in the art.” EX1099, 8:10-12. Therefore, after the SC-FDMA signal is generated, a cyclic prefix is added to it. EX1002, ¶199.

Thus, Shattil-537 discloses and renders obvious claim 3.

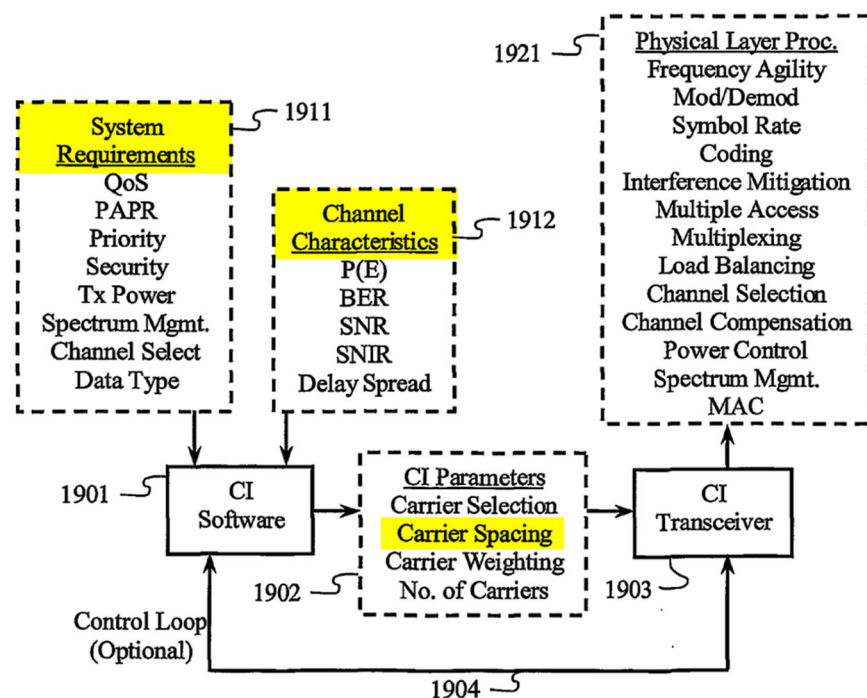
Claims 11 and 19 are substantively the same as claim 3. Accordingly, Shattil-537 discloses and renders obvious claims 11 and 19 for the same reasons provided

with respect to claim 3.

5. *Claims 5, 13, and 21*

Shattil-537 discloses wherein *the provisioning the plurality of different selectable subcarrier spacings is configured for different deployment scenarios comprising different system requirements or different channel conditions*. EX1002, ¶¶201-06.

As illustrated in FIG. 19, Shattil explicitly discloses “a software module that processes one or more system requirements and/or one or more channel characteristics to adjust one or more CI parameters,” including “Carrier Spacing[s]”:



EX1099, 4:16-17 (FIG. 19); *see also* 19:5-8 (describing responding to “changing conditions and operational requirements”), 20:3-6, cls. 48-49, 57.

A POSITA would understand that different channel conditions are characterized by different channel characteristics. EX1002, ¶204. Therefore, Shattil discloses *the provisioning the plurality of different selectable subcarrier spacings* (i.e., determining and providing the “CI Parameters” including “Carrier Spacing”) *is configured for different deployment scenarios comprising different system requirements or different channel conditions* (is adaptable based on inputs into the “CI Software” including “System Requirements” and “Channel Characteristics”). *Id.* At the very least, a POSITA would have found that to be the obvious and apparent interpretation of FIG. 19 of Shattil-537 in light of the description. EX1002, ¶205; EX1099, 20:5-6 (discussing “CI parameter adjustments and selections” that “provide corresponding adjustments to the transceiver’s 1903 physical layer processes 1921.”), 20:8-9 (“CI signaling characteristics, such as weights, symbol duration, and CI codes may be adapted to RF operating characteristics of the transceiver.”). And, thus, a POSITA would have understood that Shattil-537 describes provisioning subcarrier spacings (and other CI parameters) for different *deployment scenarios*. EX1002, ¶205.

Thus, Shattil-537 discloses and renders obvious claim 5.

Claims 13 and 21 are substantively the same as claim 5, the substantive difference between claims 5, 13, and 21 being the explicit use of the term “channel characteristics” in claim 21 (instead of “channel conditions”). EX1002, ¶¶201-06.

Accordingly, Shattil-537 discloses and renders obvious claims 13 and 21 for the same reasons provided with respect to claim 5.

B. Grounds 3 and 4: Claims 2, 4-6, 10, 12-14, 18, and 20-22 would have been obvious over (Ground 3) Shattil-537 in view of Doufexi and (Ground 4) Shattil-537 in view of Lucent

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

Grounds 3 and 4 rely on Shattil-537 as applied to claims 1, 9, and 17, above. *Supra* §§IX.A.1, IX.A.2, IX.A.3. Grounds 3 and 4 are treated together because they present similar issues. For example, claims 2, 10, and 18 involve different selectable subcarrier spacings having a particular mathematical relationship, claims 4, 12, and 20 involve different selectable subcarrier spacings with a similar mathematical relationship, claims 5, 13, and 21 involve different selectable subcarrier spacings configured for different deployment scenarios, and claims 6, 14, and 22 involve different subcarrier spacings that provide different numbers of symbols per frame. Doufexi and Lucent both describe such selectable subcarrier spacings and the benefits of having systems that support them as explained below.

Shattil-537 explains that different selectable subcarrier spacings are provisioned based on, for example, system requirements and/or channel conditions. EX1099, 5:14-15, 20:3-6. Additionally, Shattil-537 explains that the orthogonality of subcarriers is preserved through maintaining “the relationship $T_s = 1/f_s$.”

EX1099, 10:8-10. However, Shattil-537 does not provide specific working examples or numerical values of subcarrier spacings to be selected. EX1002, ¶208.

A POSITA knew that there were benefits to using variable subcarrier spacings in OFDM communications systems. These benefits are revealed in each of Doufexi and Lucent. EX1002, ¶209.

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 (Δf)	16 kHz	8 kHz

EX1003, p.193. As shown here, various parameters are adjusted including “sub-carrier spacing (Δ_f).” *Id.*; EX1002, ¶211. Thus, Doufexi motivates a POSITA to have a system in which the subcarrier spacing can be selected from among different subcarrier spacings. EX1002, ¶¶212-13. 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, ¶213. Doufexi’s different selectable subcarrier spacings also maintain the relationship $T_s = 1/f_s$ required for preserving orthogonality. EX1002, ¶214; EX1003, p.193 (“subcarrier spacing is $\Delta_f = 1/T$ ”). Thus, a POSITA would have been motivated to allow Shattil-537’s method and apparatus to provision different selectable subcarrier spacings based on Doufexi. EX1002, ¶¶214-216.

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

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

EX1006, p.5. Lucent explains that the different configurations are associated with different “suitable deployment environment[s].” *Id.*; *see also id.*, p.7 (“We have suggested an OFDM system with multiple configurations that can be deployed in different environments.”). One difference between the three configurations proposed by Lucent is the subcarrier spacing. There are three options: 19.2 kHz, 9.6 kHz, and 4.8 kHz. *Id.* Lucent thus reflects a similar theme to that found in Doufexi—different use cases call for different subcarrier spacings and other transmission parameters. EX1002, ¶237. A POSITA knew that a user may have a mobile station (e.g., a UE) that was used in each of the scenarios. EX1002, ¶238. 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). *Id.* Thus, each of these configurations may provide better performance than the others depending on the environment in which the UE is located. EX1002, ¶238. Lucent's different selectable subcarrier spacings maintain Shattil-537's relationship $T_s = 1/f_s$ required for preserving orthogonality, Lucent's useful OFDM symbol period being equal to its total "OFDM Symbol period" minus its "Guard time." EX1002, ¶238; EX1006, p.3 ("If we assume the sub-carrier spacing to be 4.8 kHz, we have a useful signal period (T_u) of 208.33 usec and a guard time (T_g) of 13.889 usec." $1/(4800\text{Hz}) = 208.\bar{3}\mu\text{s.}$). Thus, a POSITA would have been motivated to allow Shattil-537's method and apparatus to provision different selectable subcarrier spacings based on Lucent.

Based on the foregoing a POSITA would have found it obvious to provision, and select from among, the different selectable subcarrier spacings found in either Doufexi or Lucent because the prior art provides express motivation to do so. EX1002, ¶¶239-41. A POSITA would have seen clear benefits in configuring Shattil-537's method and apparatus (e.g., the software module 1901 in FIG. 19) to provision different selectable subcarrier spacings 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, ¶239.

Additionally, a POSITA would have recognized that, while Shattil-537's methods and apparatus enable provisioning of different subcarrier spacings and subcarrier-spacing selection, they lack specific options to ensure subcarrier orthogonality and would have further recognized that Doufexi and Lucent disclose specific useful selectable subcarrier spacings that maintain the orthogonality-preserving relationship $T_s = 1/f_s$ required by Shattil-537's method and apparatus. EX1002, ¶¶240-41. A POSITA would have further recognized that combining the subcarrier-spacing selection of Shattil-537 with the orthogonality-preserving selectable subcarrier spacings disclosed in Doufexi and Lucent according to their known methods would yield the predictable result of enhancing the adaptability and performance of Shattil-537's method and apparatus while preserving subcarrier orthogonality. *Id.*

Moreover, allowing Shattil-537's method and apparatus to implement different selectable subcarrier spacings, for example where one spacing could equal another multiplied by a scaling factor like a power of two or an integer, where spacings are tailored to various deployment scenarios, or where spacings offer different numbers of symbols per frame, would have simply applied the established techniques of selectable subcarrier spacings from Doufexi and Lucent to enhance Shattil-537 by preserving subcarrier orthogonality while boosting adaptability and flexibility across diverse environments. EX1002, ¶¶213, 215-16, 239, 241-42. The

results of the combinations 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 channel conditions. *Id.* And, those skilled in the art were aware of the need to tailor the various system parameters like subcarrier spacings, symbol durations, guard intervals, etc. as part of system design. EX1002, ¶¶217-18, 243-44; 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 reasonably expected to succeed in making the combinations because POSITAs were aware of the benefits of different selectable subcarrier spacings depending on channel conditions, deployment scenarios, and/or environmental conditions. EX1002, ¶¶218, 244. A POSITA was also aware of the mathematical relationships between OFDM symbol duration and subcarrier spacing that are needed to maintain orthogonality. EX1002, ¶¶218, 244; EX1015, p.22 (“[T]he carriers are linearly independent (i.e., orthogonal) if the carrier spacing is a multiple of $1/T$.”). These parameters were commonly considered by a POSITA in OFDM system design and this was textbook knowledge. EX1015, p.33.

2. Claims 2, 10, and 18

Shattil-537 in view of Doufexi (Ground 3) and Shattil-537 in view of Lucent (Ground 4) 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, ¶¶219-22, 245-47.

Doufexi: Doufexi discloses two selectable subcarrier spacings of 16kHz and 8kHz (highlighted yellow) each providing a different symbol period (highlighted green), wherein 16kHz is equal to 8kHz multiplied by 2^1 , as shown 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, p.2. Thus, Doufexi discloses a *selectable subcarrier spacing[]* that equals another *selectable subcarrier spacing[]* multiplied by a scaling factor that is a power of two. EX1002, ¶¶220-221.

Lucent: Lucent discloses three selectable subcarrier spacings equal to, in kHz, 4.8, 9.6, and 19.2 (highlighted yellow) providing different symbol periods (highlighted green), wherein 4.8 is equal to 4.8 multiplied by 2^0 , 9.6 is equal to 4.8 multiplied by 2^1 , and 19.2 is equal to 4.8 multiplied by 2^2 :

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, Lucent discloses a *selectable subcarrier spacing[]* that equals another *selectable subcarrier spacing[]* multiplied by a scaling factor that is a power of two. EX1002, ¶246.

Based on these teachings and for the reasons explained above, a POSITA would have found it obvious to modify Shattil-537's method and apparatus to provision the specific different selectable subcarrier spacings recited in claims 2, 10, and 18 based on Doufexi (Ground 3) and Lucent (Ground 4). *Supra* §IX.B.1.

3. Claims 4, 12, and 20

Shattil-537 in view of Doufexi (Ground 3) and Shattil-537 in view of Lucent (Ground 4) renders obvious wherein *the plurality of different selectable subcarrier spacings are integer multiples of a first subcarrier spacing*. EX1002, ¶¶223-25, 248-

50.

Doufexi: Doufexi discloses two selectable subcarrier spacings of 16kHz and 8kHz (highlighted yellow) each providing a different symbol period (highlighted green), wherein 8kHz and 16kHz are integer multiples of 8kHz (i.e., $8\text{kHz} = 1 \times 8\text{kHz}$ and $16\text{kHz} = 2 \times 8\text{kHz}$), as shown 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 μs	125 μs
Guard Interval Duration (T_g)	15.625 μs ($T/4$)	31.25 μs ($T/4$)
Total Symbol Duration (T_{symbol})	78.125 μs (with $GI = T/4$)	156.25 μs (with $GI = T/4$)
Inner Channel Coding	Punctured 1/2 rate convolution code, Constraint length 7, {133, 171} _{octal}	Punctured 1/2 rate convolution code, Constraint length 7, {133, 171} _{octal}
FFT Size	256	512
Number of data sub-carriers (N_D)	216	432
Sub-carrier spacing (Δ_f)	16 kHz	8 kHz

EX1003, p.2. Thus, Doufexi discloses a *plurality of different selectable subcarrier spacings that are integer multiples of a first subcarrier spacing*. EX1002, ¶224.

Lucent: Lucent discloses three selectable subcarrier spacings equal to, in kHz, 4.8, 9.6, and 19.2 (highlighted yellow) providing different symbol periods (highlighted green), wherein 4.8 is equal to 4.8 multiplied by 1, 9.6 is equal to 4.8 multiplied by 2, and 19.2 is equal to 4.8 multiplied by 4:

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, Lucent discloses a *plurality of different selectable subcarrier spacings that are integer multiples of a first subcarrier spacing*. EX1002, ¶249.

Based on these teachings and for the reasons explained above, a POSITA would have found it obvious to modify Shattil-537's method and apparatus to provision the different selectable subcarrier spacings recited in claims 4, 12, and 20 based on Doufexi (Ground 3) and Lucent (Ground 4). *Supra* §IX.B.1.

4. Claims 5, 13, and 21

Shattil-537 in view of Doufexi (Ground 3) and Shattil-537 in view of Lucent (Ground 4) renders obvious wherein *the provisioning the plurality of different selectable subcarrier spacings is configured for different deployment scenarios comprising different system requirements or different channel conditions*. EX1002,

¶¶226-29, 251-56.

Doufexi: Doufexi identifies “link parameters,” including multiple subcarrier spacings, “for a 4G OFDM system” and presents “initial physical layer performance results [] for a number of transmission modes and channel scenarios.” EX1003, p.1. Moreover, Doufexi explains that “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,” and thus recommends having different settings for “key link parameters” including “subchannel spacing.” EX1003, p.192.

By disclosing different “channel scenarios,” different subcarrier spacings, and explaining that deployment will be “in a wide range of environments,” Doufexi discloses a *provisioning of a plurality of different selectable subcarrier spacings that is configured for different deployment scenarios including different system requirements and different channel conditions*. EX1002, ¶228. This permits Doufexi to “dynamically adapt[] one or more of the” parameters to offer “superior performance.” EX1003, p.192; EX1002, ¶228.

Lucent: Lucent discloses an OFDM system “with multiple configurations suitable for different channel conditions” that “[allow a] UE to switch smoothly to different configurations” having different subcarrier spacings. EX1006, pp.3-5. Lucent shows at least three different selectable subcarrier spacings (highlighted yellow) providing different symbol periods (highlighted green) and configured for

different deployment scenarios (highlighted red):

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. Lucent explains that the benefits of these configurations include: allowing “shorter symbol durations when the multipath is less severe,” where “multipath” is a channel condition (a form of interference), EX1006, p.5; EX1002, ¶254. And, Lucent explains that a “shorter symbol duration” makes the system “less susceptible to high Doppler and hence reduces ICI [intercarrier interference],” thus demonstrating that the configurations are configured to address different deployment scenarios with different channel conditions. EX1006, p.5; EX1002, ¶254.

Thus, the different selectable subcarrier spacings are associated with specific deployment scenarios with different system requirement. Lucent thus discloses a

provisioning of a plurality of different selectable subcarrier spacings that is configured for different deployment scenarios including different system requirements and different channel conditions. EX1002, ¶¶254-55.

Based on these teachings and for the reasons explained above, a POSITA would have found it obvious to modify Shattil-537's method and apparatus to provision the different selectable subcarrier spacings recited in claims 5, 13, and 21 based on Doufexi (Ground 3) and Lucent (Ground 4). *Supra* §IX.B.1.

5. *Claims 6, 14, and 22*

Shattil-537 in view of Doufexi (Ground 3) and Shattil-537 in view of Lucent (Ground 4) renders obvious wherein *each of the plurality of different subcarrier spacings provides a different number of symbols per frame*. EX1002, ¶¶230-33, 257-60.

Doufexi: Doufexi discloses two symbol durations, one being half as long as the other, which enables twice the number of symbols in a certain fixed frame duration. EX1003, p.193. The frames in Doufexi are described as time slots allocated to the user. *Id.*, pp.193-94 (“Time slots are allocated dynamically depending on the need for transmission resources.... If a frame duration of 10ms is assumed then the number of OFDM symbols in a frame is $N_{frame}=128$). Based on the numbers provided in Doufex's Table 2, this symbol per frame number corresponds to the useful symbol duration of 78.125 μ s, whereas when the useful symbol duration is 156.25 μ s only

64 symbols per frame will be used. EX1002, ¶¶231-32; EX1003, pp.193-194. Thus, Doufexi discloses a *plurality of different subcarrier spacings*, wherein *each provides a different number of symbols per frame* (64 and 128). EX1002, ¶¶231-32.

Lucent: Lucent discloses three selectable subcarrier spacings (highlighted yellow) providing different symbol periods (highlighted green) and different number of symbols per frame—i.e., per “time slot” (highlighted orange):

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. Lucent proposes using the time slots used in UMTS as the “frame structure.” *Id.*, p.1 (“It is also foreseeable that the symbol duration of the OFDM system should fit into the 0.67 msec time slots currently defined.”). Therefore, as the symbol duration increases, the number of symbols per frame decreases as shown in Lucent’s Table 4. EX1002, ¶259. Thus, Lucent discloses a *plurality of different*

subcarrier spacings, wherein each provides a different number of symbols per frame. EX1002, ¶¶258-59.

Based on these teachings and for the reasons explained above, a POSITA would have found it obvious to modify Shattil-537's method and apparatus to provision the different selectable subcarrier spacings recited in claims 6, 14, and 22 based on based on Doufexi (Ground 3) and Lucent (Ground 4). *Supra* §IX.B.1.

X. DISCRETIONARY DENIAL UNWARRANTED⁵

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 (Mar. 20, 2020) (precedential).

1. Petitioner Will Seek a Stay

Factor 1 favors institution. Petitioner will seek a stay of co-pending litigation pending the outcome of this and related IPRs and reexaminations. The Eastern District of Texas has granted stays before claim construction because such cases have “not reached such an advanced stage that it would weigh against a stay.”

⁵ Petitioner presents these arguments without waiving additional briefing under the USPTO's March 26, 2025 “Interim Process for Workload Management.”

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, Paper 16, at 10 (Jan. 27, 2025) (Fintiv factor 2 “neutral or weigh[s] slightly in favor of not exercising discretion” where district court “set 10 cases for jury selection on the same day”).

Even when the Final Written Decision (“FWD”) may come after the trial date, the Board has instituted trial based on many of factors present here, such as diligence in filing the petition, a stipulation not to pursue the asserted grounds in litigation,

minimal investment in litigation, and the merits of the challenge were strong. *Lego Sys., Inc. v. Mq Gaming LLC*, No. IPR2020-01445, Paper 12, at 17 (Feb. 16, 2021) (finding jury trial “five months before a final written decision” outweighed by “low” “investment by the court and parties in the [parallel case] on” common issues, Petitioner’s *Sotera* stipulation, and strong merits to the challenge); *Verizon Business Network Services, Inc. v. Huawei Techs. Co.*, IPR2020-01141, Paper 12, at 17-18 (Jan. 14, 2021). Petitioner diligently filed this petition particularly considering the complexity of the analysis undertaken across eight asserted patents that collectively have (1) 638 pages, (2) 243 claims, (3) a range of effective filing dates, and (4) are part of a patent family that was pending before the Office for about two decades. EX1047, ¶1; EX1065. The way Patent Owner structured its patent families, shifted patent disclosures from one application to the next, and, at times, incorporated dozens of patents and publications by reference, placed a significant burden on Petitioner to assess its positions. EX1023, pp.233-236, 241; EX1031, pp.24, 26, 29, 32, 36, 44. The complexity presented by this, and the seven other IPR petitions Petitioner is filing, weigh strongly in favor of institution. *Apple, Inc. v. SEVEN Networks, LLC*, IPR2020-00156, Paper 10 at 21-22 (June 15, 2020) (“complexity of multiple patents and issues in the District Court Action” favored institution). Considering these procedural and technical complexities, the Board is uniquely situated to adjudicate patentability because of its expertise in patent law and

technological questions.

3. *Investment in Parallel Proceeding*

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

4. *Stipulation Favors Institution*

Factor 4 weighs strongly against discretionary denial. Petitioner hereby stipulates that, if the IPR is instituted, Petitioner will not assert that any of the claims challenged in this proceeding are invalid on any ground that Petitioner raised or reasonably could have raised during this inter partes review. *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12, at 19 (Dec. 1, 2020) (finding “stipulation here mitigates any concerns of duplicative efforts...as well as concerns of potentially conflicting decisions” and “ensures that an *inter partes* review is a ‘true alternative’ to the district court proceeding”); *Lego*, IPR2020-01445, Paper 12 at 16 (“*Fintiv* factor 4 weighs strongly against discretionary denial” where Petitioner makes *Sotera* stipulation); *Verizon Business Network Servs, Inc. v. Huawei Techs. Co.*, IPR2020-

01141, Paper 12 (Jan. 14, 2021) (“[i]nstituting trial here serves overall system efficiency and integrity goals by not duplicating efforts and by resolving materially different patentability issues.”).

5. *Identity of the Parties*

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

6. *Merits Heavily Favor Institution*

Factor 6 favors institution. The compelling merits of the challenge presented herein further weigh heavily in favor of institution. As demonstrated by the Petition, the challenged claims are unpatentable the cited prior art, which was not previously considered despite numerous continuation filings. For example, a single undisclosed reference—Galda—anticipates and/or obviates most challenged claims. The Board’s views on the patentability of the challenged claims will also benefit the public, which is otherwise faced with a thicket of similar and related patents that Patent Owner contends are essential to 4G and 5G wireless standards and which have been asserted against various companies. EX1106. This is the first and only IPR on the ’508 Patent, so a patentability determination by the Board on this Petition would conserve resources.

B. Denial Under §325(d) Unwarranted

The '508 Patent was not rejected on any prior art, and the prior art in Petitioner's Grounds was not mentioned or otherwise discussed by the Examiner during prosecution. In fact, Mr. Shattil never even cited Shattil-537 to the PTO in connection with the '508 Patent. 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 '508 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. 11,252,005:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00791; Petitioner also anticipates filing a request for reexamination as to this patent to raise grounds that cannot be raised in this proceeding.
- **U.S. Patent No. 11,381,285:** *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.
- **U.S. Patent No. 11,424,792:** U.S. Reexamination Control No. 90/019,848; *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00793.

A patent in the same family as the '508 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
Andrew R. Sommer (Reg. No. 53,932) Greenberg Traurig, LLP 1750 Tysons Boulevard, Suite 1000 McLean, VA 22102 Telephone: 703-749-1370 Facsimile: 703-749-1301 SommerA@gtlaw.com	Trenton A. Ward (Reg. No. 59,157) Greenberg Traurig, LLP Terminus 200 333 Piedmont Road NE, Suite 2500 Atlanta, GA 30305 Telephone: 678-553-2470 Facsimile: 678-553-2212 Trenton.Ward@gtlaw.com
Back-Up Counsel	Back-Up Counsel
Bryan K. Hanks (Reg. No. 52,991) Greenberg Traurig, LLP 222 S. Main St. #1730 Salt Lake City, UT 84101 Telephone: 801-478-6900 Bryan.Hanks@gtlaw.com	Elana B. Araj (Reg. No. 75,804) Greenberg Traurig, LLP One Vanderbilt Avenue New York, NY 10017 Telephone: 212-801-6566 Fax: 212-801-6400 Elana.Araj@gtlaw.com
Back-Up Counsel	Back-Up Counsel
Jared Lee (Reg. No. 72,786) Greenberg Traurig, LLP 222 S. Main St. #1730 Salt Lake City, UT 84101 Telephone: 801-478-6900 Jared.Lee@gtlaw.com	Stephen M. Ullmer (<i>pro hac vice</i> to be filed) Greenberg Traurig, LLP 0260 SW Greenburg Road Suite 400 Portland, OR 97223 Tel: 303-572-6579 ullmers@gtlaw.com

D. Service

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

XII. FEES

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

Dated: April 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 12,813 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. 11,223,508, 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, 1006-1010, 1012-1016, 1021, 1023, 1028, 1030-1032, 1034, 1036-1037, 1039, 1046-1047, 1060-1065, 1087, 1089, AND 1099-1106** by EXPRESS MAIL on the Patent Owner at the correspondence address of record for U.S. Patent No. 11,223,508 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