

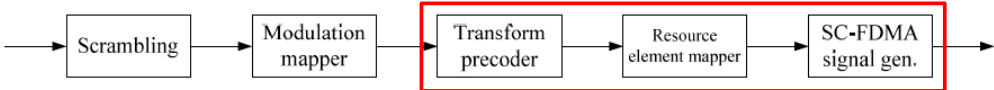
P.R. 3-1(c) EXHIBIT 4

U.S. Patent No. 11,075,786: Samsung Devices¹

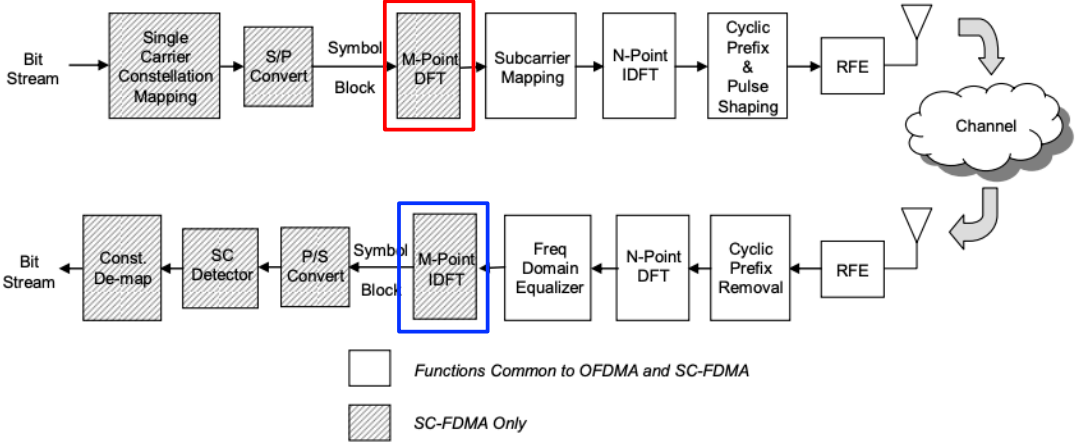
Claim 10	Analysis	Select Evidence						
An apparatus for communication in a wireless communication network	The Samsung Galaxy S22 is a non-limiting example of an apparatus for communication in a wireless communication network (e.g., LTE network). As shown to the right, Samsung devices are LTE devices, and adheres to the LTE specification.	 Galaxy S22, 128GB (Unlocked) SM-S901UZKAXAA ★★★★★ 3.9 (1358) Write a review Share your product experience ***** <table><tr><td> Network 2G GSM GSM850,GSM900,DCS1800,PC S1900 </td><td> 3G UMTS B1(2100),B2(1900),B4(AWS),B5(850),B8(900) </td><td> 4G FDD LTE B1(2100),B2(1900),B3(1800),B4(AWS),B5(850),B7(2600),B8(900),B12(700),B13(700),B14(700),B18(800),B19(800),B20(800),B25(1900),B26(850),B28(700),B29(700),B30(2300),B66(AWS-3),B71(600) </td></tr><tr><td> 4G TDD LTE B38(2600),B39(1900),B40(2300),B41(2500),B46(5200),B48(3600) </td><td> 5G FDD Sub6 N1(2100),N3(1800),N5(850),N7(2600),N8(900),N20(800),N28(700),N66(AWS-3),N71(600) </td><td> 5G TDD Sub6 N260(39GHz),N261(28GHz) </td></tr></table> Source: https://www.samsung.com/us/business/mobile/phones/galaxy-s/galaxy-s22-128gb-unlocked-sm-s901uzkaxaa/#specs (GC0007293-94; GC0007311)	Network 2G GSM GSM850,GSM900,DCS1800,PC S1900	3G UMTS B1(2100),B2(1900),B4(AWS),B5(850),B8(900)	4G FDD LTE B1(2100),B2(1900),B3(1800),B4(AWS),B5(850),B7(2600),B8(900),B12(700),B13(700),B14(700),B18(800),B19(800),B20(800),B25(1900),B26(850),B28(700),B29(700),B30(2300),B66(AWS-3),B71(600)	4G TDD LTE B38(2600),B39(1900),B40(2300),B41(2500),B46(5200),B48(3600)	5G FDD Sub6 N1(2100),N3(1800),N5(850),N7(2600),N8(900),N20(800),N28(700),N66(AWS-3),N71(600)	5G TDD Sub6 N260(39GHz),N261(28GHz)
Network 2G GSM GSM850,GSM900,DCS1800,PC S1900	3G UMTS B1(2100),B2(1900),B4(AWS),B5(850),B8(900)	4G FDD LTE B1(2100),B2(1900),B3(1800),B4(AWS),B5(850),B7(2600),B8(900),B12(700),B13(700),B14(700),B18(800),B19(800),B20(800),B25(1900),B26(850),B28(700),B29(700),B30(2300),B66(AWS-3),B71(600)						
4G TDD LTE B38(2600),B39(1900),B40(2300),B41(2500),B46(5200),B48(3600)	5G FDD Sub6 N1(2100),N3(1800),N5(850),N7(2600),N8(900),N20(800),N28(700),N66(AWS-3),N71(600)	5G TDD Sub6 N260(39GHz),N261(28GHz)						

¹ This chart applies to all Samsung devices, including those listed in Appendix A and identified in the Complaint at paragraph 30. Other Samsung LTE-enabled devices, including any recently discontinued LTE-enabled devices, infringe this patent in a substantially similar, if not identical, manner.

Claim 10	Analysis	Select Evidence
	As shown to the right, LTE uses OFDMA for the physical channel downlink (e.g., base station to user device), and SC-FDMA for the physical channel uplink (e.g., user device to base station).	The Evolved Packet System (EPS) is purely IP based. Both real time services and datacom services will be carried by the IP protocol. The IP address is allocated when the mobile is switched on and released when switched off. <u>The new access solution, LTE, is based on OFDMA (Orthogonal Frequency Division Multiple Access) and in combination with higher order modulation (up to 64QAM), large bandwidths (up to 20 MHz) and spatial multiplexing in the downlink (up to 4x4) high data rates can be achieved. The highest theoretical peak data rate on the transport channel is 75 Mbps in the uplink, and in the downlink, using spatial multiplexing, the rate can be as high as 300 Mbps.</u> Source: https://www.3gpp.org/technologies/keywords-acronyms/98-lte (GC0004804) <u>Each data symbol is DFT transformed before mapping to subcarriers, hence the SC-FDMA is called <i>DFT-precoded</i> OFDM. In a standard OFDM, each data symbol is carried on a separate subcarrier. In SC-FDMA, multiple subcarriers carry each data symbol due to mapping of the symbols' frequency domain samples to subcarriers. As each data symbol is spread over multiple subcarriers, SC-FDMA offers spreading gain or frequency diversity gain in a frequency selective channel. Thus, SC-FDMA can be viewed as <i>frequency-spread OFDM</i> or <i>DFT-spread OFDM</i>.</u> * * * * <u>As SC-FDMA is built over OFDM modulation, let's first review an OFDM system structure. A typical OFDM transmitter and receiver structure is shown in Figure 2. A transmitter includes a baseband modulator, subcarrier mapping, inverse Fourier transform, cyclic prefix addition, parallel-serial conversion, and a digital-to-analog converter followed by an I-Q RF modulator. Unlike other modulation techniques that operate symbol by symbol, OFDM transmits a block of data symbols simultaneously over one OFDM symbol. An OFDM symbol is the time used to transmit all of subcarriers that are modulated by the block of input data symbols.</u> Source: https://support.ixiacom.com/sites/default/files/resources/whitepaper/sc-fdma-indd.pdf (GC0004314; GC0004313)

Claim 10	Analysis	Select Evidence
	As shown to the right, the LTE specification requires that, in the uplink, data must be transform precoded, mapped to subcarriers, and then modulated onto those subcarriers to generate the SC-FDMA (single channel frequency division multiple access) signal for transmission.	5.3 Physical uplink shared channel The baseband signal representing the physical uplink shared channel is defined in terms of the following steps: - scrambling - modulation of scrambled bits to generate complex-valued symbols - transform precoding to generate complex-valued symbols - mapping of complex-valued symbols to resource elements - generation of complex-valued time-domain SC-FDMA signal for each antenna port  Figure 5.3-1: Overview of uplink physical channel processing. Source: https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf (GC0004231)

Claim 10	Analysis	Select Evidence
that employs a first set of complex-valued codes to encode data symbols to be transmitted,	Samsung devices employ a first set of complex-valued codes (e.g., the exponential function in the transform precoding formula at right) for encoding data symbols for transmission. The LTE specification requires transform precoding the data symbols using the DFT shown at right to generate a block of transform precoded complex-valued symbols $z(0), \dots, z(M_{\text{symb}}-1)$. These are encoded data symbols. The portion of the DFT $e^{-j \frac{2\pi i k}{M_{\text{sc}}^{\text{PUSCH}}}}$ is used to define how data symbols are spread in the frequency domain, and correspond to complex-valued spreading codes.	5.3.3 Transform precoding <u>The block of complex-valued symbols $d(0), \dots, d(M_{\text{symb}}-1)$ is divided into $M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to</u> $z(l \cdot M_{\text{sc}}^{\text{PUSCH}} + k) = \frac{1}{\sqrt{M_{\text{sc}}^{\text{PUSCH}}}} \sum_{i=0}^{M_{\text{sc}}^{\text{PUSCH}}-1} d(l \cdot M_{\text{sc}}^{\text{PUSCH}} + i) e^{-j \frac{2\pi i k}{M_{\text{sc}}^{\text{PUSCH}}}}$ $k = 0, \dots, M_{\text{sc}}^{\text{PUSCH}} - 1$ $l = 0, \dots, M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}} - 1$ <u>resulting in a block of complex-valued symbols $z(0), \dots, z(M_{\text{symb}}-1)$.</u> The variable $M_{\text{sc}}^{\text{PUSCH}} = M_{\text{RB}}^{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil $M_{\text{RB}}^{\text{PUSCH}} = 2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \leq N_{\text{RB}}^{\text{UL}}$ where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers. Source: https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf (GC0004232)

Claim 10	Analysis	Select Evidence
and employs a second set of complex-valued codes to recover transmitted data symbols from a received signal, the apparatus comprising:	In operation, Samsung devices send data to a base station/eNode B ("Base Station"). The Base Station recovers the sent data by using a second set of complex valued codes which are the inverse of the first set of complex-valued codes. Shown to the right is a schematic overview of signal processing of the physical channel, with the top portion corresponding to the physical channel uplink signal processing through transmission. The bottom portion represents the Base Station processing of the uplink signal. The M-point DFT corresponds to the transform precoding DFT defined in the LTE specification. As shown, the Base Station processes the transform precoded signals by using an M-Point Inverse DFT, which is the inverse of the M-point DFT.	 Source: https://www.nxp.com/docs/en/white-paper/3GPPEVOLUTIONWP.pdf (GC0004204)

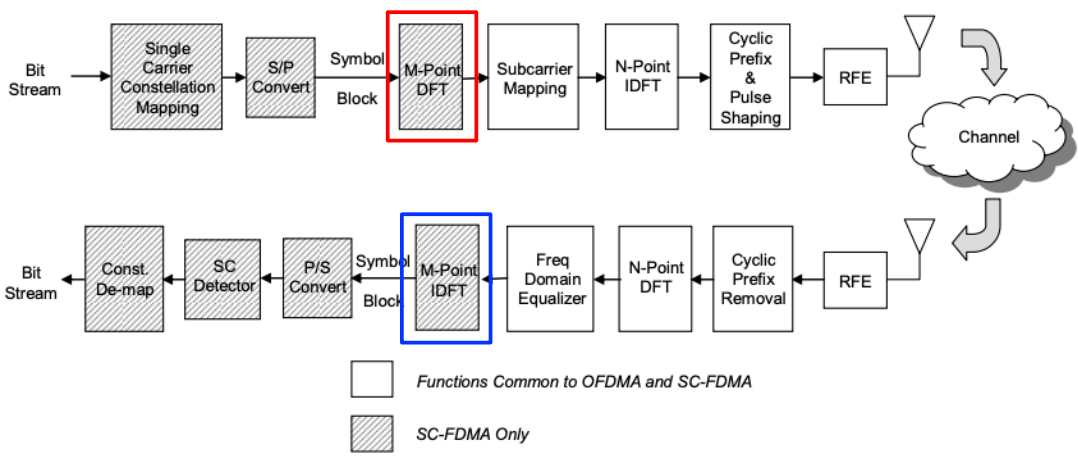
Claim 10	Analysis	Select Evidence																		
at least one processor; and a non-transitory computer-readable memory communicatively coupled to the at least one processor, the non-transitory computer-readable memory including a set of instructions stored thereon and executable by the at least one processor for:	Samsung devices have at least one processor (e.g., Qualcomm SM8450 Snapdragon 8 Gen 1 processor). ² As shown to the right, the Galaxy S22 is a non-limiting example of an LTE device that comprises a processor and a memory unit communicatively coupled to the processor.	<table><tr><td rowspan="5">PLATFORM</td><td>OS</td><td>Android 12, upgradable to Android 14, One UI 6.1</td></tr><tr><td>Chipset</td><td>Exynos 2200 (4 nm) - Europe Qualcomm SM8450 Snapdragon 8 Gen 1 (4 nm) - ROW</td></tr><tr><td>CPU</td><td>Octa-core (1x2.8 GHz Cortex-X2 & 3x2.50 GHz Cortex-A710 & 4x1.8 GHz Cortex-A510) - Europe Octa-core (1x3.00 GHz Cortex-X2 & 3x2.50 GHz Cortex-A710 & 4x1.80 GHz Cortex-A510) - ROW</td></tr><tr><td>GPU</td><td>Xclipse 920 - Europe Adreno 730 - ROW</td></tr><tr><td>MEMORY</td><td>Card slot</td><td>No</td></tr><tr><td></td><td>Internal</td><td>128GB 8GB RAM, 256GB 8GB RAM UFS 3.1</td></tr></table> Source: https://www.gsmarena.com/samsung_galaxy_s22_5g-11253.php (GC0007380) Ground-breaking innovations in AI, photography, gaming, and connectivity—for the premium experiences your devices deserve. The Snapdragon® 8 Gen 1 Mobile Platform is our most advanced 5G platform ever, with our Snapdragon® X65 5G Modem-RF System ushering in unprecedented speeds up to 10 Gbps while supp... * * * * <table><tr><td>Memory</td></tr><tr><td>Speed: 3200 MHz⁵</td></tr><tr><td>Type: LPDDR5</td></tr></table> Source: https://www.qualcomm.com/products/mobile/snapdragon/smartphones/snapdragon-8-series-mobile-platforms/snapdragon-8-gen-1-mobile-platform (GC0007688)	PLATFORM	OS	Android 12, upgradable to Android 14, One UI 6.1	Chipset	Exynos 2200 (4 nm) - Europe Qualcomm SM8450 Snapdragon 8 Gen 1 (4 nm) - ROW	CPU	Octa-core (1x2.8 GHz Cortex-X2 & 3x2.50 GHz Cortex-A710 & 4x1.8 GHz Cortex-A510) - Europe Octa-core (1x3.00 GHz Cortex-X2 & 3x2.50 GHz Cortex-A710 & 4x1.80 GHz Cortex-A510) - ROW	GPU	Xclipse 920 - Europe Adreno 730 - ROW	MEMORY	Card slot	No		Internal	128GB 8GB RAM, 256GB 8GB RAM UFS 3.1	Memory	Speed: 3200 MHz ⁵	Type: LPDDR5
PLATFORM	OS	Android 12, upgradable to Android 14, One UI 6.1																		
	Chipset	Exynos 2200 (4 nm) - Europe Qualcomm SM8450 Snapdragon 8 Gen 1 (4 nm) - ROW																		
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	GPU	Xclipse 920 - Europe Adreno 730 - ROW																		
	MEMORY	Card slot	No																	
	Internal	128GB 8GB RAM, 256GB 8GB RAM UFS 3.1																		
Memory																				
Speed: 3200 MHz ⁵																				
Type: LPDDR5																				

² See also Appendix A, listing Samsung devices including processor and memory types.

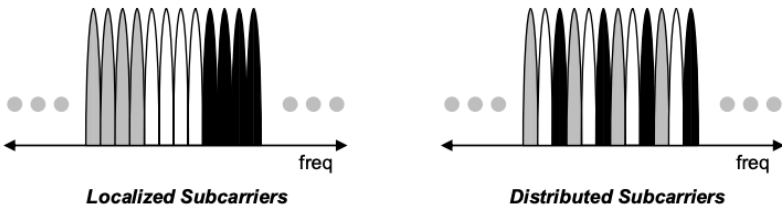
Claim 10	Analysis	Select Evidence
selecting a plurality of subcarriers to be transmitted;	As shown to the right, Samsung devices select subcarriers for transmission, with the subcarriers selected from those assigned to the device. Each physical resource block (PRB) consists of 12 subcarriers and determines the number of inputs for SC-FDMA signal generation.	5.3.4 Mapping to physical resources The block of complex-valued symbols $z(0), \dots, z(M_{\text{sym}} - 1)$ shall be multiplied with the amplitude scaling factor β_{PUSCH} in order to conform to the transmit power P_{PUSCH} specified in Section 5.1.1.1 in [4], and mapped in sequence starting with $z(0)$ to physical resource blocks assigned for transmission of PUSCH. The mapping to resource elements (k, l) corresponding to the physical resource blocks assigned for transmission and not used for transmission of reference signals and not reserved for possible SRS transmission shall be in increasing order of first the index k, then the index l, starting with the first slot in the subframe. Source: https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf (GC0004232) PUSCH The Primary Uplink Shared Channel (PUSCH) is used by uplink users to transmit data to the base station. All subcarriers not allocated for PRACH, PUCCH, or SRS are available for assignment to users. PUSCH data is modulated using SC-FDMA. Source: https://rfmw.em.keysight.com/wireless/helpfiles/89600b/webhelp/subsystems/lte/content/lte_overview.htm (GC0004795) 3.2.2 Multiplexing Uplink PRBs are assigned to UE by the base station scheduler via the downlink CCPCH. Uplink PRBs consist of a group of 12 contiguous subcarriers for a duration of one slot time. Source: https://www.nxp.com/docs/en/white-paper/3GPPEVOLUTIONWP.pdf (GC0004211) In SC-FDMA, the user data is modulated onto a single carrier modulation format (QPSK, 16QAM, or 64QAM), and the time domain symbols are transformed to the frequency domain by an FFT. Then the frequency domain points are mapped onto the subcarriers assigned to the user in the OFDM symbol. Finally, an IFFT is performed on the entire OFDM symbol and resulting time data is transmitted. The following image illustrates this process. Source: https://rfmw.em.keysight.com/wireless/helpfiles/89600b/webhelp/subsystems/lte/content/lte_overview.htm (GC0004793)

Claim 10	Analysis	Select Evidence
encoding the data symbols with the first set of complex-valued codes to produce encoded data symbols;	As shown to the right, Samsung devices employ transform precoding, which employs complex-valued codes (e.g., exponential function e). The complex-valued encode the data symbols (e.g., d variable in the transform precoding equation) to produce encoded data symbols.	5.3.3 Transform precoding The block of complex-valued symbols $d(0), \dots, d(M_{\text{symb}} - 1)$ is divided into $M_{\text{symb}} / M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to $z(l \cdot M_{\text{sc}}^{\text{PUSCH}} + k) = \frac{1}{\sqrt{M_{\text{sc}}^{\text{PUSCH}}}} \sum_{i=0}^{M_{\text{sc}}^{\text{PUSCH}} - 1} d(l \cdot M_{\text{sc}}^{\text{PUSCH}} + i) e^{-j \frac{2\pi i k}{M_{\text{sc}}^{\text{PUSCH}}}}$ $k = 0, \dots, M_{\text{sc}}^{\text{PUSCH}} - 1$ $l = 0, \dots, M_{\text{symb}} / M_{\text{sc}}^{\text{PUSCH}} - 1$ resulting in a block of complex-valued symbols $z(0), \dots, z(M_{\text{symb}} - 1)$. The variable $M_{\text{sc}}^{\text{PUSCH}} = M_{\text{RB}}^{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil $M_{\text{RB}}^{\text{PUSCH}} = 2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \leq N_{\text{RB}}^{\text{UL}}$ where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers. Source: https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf (GC0004232)

Claim 10	Analysis	Select Evidence
applying the encoded data symbols to the plurality of subcarriers to produce a spread-Orthogonal Frequency Division Multiplexing (OFDM) signal; and transmitting the spread-OFDM signal;	The SC-FMDA symbols (encoded data symbols) are then mapped to subcarriers (physical resources), and modulated onto those subcarriers during SC-FDMA baseband generation. SC-FDMA employs a DFT to spread OFDM data into a form that resembles a single carrier. As shown to the right, the encoded symbols are mapped and modulated onto OFDM symbols for transmission using the Samsung device.	5.6 SC-FDMA baseband signal generation This section applies to all uplink physical signals and physical channels except the physical random access channel. The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by $s_l(t) = \sum_{k=-\lfloor N_{RB}^{UL} N_{sc}^{RB} / 2 \rfloor}^{\lfloor N_{RB}^{UL} N_{sc}^{RB} / 2 \rfloor - 1} a_{k^{(-)l}} \cdot e^{j2\pi(k+1/2)\Delta f(t - N_{CP,l}T_s)}$ for $0 \leq t < (N_{CP,l} + N) \times T_s$ where $k^{(-)} = k + \lfloor N_{RB}^{UL} N_{sc}^{RB} / 2 \rfloor$, $N = 2048$, $\Delta f = 15$ kHz and $a_{k,l}$ is the content of resource element (k, l). The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l = 0$, where SC-FDMA symbol $l > 0$ starts at time $\sum_{l'=0}^{l-1} (N_{CP,l'} + N)T_s$ within the slot. Table 5.6-1 lists the values of $N_{CP,l}$ that shall be used. Note that different SC-FDMA symbols within a slot may have different cyclic prefix lengths. Source: https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf (GC0004250) In SC-FDMA, the user data is modulated onto a single carrier modulation format (QPSK, 16QAM, or 64QAM), and the time domain symbols are transformed to the frequency domain by an FFT. Then the frequency domain points are mapped onto the subcarriers assigned to the user in the OFDM symbol. Finally, an IFFT is performed on the entire OFDM symbol and resulting time data is transmitted. The following image illustrates this process. Source: https://rfmw.em.keysight.com/wireless/helpfiles/89600b/webhelp/subsystems/lte/content/lte_overview.htm (GC0004793)

Claim 10	Analysis	Select Evidence
wherein the first set of complex-valued codes are complex conjugates of the second set of complex-valued codes.	As discussed above, transform precoding uses complex-valued codes (e.g., e function) to generate signals that are ultimately transmitted from the user device to base station. As explained above, and as shown to the right, the base station uses the inverse of the DFT (the inverse of the complex-valued code) used during the transform precoding step to decode the signal. Because the DFT is a unitary matrix (with its complex conjugate being its inverse), the inverse DFT generates complex conjugates.	5.3.3 Transform precoding The block of complex-valued symbols $d(0), \dots, d(M_{\text{symb}} - 1)$ is divided into $M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to $z(l \cdot M_{\text{sc}}^{\text{PUSCH}} + k) = \frac{1}{\sqrt{M_{\text{sc}}^{\text{PUSCH}}}} \sum_{i=0}^{M_{\text{sc}}^{\text{PUSCH}} - 1} d(i \cdot M_{\text{sc}}^{\text{PUSCH}} + l) e^{-j \frac{2\pi i k}{M_{\text{sc}}^{\text{PUSCH}}}}$ $k = 0, \dots, M_{\text{sc}}^{\text{PUSCH}} - 1$ $l = 0, \dots, M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}} - 1$ resulting in a block of complex-valued symbols $z(0), \dots, z(M_{\text{symb}} - 1)$. The variable $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and sh $M_{\text{RB}}^{\text{PUSCH}} = 2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \leq N_{\text{RB}}^{\text{UL}}$ where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers. Source: https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf (GC0004232) Inverse of e function is a complex-conjugate of the DFT used to decode transmitted signals in the base station  Source: https://www.nxp.com/docs/en/white-paper/3GPPEVOLUTIONWP.pdf (GC0004204)

Claim 11	Analysis	Select Evidence
The apparatus of claim 10, wherein selecting is responsive to spectrum allocation or is configured to provide for orthogonal frequency division multiple access.	As discussed above and as shown to the right, the Samsung device is assigned subcarriers (spectrum allocation) which are then selected for use.	5.3.4 Mapping to physical resources The block of complex-valued symbols $z(0), \dots, z(M_{\text{symb}} - 1)$ shall be multiplied with the amplitude scaling factor β_{PUSCH} in order to conform to the transmit power P_{PUSCH} specified in Section 5.1.1.1 in [4], and mapped in sequence starting with $z(0)$ to <u>physical resource blocks assigned for transmission of PUSCH. The mapping to resource elements (k, l) corresponding to the physical resource blocks assigned for transmission and not used for transmission of reference signals and not reserved for possible SRS transmission shall be in increasing order of first the index k, then the index l, starting with the first slot in the subframe.</u> Source: https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf (GC0004232) PUSCH The Primary Uplink Shared Channel (PUSCH) is used by uplink users to transmit data to the base station. <u>All subcarriers not allocated for PRACH, PUCCH, or SRS are available for assignment to users.</u> PUSCH data is modulated using SC-FDMA. * * * * In SC-FDMA, the user data is modulated onto a single carrier modulation format (QPSK, 16QAM, or 64QAM), and the time domain symbols are transformed to the frequency domain by an FFT. Then the <u>frequency domain points are mapped onto the subcarriers assigned to the user in the OFDM symbol.</u> Finally, an IFFT is performed on the entire OFDM symbol and resulting time data is transmitted. The following image illustrates this process. Source: https://rfmw.em.keysight.com/wireless/helpfiles/89600b/webhelp/subsystems/lte/content/lte_overview.htm (GC0004795; GC0004793) 3.2.2 Multiplexing <u>Uplink PRBs are assigned to UE by the base station scheduler via the downlink CCPCH. Uplink PRBs consist of a group of 12 contiguous subcarriers for a duration of one slot time.</u> Source: https://www.nxp.com/docs/en/white-paper/3GPPEVOLUTIONWP.pdf (GC0004211)

Claim 15	Analysis	Select Evidence
The apparatus of claim 10, wherein the plurality of subcarriers are contiguous subcarriers or interleaved subcarriers.	As shown to the right, spread OFDM signals are comprised of subcarriers that can be mapped in either localized or distributed mode. In localized mode, the subcarriers are contiguous, while in distributed mode, the subcarriers are interleaved.	Unlike OFDM, the underlying SC-FDMA signal represented by the discrete subcarriers is—not surprisingly—single carrier. This is distinctly different than OFDM because the SC-FDMA subcarriers are not independently modulated. As a result, PAPR is lower than for OFDM transmissions. Analysis has shown that the LTE UE RFPA can be operated about 2 dB closer to the 1-dB compression point than would otherwise be possible if OFDM were employed on the uplink [2]. 2.5-2 SC-FDMA Subcarriers Can be Mapped in Either Localized or Distributed Mode  As mentioned above, SC-FDMA subcarriers can be mapped in one of two ways: localized or distributed as shown in Figure 2.5-2. However, the current working assumption is that LTE will use localized subcarrier mapping. This decision was motivated by the fact that with localized mapping, it is possible to exploit frequency selective gain via channel-dependent scheduling (assigning uplink frequencies to UE based on favorable propagation conditions). Source: https://www.nxp.com/docs/en/white-paper/3GPPEVOLUTIONWP.pdf (GC0004205)

Claim 16	Analysis	Select Evidence
The apparatus of claim 10, wherein encoding comprises multiplying a vector or matrix of data symbols with a vector or matrix comprising the first set of complex-valued codes.	The transform precoding step, as a non-limiting example, involves the use of a discrete Fourier transform. The DFT itself represent a vector multiplication. The DFT can also be represented as a complex matrix multiplication where data symbols (e.g., the e variable) are multiplied by the matrix of complex-valued codes (e.g., d...) variable values).	5.3.3 Transform precoding The block of complex-valued symbols $d(0), \dots, d(M_{\text{symb}} - 1)$ is divided into $M_{\text{symb}} / M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to $z(l \cdot M_{\text{sc}}^{\text{PUSCH}} + k) = \frac{1}{\sqrt{M_{\text{sc}}^{\text{PUSCH}}}} \sum_{i=0}^{M_{\text{sc}}^{\text{PUSCH}} - 1} d(l \cdot M_{\text{sc}}^{\text{PUSCH}} + i) e^{-j \frac{2\pi k i}{M_{\text{sc}}^{\text{PUSCH}}}}$ $k = 0, \dots, M_{\text{sc}}^{\text{PUSCH}} - 1$ $l = 0, \dots, M_{\text{symb}} / M_{\text{sc}}^{\text{PUSCH}} - 1$ resulting in a block of complex-valued symbols $z(0), \dots, z(M_{\text{symb}} - 1)$. The variable $M_{\text{sc}}^{\text{PUSCH}} = M_{\text{RB}}^{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil $M_{\text{RB}}^{\text{PUSCH}} = 2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \leq N_{\text{RB}}^{\text{UL}}$ where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers. Source: https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf (GC0004232)

Claim 17	Analysis	Select Evidence
The apparatus of claim 10, wherein applying comprises modulating the encoded data symbols onto the plurality of subcarriers.	As shown to the right, Samsung devices modulate complex-valued data onto subcarriers (physical resources) during the SC-FDMA baseband signal generation process,	5.6 SC-FDMA baseband signal generation This section applies to all uplink physical signals and physical channels except the physical random access channel. The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by $s_l(t) = \sum_{k=-\lfloor N_{RB}^{UL} N_{sc}^{RB} / 2 \rfloor}^{\lceil N_{RB}^{UL} N_{sc}^{RB} / 2 \rceil - 1} a_{k^{(-)}, l} \cdot e^{j2\pi(k+1/2)\Delta f(t - N_{CP, l} T_s)}$ for $0 \leq t < (N_{CP, l} + N) \times T_s$ where $k^{(-)} = k + \lfloor N_{RB}^{UL} N_{sc}^{RB} / 2 \rfloor$, $N = 2048$, $\Delta f = 15$ kHz and $a_{k, l}$ is the content of resource element (k, l). The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l = 0$, where SC-FDMA symbol $l > 0$ starts at time $\sum_{l'=0}^{l-1} (N_{CP, l'} + N) T_s$ within the slot. Table 5.6-1 lists the values of $N_{CP, l}$ that shall be used. Note that different SC-FDMA symbols within a slot may have different cyclic prefix lengths. Source: https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf (GC0004250)

Claim 18	Analysis	Select Evidence									
The apparatus of claim 10, wherein the non-transitory computer-readable memory further includes instructions stored thereon and executable by the processor for adding a cyclic prefix to the spread-OFDM signal before transmitting the spread-OFDM signal.	As shown to the right, the memory in Samsung devices includes instructions for adding a cyclic prefix to spread-OFDM signals prior to transmission.	5.2.3 Resource blocks A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain. * * * * Table 5.2.3-1: Resource block parameters. <table> <tr> <th>Configuration</th><th>$N_{\text{sc}}^{\text{RB}}$</th><th>$N_{\text{symb}}^{\text{UL}}$</th></tr> <tr> <td>Normal cyclic prefix</td><td>12</td><td>7</td></tr> <tr> <td>Extended cyclic prefix</td><td>12</td><td>6</td></tr> </table> The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k, l) in a slot is given by $n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$ Source: https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf (GC0004230-31)	Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$	Normal cyclic prefix	12	7	Extended cyclic prefix	12	6
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$									
Normal cyclic prefix	12	7									
Extended cyclic prefix	12	6									