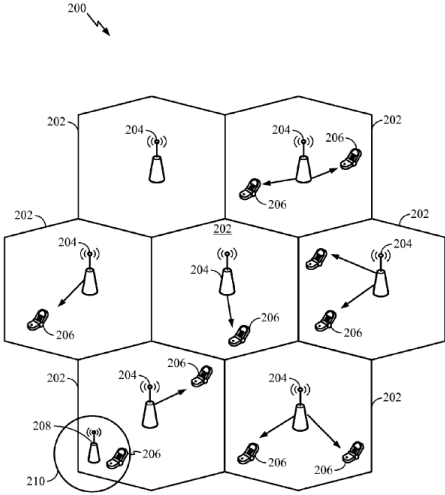


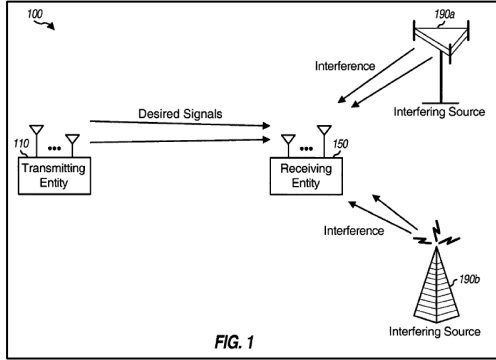
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	Claim 1	Accused Products
1.pre	1. A modem which enables efficient use of bandwidth in a multiuser wireless network including a plurality of modems in the presence of interference and noise, the modem comprising:	To the extent that the preamble is found to be limiting, the Accused '946 Instrumentalities include a modem which enables efficient use of bandwidth in a multiuser wireless network including a plurality of modems in the presence of interference and noise. An Accused '946 Instrumentality is a UE that operates in a multi-user wireless network with a plurality of other UEs. The wireless network includes the presence of interference and noise from various sources within the network, such as other UEs and adjacent base stations, as well as from sources external to the network. A SU-MIMO capable modem enables efficient use of bandwidth in the network by enabling increased data rates and/or number of users. <u>Qualcomm '341 Patent:</u> - Figure 2:  FIG. 2 <u>MIMO in LTE:</u> <u>Downlink MIMO Technology</u> Single-User MIMO (SU-MIMO) was used for the downlink for LTE Rel. 8 to increase the

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		peak data rate. The target data rates of over 100 Mbit/s were achieved by using a 20 MHz transmission bandwidth, 2×2 MIMO, and 64 Quadrature Amplitude Modulation (64QAM), and peak data rates of over 300 Mbit/s can be achieved using 4×4 SU-MIMO. The multi-antenna technology used for the downlink in LTE Rel. 8 is classified into the following three types. <u>Qualcomm LTE Advanced:</u> • Page 2: ◦ Developed by 3GPP, LTE is the leading OFDMA wireless mobile broadband technology. LTE offers high spectral efficiency, low latency and high peak data rates. LTE leverages the economies of scale of 3G, as well as the global ecosystem of infrastructure and device vendors, to provide the highest performance in a cost effective manner. ◦ The LTE standard was first published in March of 2009 as part of the 3GPP Release 8 specifications. Comparing the performance of 3G and its evolution to LTE, LTE does not offer anything unique to improve spectral efficiency, i.e. bps/Hz. However, LTE significantly improves system performance by using wider bandwidths where spectrum is available. ◦ To achieve performance improvements in LTE Advanced, the 3GPP has been working on various aspects of LTE including higher order MIMO (multiple antennas), carrier aggregation (multiple component carriers), and heterogeneous networks (picos, femtos and relays). Since improvements in spectral efficiency per link are approaching theoretical limits with 3G and LTE, as shown in Figure 1, the next generation of technology is about improving spectral efficiency per unit area.
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		<u>Qualcomm '042 Patent:</u> - Figure 1:  FIG. 1 3:22-30 (“FIG. 1 shows a MIMO system 100 with a transmitting entity 110, a receiving entity 150, and two interfering sources 190 a and 190 b. Transmitting entity 110 transmits data to receiving entity 150 via line-of-sight paths (as shown in FIG. 1) and/or reflected paths (not shown in FIG. 1). Interfering sources 190 a and 190 b transmit signals that act as interference at receiving entity 150. The interference observed by receiving entity 150 from interfering sources 190 a and 190 b may be spatially colored.”)
1.a	a multiuser detection (MUD) module configured to simultaneously demodulate and recover K wirelessly transmitted signals using co-channel demodulation;	The Accused '946 Instrumentalities include a multiuser detection (MUD) module configured to simultaneously demodulate and recover K wirelessly transmitted signals using co-channel demodulation. Multiple data streams (“K wirelessly transmitted signals”) are transmitted by the base station (eNB) to User Equipment (UE; i.e., the Accused '946 Instrumentalities) in a SU-MIMO transmission mode. Each data stream corresponds to a separate layer in the SU-MIMO transmission scheme. The multi-user detection module in the Accused '946 Instrumentalities demodulates and recovers the signal corresponding to each MIMO transmission layer (i.e., the number of independent streams of data, or rank). <u>MIMO in LTE:</u> Figure 1.

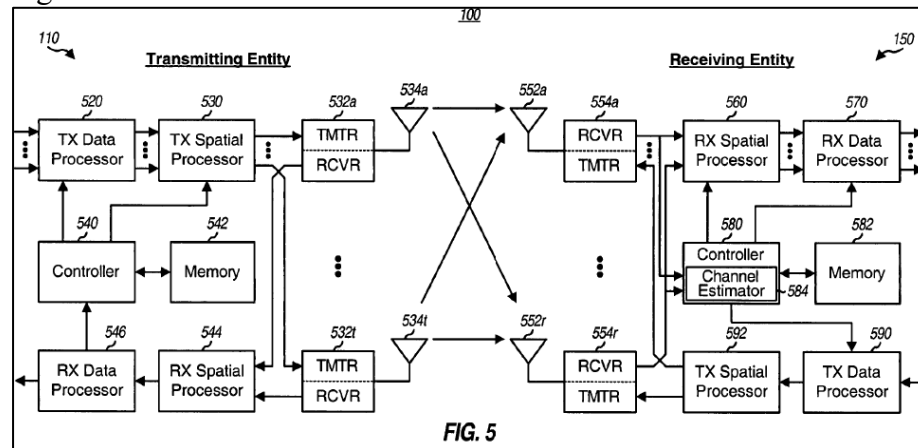
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		• <u>Downlink MIMO Technology</u> Single-User MIMO (SU-MIMO) was used for the downlink for LTE Rel. 8 to increase the peak data rate. The target data rates of over 100 Mbit/s were achieved by using a 20 MHz transmission bandwidth, 2×2 MIMO, and 64 Quadrature Amplitude Modulation (64QAM), and peak data rates of over 300 Mbit/s can be achieved using 4×4 SU-MIMO. The multi-antenna technology used for the downlink in LTE Rel. 8 is classified into the following three types. • LTE Rel. 8 adopts frequency-selective precoding, in which precoding weights are selected independently for each sub-band of bandwidth from 360 kHz to 1.44 MHz, as well as wideband precoding, with single precoding weights that are applied to the whole transmission band. The channel estimation used for demodulation and selection of the precoding weight matrix on the UE is done using a cell specific Reference Signal (RS) transmitted from each antenna. Accordingly, the specifications require the eNode B to notify the UE of the precoding weight information used for PDSCH transmission through the Physical Downlink Control Channel (PDCCH), and the UE to use this information for demodulation. <u>Qualcomm '042 Patent:</u> • 2:66-3:12 (“A receiving entity obtains N_R received symbol streams via N_R receive antennas and performs receiver spatial processing for full-CSI or partial-CSI transmission to obtain N_S detected symbol streams, which are estimates of the N_S spread symbol streams. The receiving entity further spatially despreads the N_S detected symbol streams with the same steering matrices used by the transmitting entity and obtains N_S recovered symbol streams, which are estimates of the N_S data symbol streams. The receiver spatial processing and spatial despreading may be performed jointly or separately. The receiving entity then processes (e.g., demodulates, deinterleaves, and decodes) each block of recovered symbols in the N_S recovered symbol streams to obtain a corresponding decoded data packet.”) • 10:20-43 (“FIG. 4 shows a process 400 performed by the receiving entity to receive data transmitted with spatial spreading in the MIMO system. The receiving entity obtains N_R received symbol streams (denoted by vector r) via the N_R receive antennas (block 412). The receiving entity estimates the response of the MIMO channel (block 414), performs spatial processing for full-CSI or partial-CSI transmission based on the MIMO channel estimate, and obtains N_S detected symbol streams (denoted by a vector $\hat{w}$ in FIG. 2)
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(block 416). The receiving entity further spatially despreads the N_S detected symbol streams with the same steering matrices used by the transmitting entity and obtains N_S recovered symbol streams (denoted by vector $\hat{s}$) (block 418). The receiver spatial processing and spatial despreading may be performed jointly or separately, as described above. The receiving entity then processes (e.g., demodulates deinterleaves, and decodes) each block of recovered symbols in the N_S recovered symbol streams to obtain a corresponding decoded data packet (block 420). The receiving entity may also estimate the SNR of each transmission channel used for data transmission and select a suitable rate for the transmission channel based on its SNR (block 422). The same or different rates may be selected for the N_S transmission channels.”)

- Figure 5:

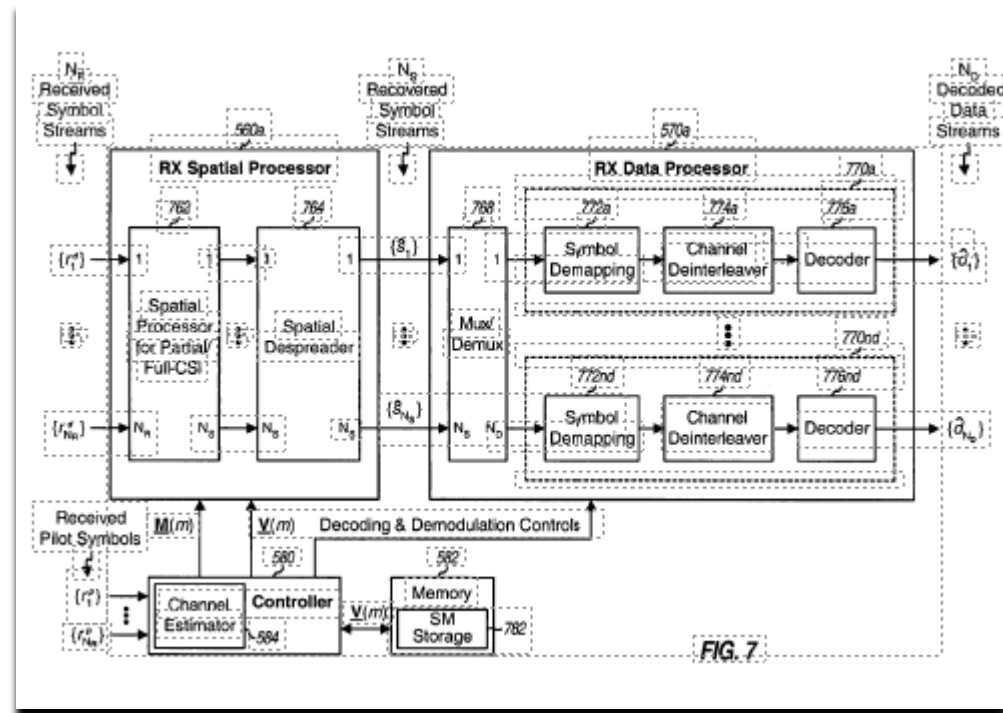


- 14:47-62** (“At receiving entity 150, N_R antennas 552 *a* through 552 *r* receive the N_T transmitted signals, and each antenna 552 provides a received signal to a respective receiver unit (RCVR) 554. Each receiver unit 554 performs processing complementary to that performed by transmitter unit 532 (including OFDM demodulation, if applicable) and provides (1) received data symbols to an RX spatial processor 560 and (2) received pilot symbols to a channel estimator 584 within a controller 580. RX spatial processor 560 performs receiver spatial processing and spatial despreading on N_R received symbol streams from N_R receiver units 554 with spatial filter matrices and steering matrices, respectively, from controller 580 and provides N_S recovered symbol streams. An RX data

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processor 570 then processes (e.g., demaps, deinterleaves, and decodes) the recovered symbols and provides decoded data.”)

- Figure 7:

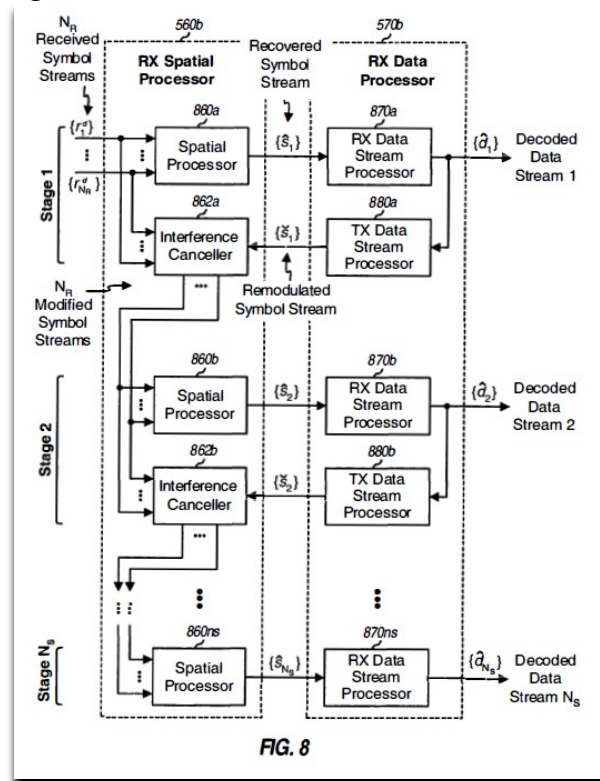


- 16:63-17:9** (“FIG. 7 shows receiver spatial spreading and spatial despreading being performed separately. RX spatial processor 560 obtains received data symbols, $\{r_i^d\}$ for $i=1 \dots N_R$, from receiver units 554 a through 554 r and the matrices $M(m)$ and $V(m)$ from controller 580. Within RX spatial processor 560, a spatial processor 762 performs receiver spatial processing on the received data symbols for each transmission span with the matrices $M(m)$. A spatial despreader 764 then performs spatial despreading with the matrix $V(m)$ and provides recovered symbols to RX data processor 570. The receiver spatial

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processing and spatial despreading may also be performed jointly using the effective MIMO channel estimate, as described above.”)

- Figure 8:



- 17:46-63 (“For stage 1, spatial processor 860 a performs receiver spatial processing on the N_R received symbol streams and provides one recovered symbol stream $\{\hat{s}_1\}$. RX data stream processor 870 a demodulates, deinterleaves, and decodes the recovered symbol stream $\{\hat{s}_1\}$ and provides a corresponding decoded data stream $\{\hat{d}_1\}$. TX data stream processor 880 a encodes, interleaves, and modulates the decoded data stream $\{\hat{d}_1\}$ in the same manner performed by transmitting entity 110 for that stream and provides a remodulated symbol stream $\{\check{s}_1\}$. Interference

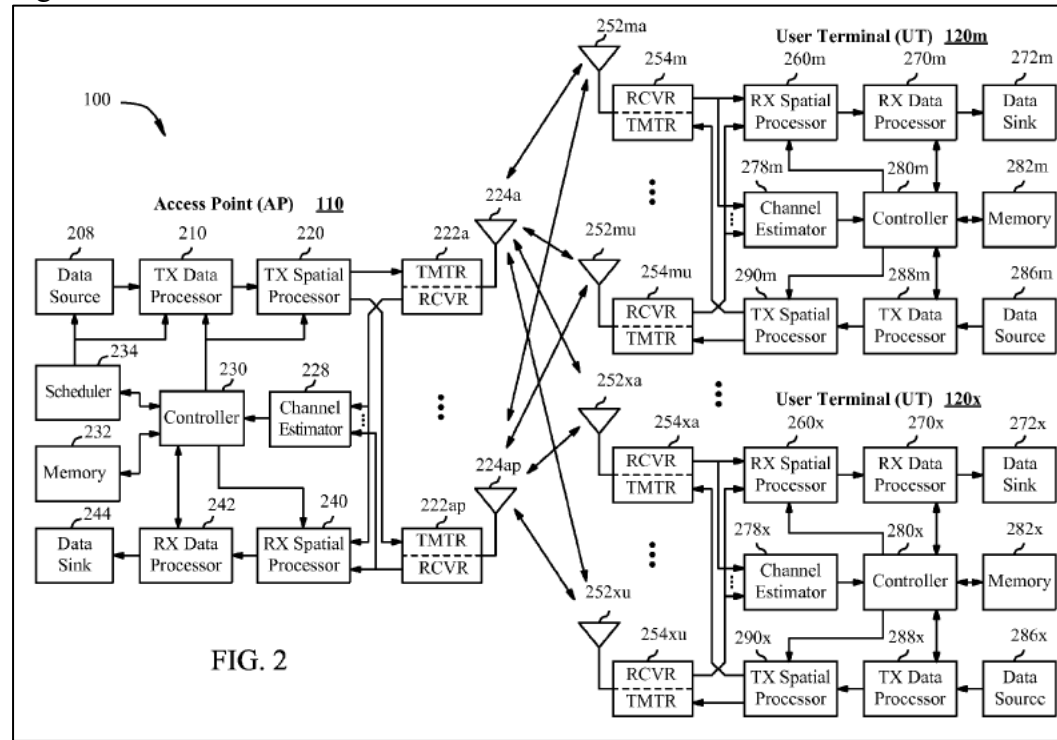
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		canceller 862 <i>a</i> spatially spreads the remodulated symbol stream $\{\{\text{hacek over (s)}\}_1\}$ with the steering matrix $V(m)$ and further multiplies the results with the channel response matrix $\hat{H}(m)$ to obtain N_R interference components due to data symbol stream $\{s_1\}$. The N_R interference components are subtracted from the N_R received symbol streams to obtain N_R modified symbol streams, which are provided to stage 2.”) <u>Qualcomm ’915 Patent:</u> • 8:57-9:4 (“At the UE 120, the antennas 452 a through 452 r may receive the downlink signals from the base station 110 and may provide received signals to the demodulators (DEMOSDs) 454 a through 454 r, respectively. Each demodulator 454 may condition (e.g., filter, amplify, downconvert, and digitize) a respective received signal to obtain input samples. Each demodulator 454 may further process the input samples (e.g., for OFDM, etc.) to obtain received symbols. A MIMO detector 456 may obtain received symbols from all the demodulators 454 a through 454 r, perform MIMO detection on the received symbols if applicable, and provide detected symbols. A receive processor 458 may process (e.g., demodulate, deinterleave, and decode) the detected symbols, provide decoded data for the UE 120 to a data sink 460, and provide decoded control information to a controller/processor 480.”)
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Qualcomm '994 Patent:

- Figure 2:



- 6:31-43** (“At each user terminal 120, $N_{ut,m}$ antennas 252 receive the N_{ap} downlink signals from access point 110. Each receiver unit (RCVR) 254 processes a received signal from an associated antenna 252 and provides a received symbol stream. An RX spatial processor 260 performs receiver spatial processing on $N_{ut,m}$ received symbol streams from $N_{ut,m}$ receiver units 254 and provides a recovered downlink data symbol stream $\{s_{dn,m}\}$ for the user terminal. The receiver spatial processing is performed in accordance with the CCMI, MMSE, or some other technique. An RX data processor 270 processes (e.g., demodulates, deinterleaves, and decodes) the recovered downlink data symbol stream to obtain decoded data for the user terminal.”)

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		• 7:49-65 (“FIG. 4 illustrates a MIMO receiver utilizing successive interference cancellation. A composite received signal vector $y(m)$ 402 enters a SIC system 400 of the MIMO receiver for decoding. The composite received signal $y(m)$ consists of a plurality of separately encoded blocks of data or ‘streams.’ The received signal $y(m)$ passes through a receiver 404 for estimation and detection of the symbols of a first stream of data. The receiver may employ minimum mean square error (MMSE) or any general linear or non-linear estimator/detector. The detected symbols of the first stream enter a first channel decoder 406 for decoding. In 408, the decoded stream is subtracted from the received composite signal $y(m)$, which passes through a second receiver 410 and a second decoder 412 to detect and decode the second stream, respectively. After decoding, both of the first and second streams of data are subtracted, at 414, from the received composite signal $y(m)$ to decode the third stream. The process may continue with subtraction, at 420, utilizing receiver 422 and decoder 424 until all the N streams are decoded. The decoders 406, 412 and 418 may decode any kind of error correcting code, such as turbo or convolutional codes. The decoders 406, 412 and 418 may decode a plurality of encoded streams with a plurality of types and code rates. The subtraction operation may not be performed if the decoding operation fails at any step. Each successful decode and subtract operation of the SIC system is referred to herein as one ‘iteration.’”)
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• Figure 6:

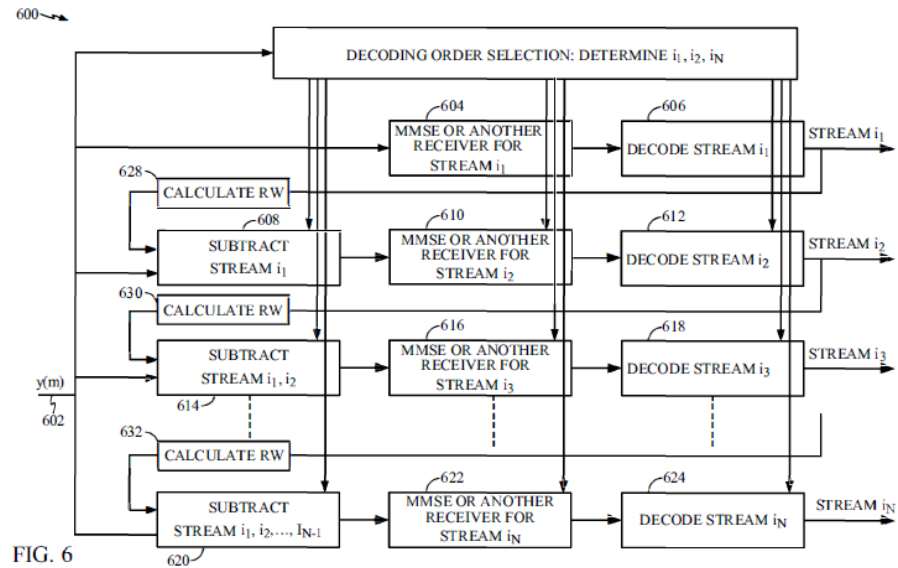


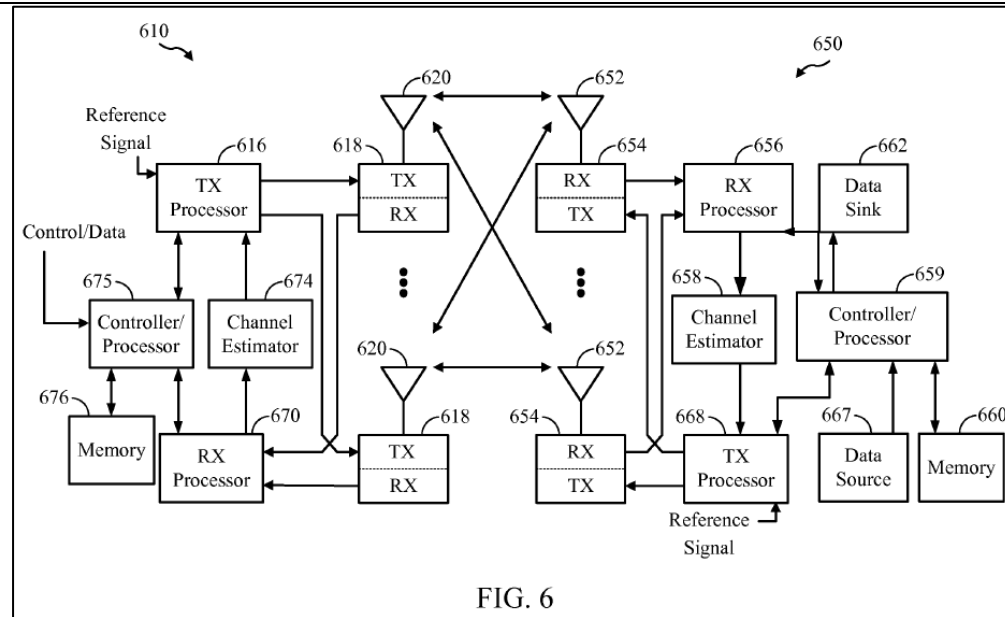
FIG. 6

- **9:25-33** (“As illustrated in FIG. 6, a composite received signal $y(m)$ 602 enters a SIC system 600 with decoding order selection and reconstruction weight calculation. The composite received signal $y(m)$ consists of a plurality of separately encoded streams of data. The decoding order selector 626 determines a decoding order for the N streams of data based on the received SNR of each and the required SNR at the input of each decoder. Based on the selected order, the streams are decoded and subtracted from the received signal.”)
- **9:34-43** (“The received signal $y(m)$ passes through a receiver 604 for estimation and detection of the received symbols of a first stream of data. The receiver 604 may comprise a minimum mean square error (MMSE) or any general linear or non-linear estimator/detector. The detected symbols of the first stream enter the channel decoder 606 for decoding. The decoded stream is re-encoded and re-modulated to reconstruct the first stream. The scale of this reconstructed stream may differ from the scale of the first transmitted stream or the scale of first stream in the received composite signal.”)

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		• 9:56-10:2 (“After decoding, effects of both of the first and second streams of data are subtracted at 614 from the received signal to cancel the interference and condition the received signal to enter the third decoding block 618 for decoding the third stream. The process continues with subtraction 620, receiver operation 622 and decoding 624 until all the streams are decoded. The decoders 606, 612 and 618 may use any kind of error correcting code such as turbo codes. The decoders 606, 612 and 618 may decode a plurality of encoded streams with a plurality of types and code rates. The subtraction operation may not be performed if the decoding operation fails at any step. The decoding order selector may update the decoding order of the remaining streams after each successful decode and subtract operation (i.e., each SIC iteration).”) • 10:3-11 (“As illustrated, components with similar functionality may be repeated for different iterations and configured to operate on different numbers of streams. For example, components 614 and 620 operate to subtract multiple streams, while 608 subtracts a single stream. Blocks 610, 616, and 622 may perform similar MMSE operations as block 604, but on different streams. Similarly, Blocks 612, 618, and 624 may perform similar decoding operations as block 606, but on different streams.”) <u>Qualcomm '341 Patent:</u> • Figure 6:
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- 9:24-46** (“At the UE 650, each receiver 654RX receives a signal through its respective antenna 652. Each receiver 654RX recovers information modulated onto an RF carrier and provides the information to the receiver (RX) processor 656. The RX processor 656 implements various signal processing functions of the L1 layer. The RX processor 656 performs spatial processing on the information to recover any spatial streams destined for the UE 650. If multiple spatial streams are destined for the UE 650, they may be combined by the RX processor 656 into a single OFDM symbol stream. The RX processor 656 then converts the OFDM symbol stream from the time-domain to the frequency domain using a Fast Fourier Transform (FFT). The frequency domain signal comprises a separate OFDM symbol stream for each subcarrier of the OFDM signal. The symbols on each subcarrier, and the reference signal, is recovered and demodulated by determining the most likely signal constellation points transmitted by the eNB 610. These soft decisions may be based on channel estimates computed by the channel estimator 658. The soft decisions are then decoded and deinterleaved to recover the data and control signals that were originally transmitted by the

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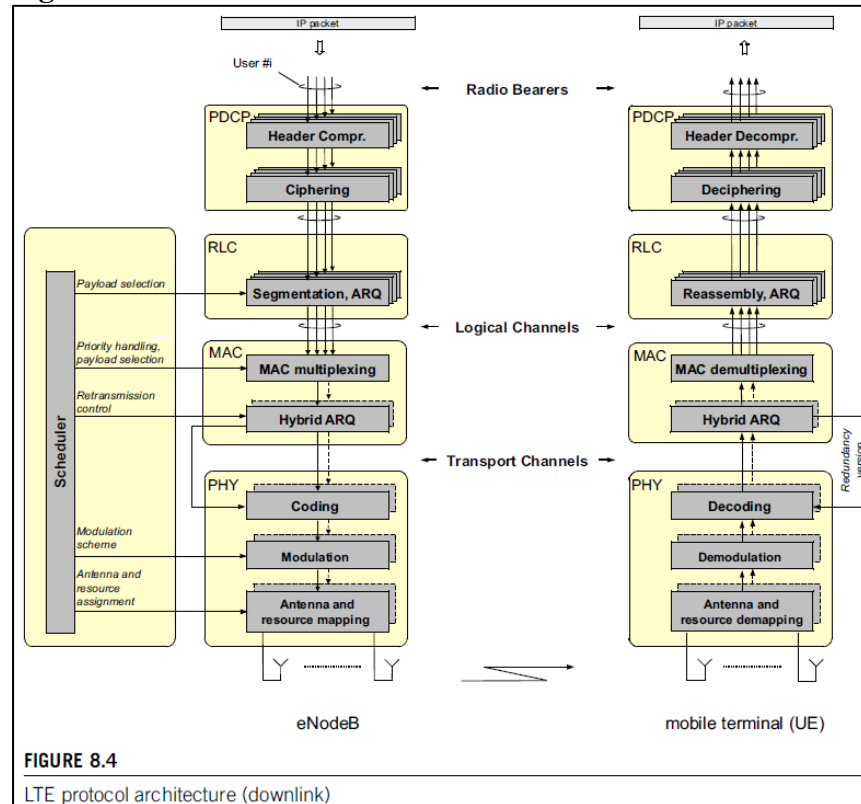
		eNB 610 on the physical channel. The data and control signals are then provided to the controller/processor 659.”) • 10:39-53 (“MIMO transmissions may consist of two or more streams/layers of data carrying independent information which is spatially multiplexed and sent over the air. In certain aspects, Minimum Mean-Square Error (MMSE) based SIC receiver is commonly used for MIMO decoding. The SIC receiver generally aims at exploiting the varying Signal to Noise Ratios (SNRs) and/or rates (e.g., data rates) on the MIMO streams by attempting to decode a first stream with higher chance of successful decode, followed by cancellation of that stream from the input signal and then attempting to decode the remaining stream(s). For example, for a 2×2 MIMO system consisting of first and second streams, the SIC receiver may decode a first stream and iteratively cancel out the first stream from the input signal to improve decoding of the second stream.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
1.b	a data formatting module operatively coupled to the multiuser detection module, and configured to produce network data packets for at least one of the K recovered signals;	The Accused '946 Instrumentalities include a data formatting module operatively coupled to the multiuser detection module, and configured to produce network data packets for at least one of the K recovered signals. Data sent from a base station to an Accused '946 Instrumentality that is ultimately destined for a device tethered to the UE via WiFi will be in a packet format and conform to network protocols, such as TCP/IP. After one of the MIMO layers has been recovered by the MUD module, the signal will work its way up the LTE protocol stack. At the Packet Data Convergence Protocol (PDCP) layer in the stack, IP packets will be produced from the signal. <u>Dahlman</u> • 106 (“At the core of the LTE transmission scheme is the use of shared-channel transmission with the overall time–frequency resource dynamically shared between users. The use of shared-channel transmission is well matched to the rapidly varying resource requirements

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		posed by packet-data communication and also enables several of the other key technologies on which LTE is based.”) • 121 (“The EPC is a radical evolution from the GSM/GPRS core network used for GSM and WCDMA/HSPA. EPC supports access to the packet-switched domain only, with no access to the circuit-switched domain. It consists of several different types of nodes, some of which are briefly described below and illustrated in Figure 8.1.”) • 122 (“The Packet Data Network Gateway (PDN Gateway, P-GW) connects the EPC to the internet. Allocation of the IP address for a specific terminal is handled by the P-GW, as well as quality-of-service enforcement according to the policy controlled by the PCRF (see below). The P-GW is also the mobility anchor for non-3GPP radio-access technologies, such as CDMA2000, connected to the EPC.”) • 124 (“The LTE radio-access network provides one or more Radio Bearers to which IP packets are mapped according to their Quality-of-Service requirements. A general overview of the LTE (user-plane) protocol architecture for the downlink is illustrated in Figure 8.4. As will become clear in the subsequent discussion, not all the entities illustrated in Figure 8.4 are applicable in all situations. For example, neither MAC scheduling nor hybrid ARQ with soft combining is used for broadcast of the basic system information. The LTE protocol structure related to uplink transmissions is similar to the downlink structure in Figure 8.4, although there are some differences with respect to, for example, transport-format selection.”)
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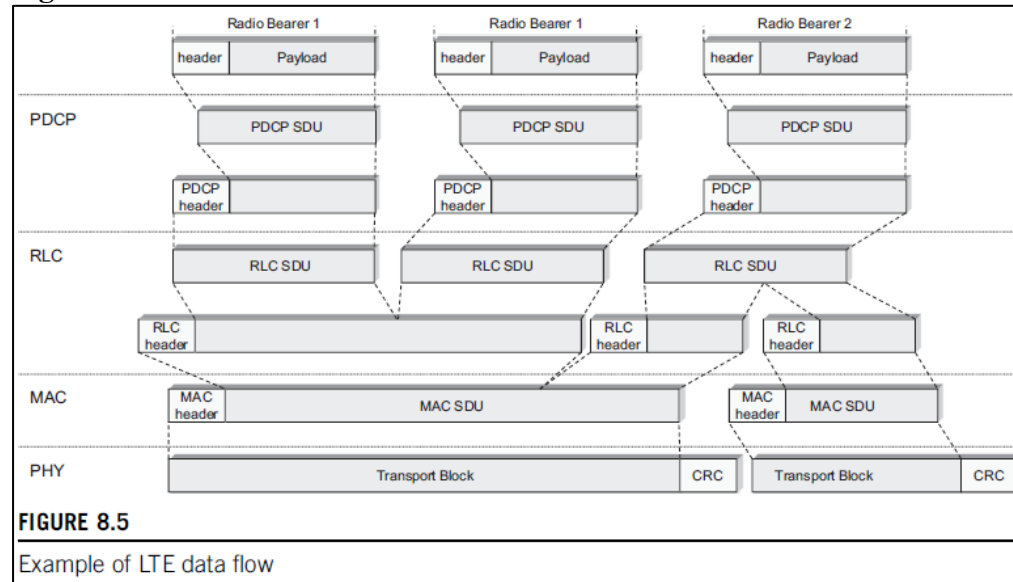
• **Figure 8.4:**



- **124-125** (“Packet Data Convergence Protocol (PDCP) performs IP header compression to reduce the number of bits to transmit over the radio interface. The header-compression mechanism is based on Robust Header Compression (ROHC) [68], a standardized header-compression algorithm also used for several other mobile-communication technologies. PDCP is also responsible for ciphering and, for the control plane, integrity protection of the transmitted data, as well as in-sequence delivery and duplicate removal for handover. At the receiver side, the PDCP protocol performs the corresponding deciphering and decompression operations. There is one PDCP entity per radio bearer configured for a terminal.”)

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- **Figure 8.5:**



- **126** (“To summarize the flow of downlink data through all the protocol layers, an example illustration for a case with three IP packets, two on one radio bearer and one on another radio bearer, is given in Figure 8.5. The data flow in the case of uplink transmission is similar. The PDCP performs (optional) IP-header compression, followed by ciphering. A PDCP header is added, carrying information required for deciphering in the terminal. The output from the PDCP is forwarded to the RLC.
- **126-27** (“The RLC protocol performs concatenation and/or segmentation of the PDCP SDUs³ and adds an RLC header. The header is used for in-sequence delivery (per logical channel) in the terminal and for identification of RLC PDUs in the case of retransmissions. The RLC PDUs are forwarded to the MAC layer, which multiplexes a number of RLC PDUs and attaches a MAC header to form a transport block. The transport-block size depends on the instantaneous data rate selected by the link-adaptation mechanism. Thus, the link adaptation affects both the MAC and RLC processing. Finally, the physical layer attaches a CRC to the transport block for error-detection purposes, performs coding and modulation, and transmits the resulting signal, possibly using multiple transmit antennas.”)

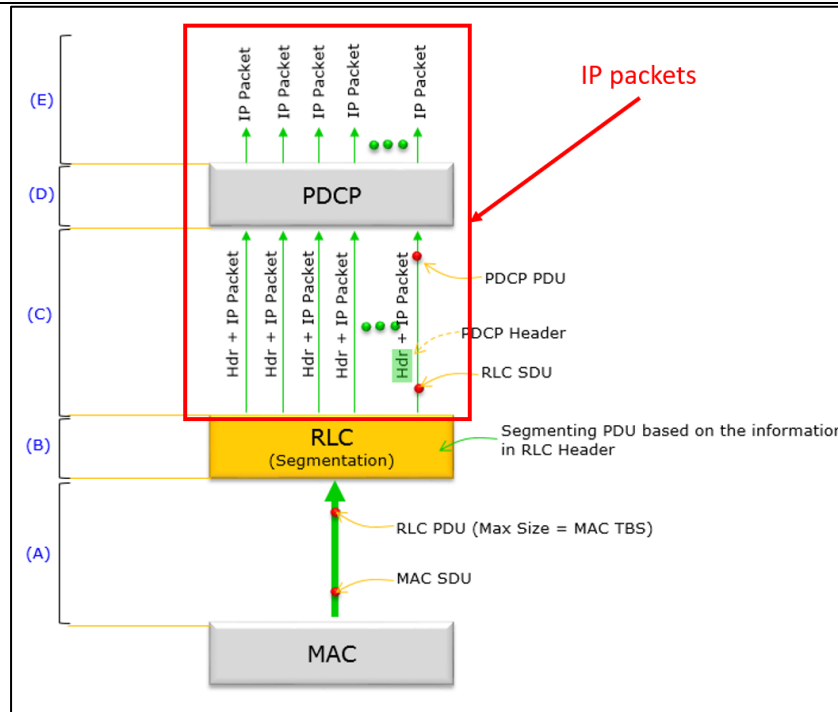
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		• 127 (“The RLC protocol is responsible for segmentation/concatenation of (header-compressed) IP packets, also known as RLC SDUs, from the PDCP into suitably sized RLC PDUs. It also handles retransmission of erroneously received PDUs, as well as removal of duplicated PDUs. Finally, the RLC ensures in-sequence delivery of SDUs to upper layers. Depending on the type of service, the RLC can be configured in different modes to perform some or all of these functions.”) • 299 (“Retransmissions of missing or erroneous data units are handled primarily by the hybrid-ARQ mechanism in the MAC layer, complemented by the retransmission functionality of the RLC protocol. ... Keeping the cost reasonable typically results in a feedback error rate of around 1%, which results in a hybrid-ARQ residual error rate of a similar order. Such an error rate is in many cases far too high; high data rates with TCP may require virtually error-free delivery of packets to the TCP protocol layer. As an example, for sustainable data rates exceeding 100 Mbit/s, a packet-loss probability less than 10^{-5} is required [72]. The reason is that TCP assumes packet errors to be due to congestion in the network. Any packet error therefore triggers the TCP congestion-avoidance mechanism with a corresponding decrease in data rate.”) • 315 (“Different services have different requirements; for some services (for example, transfer of a large file), error-free delivery of data is important, whereas for other applications (for example, streaming services), a small amount of missing packets is not a problem. The RLC can therefore operate in three different modes, depending on the requirements from the application: ... • <i>Acknowledged mode</i> (AM) is the main mode of operation for TCP/IP packet data transmission on the DL-SCH. Segmentation/reassembly, in-sequence delivery, and retransmissions of erroneous data are all supported.”) • 474 (“By contrast, users who download a web page or movie clip via packet data describe quality of service in terms of the delay they experience from the time they start the download until the web page or movie clip is displayed.”) • 475 (“The Transmission Control Protocol (TCP)—the protocol at the transport layer—is commonly used together with IP traffic. However, due to the so-called slow-start algorithm, which is sensitive to latency in the network, it is especially prone to cause delay for small
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		files. The slow-start algorithm is meant to ensure that the packet transmission rate from the source does not exceed the capability of network nodes and interfaces.”) • 477 (“The ITU-R target for latency in [65] is set with a different definition than in Figure 20.1. Instead of a two-way latency, there is a 10 ms target for the one-way latency in both downlink and uplink. The one-way latency is defined as the one-way transit time between a packet being available at the IP layer in the user base station and the availability of this packet at the IP layer in the user terminal, and vice versa. This is achieved with a good margin for LTE, where the latency achieved is 4 ms for LTE FDD and 4.9 ms for LTE TDD.”) The reverse process applies on the receiver-side, as described in the excerpt below from ShareTechnote 4G/LTE Protocol Stack. <u>ShareTechnote 4G/LTE Protocol Stack:</u>
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- The Recieving [sic] flow can be summarized as illustrated below. In this illustration, a lot of details for each layers are not mentioned. I focused only on data flow and how a big packets received at PHY/MAC get splitted [sic] into individual IP packets as it goes through higher layer. More specifically, in this illustration I assume that very large amount of resources (just assume that maximum possible resources) are allocated for MAC/PHY layer. (A) MAC layer received a huge packet carrying many IP packets in it and forward it to RLC layer. (B) RLC layer splits (segments) the huge packets into multiple SDUs based on the information carried by RLC header. After this segmentation, RLC header is removed. (C) Each of the RLC SDUs from RLC is forwarded to PDCP(NOTE : You see multiple arrows coming in parallel at this step, but this doesn't mean that the multiple packets are forwarded simultaneously. In reality, each of the arrows are forwarded one by one in sequence.)

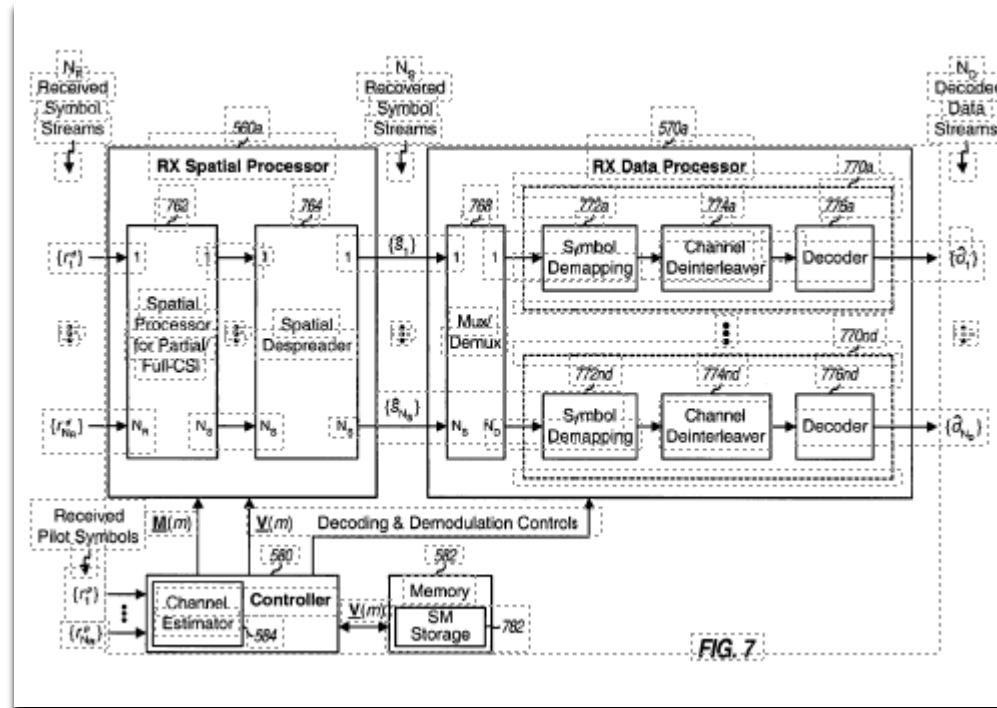
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		(D) Each of the packets coming into PDCP is now stripped of PDCP header. (E) Each of the packets stripped of PDCP header produces individual IP packets and forwarded up to IP layer. (NOTE : You see multiple arrows coming in parallel at this step, but this doesn't mean that the multiple packets are forwarded simultaneously. In reality, each of the arrows are forwarded one by one in sequence.) While the above excerpt from ShareTechnote 4G/LTE Protocol Stack describes a large transport block containing multiple IP packets, it is also possible that a single IP packet will be split among multiple transport blocks. <i>See, e.g.</i>, Dahlman at Figure 8.5. <u>Qualcomm '042 Patent:</u> • 2:66-3:12 (“A receiving entity obtains N_R received symbol streams via N_R receive antennas and performs receiver spatial processing for full-CSI or partial-CSI transmission to obtain N_S detected symbol streams, which are estimates of the N_S spread symbol streams. The receiving entity further spatially despreads the N_S detected symbol streams with the same steering matrices used by the transmitting entity and obtains N_S recovered symbol streams, which are estimates of the N_S data symbol streams. The receiver spatial processing and spatial despreading may be performed jointly or separately. The receiving entity then processes (e.g., demodulates, deinterleaves, and decodes) each block of recovered symbols in the N_S recovered symbol streams to obtain a corresponding decoded data packet.”) • 10:20-43 (“FIG. 4 shows a process 400 performed by the receiving entity to receive data transmitted with spatial spreading in the MIMO system. The receiving entity obtains N_R received symbol streams (denoted by vector r) via the N_R receive antennas (block 412). The receiving entity estimates the response of the MIMO channel (block 414), performs spatial processing for full-CSI or partial-CSI transmission based on the MIMO channel estimate, and obtains N_S detected symbol streams (denoted by a vector $\hat{w}$ in FIG. 2) (block 416). The receiving entity further spatially despreads the N_S detected symbol streams with the same steering matrices used by the transmitting entity and obtains N_S recovered symbol streams (denoted by vector $\hat{s}$) (block 418). The receiver spatial processing and spatial despreading may be performed jointly or separately, as described above. The receiving entity then processes (e.g., demodulates deinterleaves, and decodes) each block of recovered symbols in the N_S recovered symbol streams to obtain a corresponding decoded data packet
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(block 420). The receiving entity may also estimate the SNR of each transmission channel used for data transmission and select a suitable rate for the transmission channel based on its SNR (block 422). The same or different rates may be selected for the N_S transmission channels.”)

- Figure 7:



- 17:10-30** (“For the embodiment shown in FIG. 7, RX data processor 570 a includes a multiplexer/demultiplexer (Mux/Demux) 768 and N_D RX data stream processors 770 a through 770 nd for the N_D data streams. Mux/Demux 768 receives and multiplexes/demultiplexes the N_S recovered symbol streams for the N_S transmission channels into N_D recovered symbol streams for the N_D data streams. Within each RX data stream processor 770, a symbol demapping unit 772 demodulates the recovered symbols for its data stream in accordance with the modulation scheme used for that stream and provides

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		demodulated data. A channel deinterleaver 774 deinterleaves the demodulated data in a manner complementary to the interleaving performed on that stream by transmitting entity 110. A decoder 776 decodes the deinterleaved data in a manner complementary to the encoding performed by transmitting entity 110 on that stream. For example, a Turbo decoder or a Viterbi decoder may be used for decoder 776 if Turbo or convolutional coding, respectively, is performed by transmitting entity 110. Decoder 776 provides a decoded data stream, which includes a decoded data packet for each data symbol block.”) <u>Qualcomm ’341 Patent:</u> • 8:15-23 (“The PDCP sublayer 514 provides multiplexing between different radio bearers and logical channels. The PDCP sublayer 514 also provides header compression for upper layer data packets to reduce radio transmission overhead, security by ciphering the data packets, and handover support for UEs between eNBs. The RLC sublayer 512 provides segmentation and reassembly of upper layer data packets, retransmission of lost data packets, and reordering of data packets to compensate for out-of-order reception due to hybrid automatic repeat request (HARQ). The MAC sublayer 510 provides multiplexing between logical and transport channels. The MAC sublayer 510 is also responsible for allocating the various radio resources (e.g., resource blocks) in one cell among the UEs. The MAC sublayer 510 is also responsible for HARQ operations.”) • 9:47-61 (“The controller/processor 659 implements the L2 layer. The controller/processor can be associated with a memory 660 that stores program codes and data. The memory 660 may be referred to as a computer-readable medium. In the UL, the control/processor 659 provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, control signal processing to recover upper layer packets from the core network. The upper layer packets are then provided to a data sink 662, which represents all the protocol layers above the L2 layer. Various control signals may also be provided to the data sink 662 for L3 processing. The controller/processor 659 is also responsible for error detection using an acknowledgement (ACK) and/or negative acknowledgement (NACK) protocol to support HARQ operations.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be
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		insubstantially different from or function in the same way to provide the same result as the relevant claim element.																																													
1.c.1	a control processor operatively coupled to the formatting module, and configured to detect with which protocol mode the at least one of the K recovered signals was transmitted,	The Accused '946 Instrumentalities include a control processor operatively coupled to the formatting module, and configured to detect with which protocol mode the at least one of the K recovered signals was transmitted. The Physical Downlink Control Channel (PDCCH) carries downlink control information (DCI) comprised of scheduling assignments and other control information to the Accused '946 Instrumentalities. The DCI carries transport format information, scheduling assignments and other control information for the downlink shared channel (DL-SCH). After receiving and decoding the PDCCH signal, a control processor will detect with which protocol mode the K wireless signals was transmitted by reading the DCI information. The protocols may include, e.g., MIMO and SISO (non-MIMO). <u>ShareTechnote 4G/LTE – DCI:</u> DCI has various formats for the information sent to define resource allocations. The DCI formats defined in LTE are as follows. <table border="1"> <thead> <tr> <th>DCI Format</th><th>Usage</th><th>Major Contents</th></tr> </thead> <tbody> <tr> <td>Format 0</td><td>UL Grant. Resource Allocation for UL Data</td><td>RB Assignment,TPC,PUSCH Hopping Flag</td></tr> <tr> <td>Format 1</td><td>DL Assignment for SISO</td><td>RB Assignment,TPC, HARQ</td></tr> <tr> <td>Format 1A</td><td>DL Assignment for SISO (compact)</td><td>RB Assignment,TPC, HARQ</td></tr> <tr> <td>Format 1A</td><td>Triggering RACH in Connected States</td><td>PRACH Sequence Index</td></tr> <tr> <td>Format 1B</td><td>DL Assignment for MIMO with Rank 1</td><td>RB Assignment,TPC, HARQ,TPMI, PMI</td></tr> <tr> <td>Format 1C</td><td>DL Assignment for SISO (minimum size)</td><td>RB Assignment</td></tr> <tr> <td>Format 1D</td><td>DL Assignment for Multi User MIMO</td><td>RB Assignment,TPC, HARQ,TPMI,DL Power Offset</td></tr> <tr> <td>Format 2</td><td>DL Assignment for Closed Loop MIMO</td><td>RB Assignment,TPC, HARQ, Precoding Information</td></tr> <tr> <td>Format 2A</td><td>DL Assignment for Open Loop MIMO</td><td>RB Assignment,TPC, HARQ, Precoding Information</td></tr> <tr> <td>Format 2B</td><td>DL Assignment for TM8 (Dual Layer Beamforming)</td><td>RB Assignment,TPC, HARQ, Precoding Information</td></tr> <tr> <td>Format 2C</td><td>DL Assignment for TM9</td><td>RB Assignment,TPC, HARQ, Precoding Information</td></tr> <tr> <td>Format 3</td><td>TPC Commands for PUCCH and PUSCH with 2 bit power adjustment</td><td>Power Control Only</td></tr> <tr> <td>Format 3A</td><td>TPC Commands for PUCCH and PUSCH with 1 bit power adjustment</td><td>Power Control Only</td></tr> <tr> <td>Format 4</td><td>UL Assignment for UL MIMO (up to 4 layers)</td><td>RB Assignment,TPC, HARQ, Precoding Information</td></tr> </tbody> </table>	DCI Format	Usage	Major Contents	Format 0	UL Grant. Resource Allocation for UL Data	RB Assignment,TPC,PUSCH Hopping Flag	Format 1	DL Assignment for SISO	RB Assignment,TPC, HARQ	Format 1A	DL Assignment for SISO (compact)	RB Assignment,TPC, HARQ	Format 1A	Triggering RACH in Connected States	PRACH Sequence Index	Format 1B	DL Assignment for MIMO with Rank 1	RB Assignment,TPC, HARQ,TPMI, PMI	Format 1C	DL Assignment for SISO (minimum size)	RB Assignment	Format 1D	DL Assignment for Multi User MIMO	RB Assignment,TPC, HARQ,TPMI,DL Power Offset	Format 2	DL Assignment for Closed Loop MIMO	RB Assignment,TPC, HARQ, Precoding Information	Format 2A	DL Assignment for Open Loop MIMO	RB Assignment,TPC, HARQ, Precoding Information	Format 2B	DL Assignment for TM8 (Dual Layer Beamforming)	RB Assignment,TPC, HARQ, Precoding Information	Format 2C	DL Assignment for TM9	RB Assignment,TPC, HARQ, Precoding Information	Format 3	TPC Commands for PUCCH and PUSCH with 2 bit power adjustment	Power Control Only	Format 3A	TPC Commands for PUCCH and PUSCH with 1 bit power adjustment	Power Control Only	Format 4	UL Assignment for UL MIMO (up to 4 layers)	RB Assignment,TPC, HARQ, Precoding Information
DCI Format	Usage	Major Contents																																													
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		• L1 signaling is done by DCI and Up to 8 DCIs can be configured in the PDCCH. These DCIs can have 6 formats : 1 format for UL scheduling, 2 formats for Non-MIMO DL scheduling, 1 format for MIMO DL Scheduling and 2 formats for UL power control. • There are two major factors to determine a DCI format for a specific situation as follows : i) RNTI Type ii) Transmission Mode • Those tables from 3GPP 36.213 shows the relationships between RNTI Type, Transmission Mode and DCI format. (You would notice that same information (same RNTI type) can have multiple candidates of DCI format. Then, the question is "How network determine which DCI format it has to use at a specific moment ?". In some case, you can find a clear criteria from following table, but some other case the selection criteria is not clear. For example, if you ask "Do I have to use DCI format 1A or 2A when I am using TM3, C-RNTI ?". You may say "Use DCI format 2A in MIMO configuration and use 1 A in non-MIMO configuration". But the answer would not be clear if you ask "What kind of DCI format (1A or 1C) for Paging message (P-RNTI) ?". At least table 7.1-2 does now show any different selection criteria and I haven't found anywhere else in the spec about this selection criteria. In this case, I just ask to several other people who is working on that specific area and trying to draw conclusion by a kind of 'vote'. For this specific case (DCI format for P-RNTI), I got the response saying "There is no clear criteria, it is just upto network on which one to pick".) <u>ShareTechnote 4G/LTE – Transmission Mode:</u> • In LTE, usually they use multiple Antenna for downlink (at least from Category 3 UE and higher), meaning that eNode (Network) has use multiple Tx Antenna and UE use multiple Rx antenna. • Now you almost automatically think about 'MIMO', but in reality 'multiple antenna' does not automatically mean 'MIMO'. For example, you have two downlink antenna. You can use these two antenna in various ways. Of course, one ways is to use it as 2 x 2 MIMO, but this is not the only way. You can use the two antenna in diversity configuration rather than MIMO configuration. Or you can just use only one of the antenna and sometimes you would like to use various different multiplexing, precoding methods etc.
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- In LTE, they give a special name for each of the way of transmission and it is called 'Transmission Mode'. For example, what we normally call 'SISO' (Single Transmission Antenna and Single Reciever Antenna) is called 'TM1(Transmission Mode 1)'. What we normally call 'Diversity' is called 'TM2'. What we call 'MIMO' but no feedback from UE is called 'TM3'. MIMO and UE feedback from UE (CQI, PMI, RI) is called 'TM4'.
- Some important parameter sets for each transmission mode are as follows. (To understand this process in detail, it is crucial to understand details of Precoding in basic procedure page).

TM	No of Codewords	No of Layers	Precoding	Codebook	No of Antenna
TM1	1	1	36.211 6.3.4.1 a single antenna port	N/A	1
TM2	1	2	36.211 6.3.4.3 Transmit diversity	N/A	2
TM3	1	2	36.211 6.3.4.3 Transmit diversity	N/A	2
	2	2	36.211 6.3.4.2.2 Large delay CDD	Fixed. 36.211 6.3.4.2.3 Table 6.3.4.2.3-1 {Number of layers, Codebook index} = {2, 0}	
TM4	1	2	36.211 6.3.4.2.1 without CDD	36.211 6.3.4.2.3 Table 6.3.4.2.3-1 {Number of layers, Codebook index} = {1, 0} or {1, 1} or {1, 2} or {1, 3}	2
	2	2	36.211 6.3.4.2.1 without CDD	36.211 6.3.4.2.3 Table 6.3.4.2.3-1 {Number of layers, Codebook index} = {2, 1} or {2, 2}	
TM5	1	2(cell specific)	36.211 6.3.4.3 Transmit diversity	N/A	2
		2	36.211 6.3.4.2.1 without CDD	36.211 6.3.4.2.3 Table 6.3.4.2.3-1 {Number of layers, Codebook index} = {1, 0} or {1, 1} or {1, 2} or {1, 3}	
TM6	1	2	36.211 6.3.4.2.1 without CDD	36.211 6.3.4.2.1 without CDD	2
TM7	1	2(cell specific)	36.211 6.3.4.3 Transmit diversity	N/A	1
		1	36.211 6.3.4.1 a single antenna port	N/A	
TM8	1	1	36.211 6.3.4.1 a single antenna port	N/A	2
		2(cell specific)	36.211 6.3.4.3 Transmit diversity	N/A	
	2	2	36.211 6.3.4.4 Spatal multiplexing with UE-specific RS	N/A	

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TS 36.213:

• **Table 7.1-5: PDCCH and PDSCH configured by C-RNTI**

Transmission mode	DCI format	Search Space	Transmission scheme of PDSCH corresponding to PDCCH
Mode 1	DCI format 1A	Common and UE specific by C-RNTI	Single-antenna port, port 0 (see Subclause 7.1.1)
	DCI format 1 and 7-1A	UE specific by C-RNTI	Single-antenna port, port 0 (see Subclause 7.1.1)
Mode 2	DCI format 1A	Common and UE specific by C-RNTI	Transmit diversity (see Subclause 7.1.2)
	DCI format 1 and 7-1A	UE specific by C-RNTI	Transmit diversity (see Subclause 7.1.2)
Mode 3	DCI format 1A	Common and UE specific by C-RNTI	Transmit diversity (see Subclause 7.1.2)
	DCI format 2A and 7-1B	UE specific by C-RNTI	Large delay CDD (see Subclause 7.1.3) or Transmit diversity (see Subclause 7.1.2)
Mode 4	DCI format 1A	Common and UE specific by C-RNTI	Transmit diversity (see Subclause 7.1.2)
	DCI format 2 and 7-1C	UE specific by C-RNTI	Closed-loop spatial multiplexing (see Subclause 7.1.4) or Transmit diversity (see Subclause 7.1.2)
Mode 5	DCI format 1A	Common and UE specific by C-RNTI	Transmit diversity (see Subclause 7.1.2)
	DCI format 1D	UE specific by C-RNTI	Multi-user MIMO (see Subclause 7.1.5)
Mode 6	DCI format 1A	Common and UE specific by C-RNTI	Transmit diversity (see Subclause 7.1.2)
	DCI format 1B	UE specific by C-RNTI	Closed-loop spatial multiplexing (see Subclause 7.1.4) using a single transmission layer
	DCI format 7-1D	UE specific by C-RNTI	Closed-loop spatial multiplexing (see Subclause 7.1.4) using a single transmission layer or transmit diversity (see Subclause 7.1.2)
Mode 7	DCI format 1A	Common and UE specific by C-RNTI	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see Subclause 7.1.1), otherwise Transmit diversity (see Subclause 7.1.2)
	DCI format 1	UE specific by C-RNTI	Single-antenna port, port 5 (see Subclause 7.1.1)
Mode 8	DCI format 1A	Common and UE specific by C-RNTI	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see Subclause 7.1.1), otherwise Transmit diversity (see Subclause 7.1.2)
	DCI format 2B	UE specific by C-RNTI	Dual layer transmission, port 7 and 8 (see Subclause 7.1.5A) or single-antenna port, port 7 or 8 (see Subclause 7.1.1)
	DCI format 7-1E	UE specific by C-RNTI	Dual layer transmission, port 7 and 8 (see Subclause 7.1.5A) or single-antenna port, port 7 or 8 (see Subclause 7.1.1) or Transmit Diversity, port 7 and 8 (see Subclause 7.1.2)
Mode 9	DCI format 1A	Common and UE specific by C-RNTI	- Non-MBSFN subframe: If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see Subclause 7.1.1), otherwise Transmit diversity (see Subclause 7.1.2) - MBSFN subframe: Single-antenna port, port 7 (see Subclause 7.1.1)
	DCI format 2C	UE specific by C-RNTI	Transmit diversity, port 7-8 (see Subclause 7.1.2) or dual layer transmission port 7-8 (see Subclause 7.1.5A), if UE is configured with higher layer parameter <i>semiOpenLoop</i> , up to 8 layer transmission, ports 7-14 (see Subclause 7.1.5B) otherwise; or single-antenna port, port 7, 8, 11, or 13 (see Subclause 7.1.1) if UE is configured with higher layer parameter <i>dmrs-tableAlt</i> , single-antenna port, port 7 or 8 (see Subclause 7.1.1) otherwise

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• **Table 7.2.3-0: PDSCH transmission scheme assumed for CSI reference resource**

Transmission mode	Transmission scheme of PDSCH
1	Single-antenna port, port 0
2	Transmit diversity
3	Transmit diversity if the associated rank indicator is 1, otherwise large delay CDD
4	Closed-loop spatial multiplexing
5	Multi-user MIMO
6	Closed-loop spatial multiplexing with a single transmission layer
7	If the number of PBCH antenna ports is one, Single-antenna port, port 0; otherwise Transmit diversity
8	If the UE is configured without PMI/RI reporting: if the number of PBCH antenna ports is one, single-antenna port, port 0; otherwise transmit diversity. If the UE is configured with PMI/RI reporting: closed-loop spatial multiplexing.
9	For activated serving cells, and a non-BL/CE UE, if the UE is configured without PMI/RI reporting: if the number of PBCH antenna ports is one, single-antenna port, port 0; otherwise transmit diversity. For activated serving cells, and a non-BL/CE UE, if the UE is configured with PMI/RI reporting or without PMI reporting: if the number of CSI-RS ports is one, single-antenna port, port 7; otherwise up to 8 layer transmission, ports 7-14 (see Subclause 7.1.5B). For activated serving cells, and a BL/CE UE, if the UE is not configured with periodic CSI reporting mode 1-1: if the number of PBCH antenna ports is one, single-antenna port, port 0; otherwise transmit diversity. For activated serving cells, and a BL/CE UE, if the UE is configured with periodic CSI reporting mode 1-1: if the number of PBCH antenna ports is one, single-antenna port, port 0; otherwise closed-loop spatial multiplexing with a single transmission layer. For dormant serving cells: if the number of PBCH antenna ports is one, single-antenna port, port 0; otherwise transmit diversity.
10	For activated serving cells, if a CSI process of the UE is configured without PMI/RI reporting: if the number of CSI-RS ports is one, single-antenna port, port 7; otherwise transmit diversity. For activated serving cells, and if a CSI process of the UE is configured with PMI/RI reporting or without PMI reporting: if the number of CSI-RS ports is one, single-antenna port, port 7; otherwise up to 8 layer transmission, ports 7-14 (see Subclause 7.1.5B). For dormant serving cells: if the number of PBCH antenna ports is one, single-antenna port, port 0; otherwise transmit diversity.

Qualcomm '042 Patent:

- **2:66-3:12** (“A receiving entity obtains N_R received symbol streams via N_R receive antennas and performs receiver spatial processing for full-CSI or partial-CSI transmission to obtain N_S detected symbol streams, which are estimates of the N_S spread symbol streams. The receiving entity further spatially despreads the N_S detected symbol streams with the same steering matrices used by the transmitting entity and obtains N_S recovered symbol streams, which are estimates of the N_S data symbol streams. The receiver spatial processing and spatial despreading may be performed jointly or separately. The receiving entity then processes (e.g., demodulates, deinterleaves, and decodes) each block of recovered symbols in the N_S recovered symbol streams to obtain a corresponding decoded data packet.”)

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		If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
1.c.2	<i>[control processor configured to]</i> and to enable a corresponding transmission mode including one of a legacy protocol mode and a bandwidth efficient aggressive access protocol mode that exploits co-channel demodulation capabilities of the modem,	The control processor of the Accused '946 Instrumentalities is configured to enable a corresponding transmission mode including one of a legacy protocol mode and a bandwidth efficient aggressive access protocol mode that exploits co-channel demodulation capabilities of the modem. For transmissions back to the base station in the Physical Uplink Shared Channel (PUSCH), the control processor will enable a transmission mode corresponding to the downlink control information (PDCCH) received by the Accused '946 Instrumentalities. The available transmission modes include a legacy protocol mode (i.e., non-MIMO, single antenna) and a bandwidth efficient mode (SU-MIMO, i.e., “closed-loop spatial multiplexing). SU-MIMO exploits co-channel demodulation capabilities of the modem. <u>TS 36.213:</u> • § 8.0 (“If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the C-RNTI, the UE shall decode the PDCCH according to the combination defined in Table 8-3 and transmit the corresponding PUSCH if a transport block corresponding to the HARQ process of the PUSCH transmission is generated as described in [8]. The scrambling initialization of this PUSCH corresponding to these PDCCHs and the PUSCH retransmission for the same transport block is by C-RNTI.”) • Table 8.3. • § 8.0 (“If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the SPS C-RNTI or UL-SPS-VRNTI, the UE shall decode the PDCCH according to the combination defined in Table 8-5 and transmit the corresponding PUSCH if a transport block corresponding to the HARQ process of the PUSCH transmission is generated as described in [8] except when the UE is configured with higher layer parameter <i>shortProcessingTime</i> and with DCI format 0 mapped onto the UE-specific search space.”)

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		• Table 8.5. <u>Qualcomm '042 Patent:</u> • 2:66-3:12 (“A receiving entity obtains N_R received symbol streams via N_R receive antennas and performs receiver spatial processing for full-CSI or partial-CSI transmission to obtain N_S detected symbol streams, which are estimates of the N_S spread symbol streams. The receiving entity further spatially despreads the N_S detected symbol streams with the same steering matrices used by the transmitting entity and obtains N_S recovered symbol streams, which are estimates of the N_S data symbol streams. The receiver spatial processing and spatial despreading may be performed jointly or separately. The receiving entity then processes (e.g., demodulates, deinterleaves, and decodes) each block of recovered symbols in the N_S recovered symbol streams to obtain a corresponding decoded data packet.”) <u>Qualcomm '341 Patent:</u> • 9:1-23 (“The TX processor 616 implements various signal processing functions for the L1 layer (i.e., physical layer). The signal processing functions includes coding and interleaving to facilitate forward error correction (FEC) at the UE 650 and mapping to signal constellations based on various modulation schemes (e.g., binary phase-shift keying (BPSK), quadrature phase-shift keying (QPSK), M-phase-shift keying (M-PSK), M-quadrature amplitude modulation (M-QAM)). The coded and modulated symbols are then split into parallel streams. Each stream is then mapped to an OFDM subcarrier, multiplexed with a reference signal (e.g., pilot) in the time and/or frequency domain, and then combined together using an Inverse Fast Fourier Transform (IFFT) to produce a physical channel carrying a time domain OFDM symbol stream. The OFDM stream is spatially precoded to produce multiple spatial streams. Channel estimates from a channel estimator 674 may be used to determine the coding and modulation scheme, as well as for spatial processing. The channel estimate may be derived from a reference signal and/or channel condition feedback transmitted by the UE 650. Each spatial stream is then provided to a different antenna 620 via a separate transmitter 618TX. Each transmitter 618TX modulates an RF carrier with a respective spatial stream for transmission.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be
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		insubstantially different from or function in the same way to provide the same result as the relevant claim element.				
1.c.3	wherein the signals of the one of a legacy protocol mode can be selected from the group consisting of low data rate BPSK, QPSK, GMSK and OAM; and	The Accused '946 Instrumentalities include a legacy protocol mode wherein the signals of the one of a legacy protocol mode can be selected from the group consisting of low data rate BPSK, QPSK, GMSK and OAM. In a legacy transmission mode (e.g., non-MIMO), the available modulation schemes for uplink signals transmitted by the Accused '946 Instrumentalities include BPSK, QPSK, and QAM. One of these modulation schemes will be selected depending on the particular legacy protocol mode selected and channel conditions, among other factors. <u>TS 36.211:</u> • § 5.3.2: 5.3.2 Modulation For each codeword q, the block of scrambled bits $\tilde{b}^{(q)}(0), \dots, \tilde{b}^{(q)}(M_{\text{bit}}^{(q)} - 1)$ shall be modulated as described in clause 7.1, resulting in a block of complex-valued symbols $d^{(q)}(0), \dots, d^{(q)}(M_{\text{ymb}}^{(q)} - 1)$. Table 5.3.2-1 specifies the modulation mappings applicable for the physical uplink shared channel. For sub-PRB allocations only $\pi/2$ BPSK and QPSK are supported. Table 5.3.2-1: Uplink modulation schemes <table><tr><th>Physical channel</th><th>Modulation schemes</th></tr><tr><td>PUSCH</td><td>$\pi/2$ BPSK, QPSK, 16QAM, 64QAM, 256QAM</td></tr></table>	Physical channel	Modulation schemes	PUSCH	$\pi/2$ BPSK, QPSK, 16QAM, 64QAM, 256QAM
Physical channel	Modulation schemes					
PUSCH	$\pi/2$ BPSK, QPSK, 16QAM, 64QAM, 256QAM					

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• **§ 6.3.2:**

6.3.2 Modulation

For each codeword q , the block of scrambled bits $\tilde{b}^{(q)}(0), \dots, \tilde{b}^{(q)}(M_{\text{bit}}^{(q)} - 1)$ shall be modulated as described in clause 7.1 using one of the modulation schemes in Table 6.3.2-1, resulting in a block of complex-valued modulation symbols $d^{(q)}(0), \dots, d^{(q)}(M_{\text{sym}}^{(q)} - 1)$.

Table 6.3.2-1: Modulation schemes

Physical channel	Modulation schemes
PDSCH	QPSK, 16QAM, 64QAM, 256QAM
PMCH	QPSK, 16QAM, 64QAM, 256QAM

Qualcomm '042 Patent:

- **2:66-3:12** (“A receiving entity obtains N_R received symbol streams via N_R receive antennas and performs receiver spatial processing for full-CSI or partial-CSI transmission to obtain N_S detected symbol streams, which are estimates of the N_S spread symbol streams. The receiving entity further spatially despreads the N_S detected symbol streams with the same steering matrices used by the transmitting entity and obtains N_S recovered symbol streams, which are estimates of the N_S data symbol streams. The receiver spatial processing and spatial despreading may be performed jointly or separately. The receiving entity then processes (e.g., demodulates, deinterleaves, and decodes) each block of recovered symbols in the N_S recovered symbol streams to obtain a corresponding decoded data packet.”)

Qualcomm '341 Patent:

- **9:1-23** (“The TX processor 616 implements various signal processing functions for the L1 layer (i.e., physical layer). The signal processing functions includes coding and interleaving to facilitate forward error correction (FEC) at the UE 650 and mapping to signal constellations based on various modulation schemes (e.g., binary phase-shift keying (BPSK), quadrature phase-shift keying (QPSK), M-phase-shift keying (M-PSK), M-quadrature amplitude modulation (M-QAM)). The coded and modulated symbols are then split into parallel streams. Each stream is then mapped to an OFDM subcarrier, multiplexed with a reference signal (e.g., pilot) in the time and/or frequency domain, and then combined together using an Inverse Fast Fourier Transform (IFFT) to produce a physical channel carrying a time domain

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		OFDM symbol stream. The OFDM stream is spatially precoded to produce multiple spatial streams. Channel estimates from a channel estimator 674 may be used to determine the coding and modulation scheme, as well as for spatial processing. The channel estimate may be derived from a reference signal and/or channel condition feedback transmitted by the UE 650. Each spatial stream is then provided to a different antenna 620 via a separate transmitter 618TX. Each transmitter 618TX modulates an RF carrier with a respective spatial stream for transmission.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
1.d.1	a demultiplexer operatively coupled to the data formatting module and the control processor, and configured to select one of the recovered K wirelessly transmitted signals as a target signal intended for a user associated with the modem,	The Accused '946 Instrumentalities include a demultiplexer operatively coupled to the data formatting module and the control processor, and configured to select one of the recovered K wirelessly transmitted signals as a target signal intended for a user associated with the modem. The Accused '946 Instrumentalities process the received MIMO signals to recover the network data packets (e.g., IP packets). The Accused '946 Instrumentalities read the address header of the IP packets and separate (i.e., demultiplex) the IP packets according to their appropriate destination. In certain circumstances, the transport block of a MIMO layer transmission will contain only data intended for a specific device tethered to the Accused '946 Instrumentalities. The address of those IP packets corresponds to the tethered device in the routing table, and the IP packets are forwarded to the tethered device. The routing table and the components used to accomplish the routing function is a demultiplexer because it takes an input stream of IP packets (single input stream) and separates them based on their destination address (multiple output streams). <u>IP Routing Basics:</u> • Overview ◦ Routing is an activity that transmits information from a source address to a destination address through an interconnected network. Routing occurs at the network layer, Layer 3, in the Open Systems Interconnection (OSI) reference model.

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		◦ When a router receives an IP packet, the router searches its routing table for the best matching route based on the destination IP address of the packet and forwards the packet through the outbound interface or next-hop IP address for the route. The routing table contains the routing entries (routes) learned by the router in various ways. The router can obtain routing entries in static or dynamic mode and maintain its own routing table. • Routing Table and FIB Table ◦ Routers forward packets based on routing tables and forwarding information base (FIB) tables. Each router maintains at least one routing table and one FIB table. Routers select routes based on routing tables and forward packets based on FIB tables. • Routing Table ◦ Each router maintains a local core routing table (namely, an IP routing table), and each routing protocol maintains its own routing table. ◦ Local core routing table A router uses the local core routing table to store preferred routes. The router then sends the preferred routes to the FIB table to guide packet forwarding. The router selects routes according to the priorities of protocols and costs stored in the routing table. A router that supports Layer 3 Virtual Private Network (L3VPN) maintains a local core routing table for each VPN instance. ◦ Protocol routing table A protocol routing table stores routing information discovered by the protocol. A routing protocol can import and advertise routes that are discovered by other routing protocols. For example, if a router running the Open Shortest Path First (OSPF) protocol needs to use OSPF to advertise direct routes, static routes, or Intermediate System-Intermediate System (IS-IS) routes, the router must import the routes into the OSPF routing table. • A routing table contains the following key data for each IP packet: ◦ Destination: identifies the destination IP address or destination network address of an IP packet.
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		◦ Mask: supplements the destination address to specially identify the address of the network segment where the destination host or router resides. ◦ The network segment address of a destination host or router is obtained through the "AND" operation on the destination address and network mask. For example, if the destination address is 10.1.1.1 and the mask is 255.255.255.0, the address of the network segment where the host or router resides is 10.1.1.0. ◦ The network mask is composed of several consecutive 1s. These 1s can be expressed in either the dotted decimal notation or the number of consecutive 1s in the mask. For example, the network mask can be expressed either as 255.255.255.0 or 24. ◦ Proto: indicates the protocol through which routes are learned. ◦ Pre: indicates the routing protocol preference of a route. There may multiple routes to the same destination, which have different next hops and outbound interfaces. These routes may be discovered by different routing protocols or manually configured. A router selects the route with the highest preference (the smallest value) as the optimal route. For the routing protocol preference, see Routing Protocol Preference. ◦ Cost: indicates the route cost. When multiple routes to the same destination have the same preference, the route with the lowest cost is selected as the optimal route. <u>Dynamic Host Configuration Protocol (DHCP)</u> • Dynamic Host Configuration Protocol (DHCP) is a client/server protocol that automatically provides an Internet Protocol (IP) host with its IP address and other related configuration information such as the subnet mask and default gateway. RFCs 2131 and 2132 define DHCP as an Internet Engineering Task Force (IETF) standard based on Bootstrap Protocol (BOOTP), a protocol with which DHCP shares many implementation details. DHCP allows hosts to obtain required TCP/IP configuration information from a DHCP server. • Every device on a TCP/IP-based network must have a unique unicast IP address to access the network and its resources. Without DHCP, IP addresses for new computers or computers that are moved from one subnet to another must be configured manually; IP addresses for computers that are removed from the network must be manually reclaimed.
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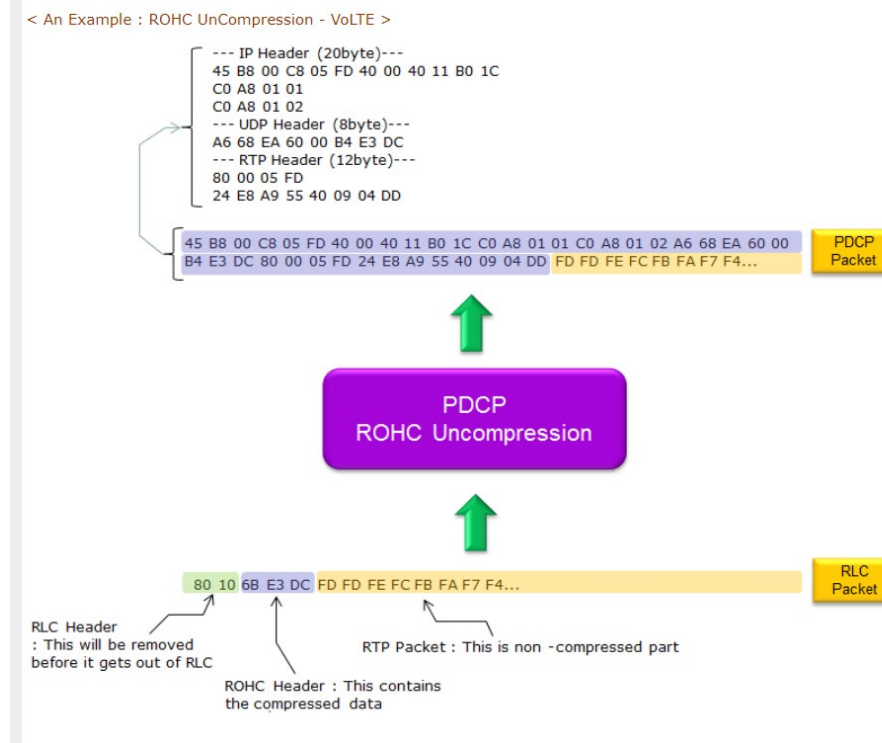
		With DHCP, this entire process is automated and managed centrally. The DHCP server maintains a pool of IP addresses and leases an address to any DHCP-enabled client when it starts up on the network. Because the IP addresses are dynamic (leased) rather than static (permanently assigned), addresses no longer in use are automatically returned to the pool for reallocation. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
1.d.2	where the selection <i>[of the one K wirelessly transmitted signal intended for user]</i> is based on a control input from the control processor,	The selection of the K wirelessly transmitted signal by the demultiplexer of the Accused '946 Instrumentalities is based on a control input from the control processor. The routing of the IP packets from the Accused '946 Instrumentalities to the tethered device is accomplished via the routing table, which the control processor maintains and updates. When a tethered device connects to the UE hotspot the control processor assigns it an IP address and adds that address to the routing table. See disclosures of 1.d.1. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
1.d.3	wherein the data formatting module supports multiple types of format modes,	The data formatting module of the Accused '946 Instrumentalities supports multiple types of format modes. The Accused '946 Instrumentalities support multiple IP packet formats for both the IP packets received and recovered from the base station, and the IP packets to be forwarded to the tethered device over WiFi. The data formatting module responsible for producing those IP packets from the received signals is capable of supporting multiple IP packet formats. For example, PDCP entity of the LTE protocol stack will perform decompression and deciphering of data packets received from

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the Radio Link Control protocol to generate IP packets, which may be in multiple formats, including e.g., IPv4 or IPv6. Other supported formats include UDP, RTP, TCP, and ESP.

ShareTechnote 4G/LTE - Header Compression:

- ROHC is a kind of algorithm to compress the header of various IP packets. In case of IPv4, the size of uncompressed IP header is 40 bytes and in case of IPv6, the size of uncompressed IP header is 60 bytes.



TS 36.323:

- § 4.1 Introduction (“The present document describes the functionality of the PDCP. Functionality specified for the UE equally applies to the RN for functionality necessary for

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the RN. There is also functionality which is only applicable to the RN in its communication with the E-UTRAN, in which case the specification denotes the RN instead of the UE. RN-specific behaviour is not applicable to the UE. The functionality specified for the UE applies to communication on Uu interface and PC5 interface [14].”)

- **§ 4.4 Functions** (“The Packet Data Convergence Protocol supports the following functions: - header compression and decompression of IP data flows using the ROHC protocol; ...”)
- **§ 5.5 Header Compression and Decompression**
 - **§ 5.5.1 Supported header compression protocols and profiles** (“The header compression protocol is based on the Robust Header Compression (ROHC) framework [7]. There are multiple header compression algorithms, called profiles, defined for the ROHC framework. Each profile is specific to the particular network layer, transport layer or upper layer protocol combination e.g. TCP/IP and RTP/UDP/IP.”)
 - **Table 5.5.1.1: Supported header compression protocols and profiles**

Multiple packet formats

Table 5.5.1.1: Supported header compression protocols and profiles

Profile Identifier	Usage:	Reference
0x0000	No compression	RFC 5795
0x0001	RTP/UDP/IP	RFC 3095, RFC 4815
0x0002	UDP/IP	RFC 3095, RFC 4815
0x0003	ESP/IP	RFC 3095, RFC 4815
0x0004	IP	RFC 3843, RFC 4815
0x0006	TCP/IP	RFC 6846
0x0101	RTP/UDP/IP	RFC 5225
0x0102	UDP/IP	RFC 5225
0x0103	ESP/IP	RFC 5225
0x0104	IP	RFC 5225

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		◦ § 5.5.5 Header decompression (“If header compression is configured by upper layers for PDCP entities associated with u-plane data the PDCP PDUs are de-compressed by the header compression protocol after performing deciphering as explained in the subclause 5.6.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
1.d.4	and the control processor is configured to select a network data packet formatting mode in which the data formatting operates.	The control processor of the Accused '946 Instrumentalities is configured to select a network data packet formatting mode in which the data formatting operates. The control processor will select the network data packet formatting mode depending on the type of data packets received and the intended destination of the IP packets. For example, to obtain network data packets from the received signals, the Accused '946 Instrumentalities may use ROHC decompression at the PDCP layer of the LTE protocol stack. The format of the resulting network data packet (e.g., RTP/UDP/IP, TCP/IP) will depend on the associated ROHC profile. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
2.	2. The modem of claim 1, further comprising a front end configured to simultaneously receive the K wirelessly transmitted signals, and to provide those signals to the MUD and a	The Accused '946 Instrumentalities include the modem of Claim 1 (<i>see</i> Claim 1) that further comprises a front end configured to simultaneously receive the K wirelessly transmitted signals, and to provide those signals to the MUD and a parameter estimator in a form that facilitates their subsequent processing by the multiuser detection module. See disclosures of 1.a and 20.e (describing MUD); 20.a-d (describing front end); 20.f (describing parameter estimator). If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be

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	parameter estimator in a form that facilitates their subsequent processing by the multiuser detection module.	insubstantially different from or function in the same way to provide the same result as the relevant claim element.
3.	3. The modem of claim 1, wherein in response to the control processor knowing that a modem with which it is communicating does not support the bandwidth efficient aggressive access protocol mode, the control processor is further adapted to enable a legacy protocol mode.	The Accused '946 Instrumentalities include the modem of Claim 1 (<i>see</i> Claim 1) wherein in response to the control processor knowing that a modem with which it is communicating does not support the bandwidth efficient aggressive access protocol mode, the control processor is further adapted to enable a legacy protocol mode. See disclosures of 1.c.2. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
4.	4. The modem of claim 1, further comprising a parameter estimator module receiving D diversity inputs from D analog to digital (A/D)	The Accused '946 Instrumentalities include the modem of Claim 1 (<i>see</i> Claim 1) that further comprises a parameter estimator module receiving D diversity inputs from D analog to digital (A/D) converters, the parameter estimator module outputting an S matrix to the MUD module, wherein the S matrix comprises estimated composite signature waveforms. See disclosures of 1.a and 20.e (describing MUD); 20.a-d (describing A/D converters); 20.f (describing parameter estimator).

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	converters, the parameter estimator module outputting an S matrix to the MUD module, wherein the S matrix comprises estimated composite signature waveforms.	If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
5.	5. The modem of claim 1, further comprising a bank of K decoders communicating with the K MUD module outputs, the bank of K decoders producing a matrix b_n output to the MUD module from the input of K MUD module recovered signals, wherein the matrix b_n is a matrix of symbol estimates.	The Accused '946 Instrumentalities include the modem of Claim 1 (<i>see</i> Claim 1) that further comprises a bank of K decoders communicating with the K MUD module outputs, the bank of K decoders producing a matrix b_n output to the MUD module from the input of K MUD module recovered signals, wherein the matrix b_n is a matrix of symbol estimates. See disclosures of 10.c. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
7.	7. The modem of claim 1, wherein the control processor detects	The Accused '946 Instrumentalities include the modem of Claim 1 (<i>see</i> Claim 1) wherein the control processor detects which of the received data signals 1-K is the intended data signal m , based on packet header information provided by the data formatting module.

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	which of the received data signals 1-K is the intended data signal m, based on packet header information provided by the data formatting module.	See disclosures of 1.c.1 (discussing control processor), and 1.d.1 (discussing header information and target signal intended for a user). If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
9.	9. The modem of claim 1, wherein the data formatting module provides packet header information to the control processor for each of the received signals 1-K, whereby a data signal intended for a particular modem can be identified, while other received data signals can be ignored.	The Accused '946 Instrumentalities include the modem of Claim 1 (<i>see</i> Claim 1) wherein the data formatting module provides packet header information to the control processor for each of the received signals 1-K, whereby a data signal intended for a particular modem can be identified, while other received data signals can be ignored. See disclosures of 1b (discussing formatting module), 1.c.1 (discussing control processor), and 1.d.1 (discussing header information and target signal intended for a user). If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.pre	10. A modem which enables efficient use of bandwidth in a multiuser wireless network including	To the extent that the preamble is found to be limiting, the Accused '946 Instrumentalities include a modem which enables efficient use of bandwidth in a multiuser wireless network including a plurality of modems in the presence of interference and noise. See disclosures of 1.pre.

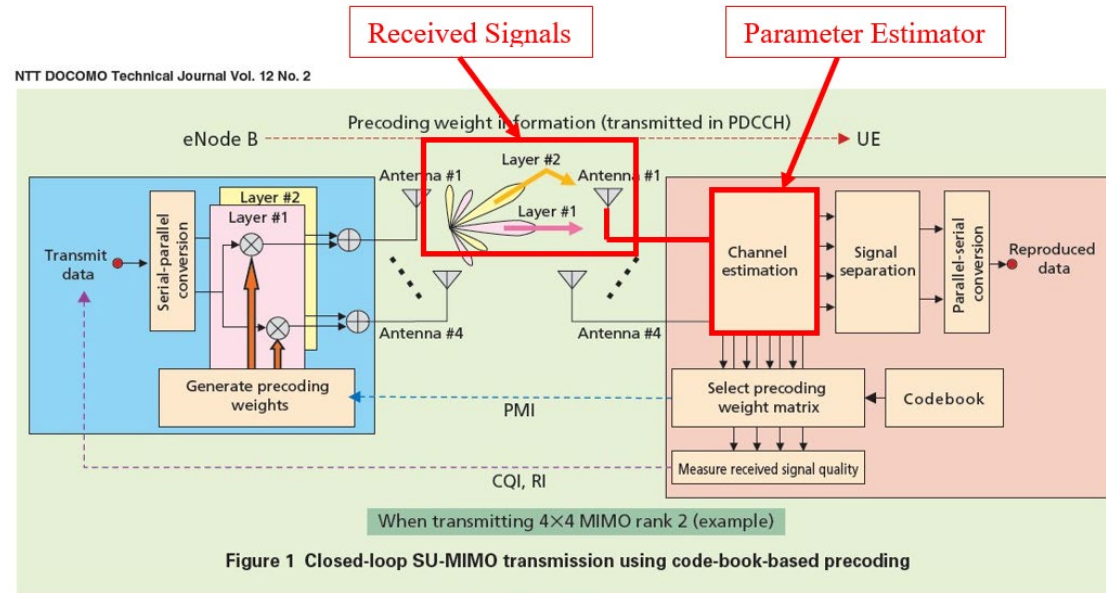
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	a plurality of modems in the presence of interference and noise, the modem comprising:	
10.a	a multiuser detection (MUD) module receiving D inputs from D analog to digital (A/D) converters configured to simultaneously demodulate and recover K wirelessly transmitted signals using co-channel demodulation, simultaneously outputting K recovered signals;	The Accused '946 Instrumentalities include a multiuser detection (MUD) module receiving D inputs from D analog to digital (A/D) converters configured to simultaneously demodulate and recover K wirelessly transmitted signals using co-channel demodulation, simultaneously outputting K recovered signals. Multiple data streams (“K wirelessly transmitted signals”) are transmitted by the base station (eNB) to User Equipment (UE; i.e., the Accused '946 Instrumentalities) in a SU-MIMO transmission mode. The Accused '946 Instrumentalities have two or more antennas (e.g., 2 antennas for 2x2 MIMO or 4 antennas for 4x4 MIMO) that receive the data streams. Each analog signal received by each antenna is provided to a separate A/D converter and converted to a digital signal and provided to the MUD module. The multi-user detection module in the Accused '946 Instrumentalities demodulates and recovers the signals for each MIMO transmission layer (i.e., the number of independent streams of data, or rank). See disclosures of 1.a. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.b	a parameter estimator module receiving the D inputs from the D A/D converters;	The Accused '946 Instrumentalities include a parameter estimator module receiving the D inputs from the D A/D converters. The Accused '946 Instrumentalities include a parameter estimator (e.g., channel estimator) that receives separate inputs from each A/D converter.

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MIMO in LTE:

- Figure 1:



Via: 3g4g.blogspot.com

- Downlink MIMO Technology
Single-User MIMO (SU-MIMO) was used for the downlink for LTE Rel. 8 to increase the peak data rate. The target data rates of over 100 Mbit/s were achieved by using a 20 MHz transmission bandwidth, 2×2 MIMO, and 64 Quadrature Amplitude Modulation (64QAM), and peak data rates of over 300 Mbit/s can be achieved using 4×4 SU-MIMO. The multi-antenna technology used for the downlink in LTE Rel. 8 is classified into the following three types.”
- LTE Rel. 8 adopts frequency-selective precoding, in which precoding weights are selected independently for each sub-band of bandwidth from 360 kHz to 1.44 MHz, as well as wideband precoding, with single precoding weights that are applied to the whole transmission band. The channel estimation used for demodulation and selection of the precoding weight matrix on the UE is done using a cell specific Reference Signal (RS) transmitted from each antenna. Accordingly, the specifications require the eNode B to notify the UE of the

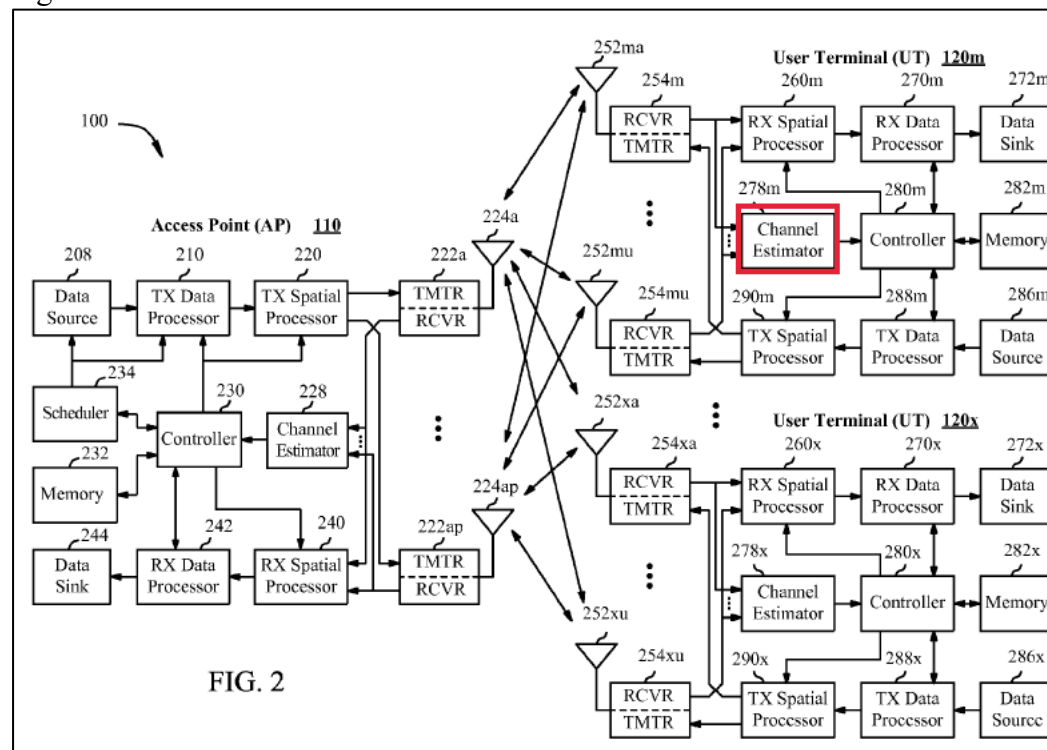
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		precoding weight information used for PDSCH transmission through the Physical Downlink Control Channel (PDCCH), and the UE to use this information for demodulation. • LTE Rel. 8 also adopts rank adaptation, which adaptively controls the number of transmission layers (the rank) according to channel conditions, such as the received SINR and fading correlation between antennas (Figure 2). Each UE feeds back a Channel Quality Indicator (CQI), a Rank Indicator (RI) specifying the optimal rank, and the PMI described earlier, and the eNode B adaptively controls the number of layers transmitted to each UE based on this information. • <u>Downlink 8-Layer SU-MIMO Technology</u> The target peak spectral efficiency in LTE-Advanced is 30 bit/s/Hz. To achieve this, high-order SU-MIMO with more antennas is necessary. Accordingly, it was agreed to extend the number of layers of SU-MIMO transmission in the LTE-Advanced downlink to a maximum of 8 layers. The number of transmission layers is selected by rank adaptation. The most significant issue with the radio interface in supporting up to 8 layers is the RS structure used for CQI measurements and PDSCH demodulation.
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Qualcomm '994 Patent:

- Figure 2:



Qualcomm '915 Patent:

- **11:2-12:21** (“Certain channels, most notably Common Reference Signal (CRS) tones and/or DRS tones, have a known sequence. Thus, the channel of the cell to be cancelled can be estimated based on the CRS tones or DRS tones. For example, the UE uses the CRS and/or DRS tones transmitted from an eNB to obtain estimates of the channels between the eNB and the UE. The UE then reconstructs the CRS tones or DRS tones based on the channel estimates and the known sequence and cancels out the CRS tones or DRS tones. In this document, the CRS and/or the DRS reconstruction and cancellation procedure is referred to as “RS interference cancellation.” Control channels (PBCH, PCFICH, PHICH, PDCCH, R-PHICH

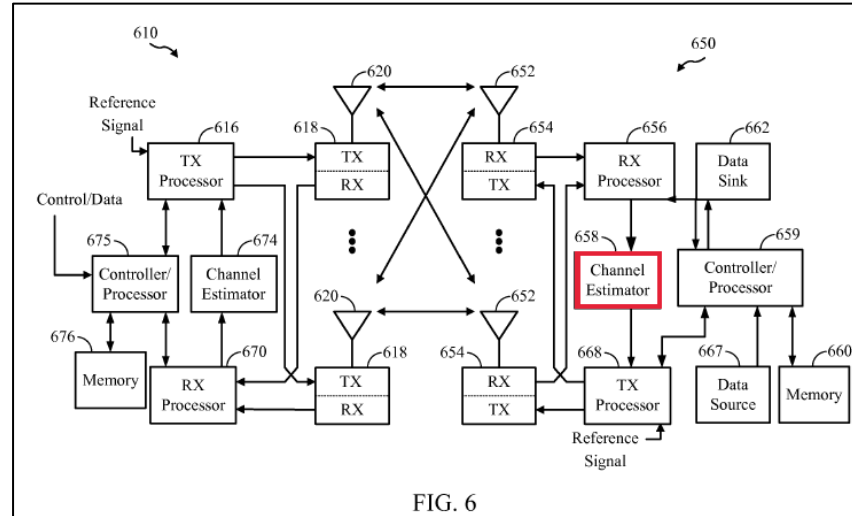
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		(relay-PHICH), R-PDCCH (relay-PDCCH), and the like) and some data channels (PDSCH, R-PDSCH (relay-PDSCH), and the like) have unknown payloads. For control channels and data channels that do not carry a Dedicated Reference Signal (DRS) tones (e.g., Demodulation Reference Signal (DMRS) tones), the UE relies on the channel estimates obtained from the CRS tones to decode, re-encode, reconstruct, and cancel out the channels. For control channels and data channels that have embedded DRS tones (e.g., Demodulation Reference Signal (DMRS) tones), the UE may rely on the channel estimates obtained from the DRS tones (e.g., Demodulation Reference Signal (DMRS) tones) to decode, re-encode, reconstruct, and cancel out the channels. Whether to use a CRS tones or a DRS tones (e.g., Demodulation Reference Signal (DMRS) tones) to obtain a channel estimate may be based at least in part on a type of the channel, transmission mode, and/or other parameters. For example, the Dedicated Reference Signal (DRS) tones may be transmitted for each channel based at least in part on a request. For example, as described above, DRS tones may be imbedded in a same resource block with the control/data channels in order to obtain a channel estimate of a corresponding channel. In this document, the control and/or data channel re-encoding, reconstruction, and cancellation procedure is referred to as "control/data channel interference cancellation."")
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Qualcomm '341 Patent:

• **Figure 6**



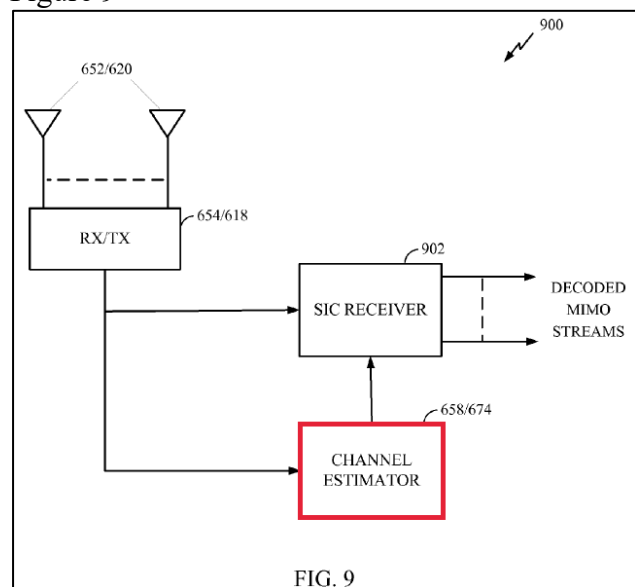
- **9:24-46** (“At the UE 650, each receiver 654RX receives a signal through its respective antenna 652. Each receiver 654RX recovers information modulated onto an RF carrier and provides the information to the receiver (RX) processor 656. The RX processor 656 implements various signal processing functions of the L1 layer. The RX processor 656 performs spatial processing on the information to recover any spatial streams destined for the UE 650. If multiple spatial streams are destined for the UE 650, they may be combined by the RX processor 656 into a single OFDM symbol stream. The RX processor 656 then converts the OFDM symbol stream from the time-domain to the frequency domain using a Fast Fourier Transform (FFT). The frequency domain signal comprises a separate OFDM symbol stream for each subcarrier of the OFDM signal. The symbols on each subcarrier, and the reference signal, is recovered and demodulated by determining the most likely signal constellation points transmitted by the eNB 610. These soft decisions may be based on channel estimates computed by the channel estimator 658. The soft decisions are then decoded and deinterleaved to recover the data and control signals that were originally transmitted by the eNB 610 on the physical channel. The data and control signals are then provided to the controller/processor 659.”)

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		11:26-42 (“In certain aspects, for a 2×2 MIMO system including two streams/layers of data, a receiver (e.g., SIC receiver) may select a stream to decode first based on a gap between the measured SNR and expected SNR for each stream in the received signal. In an aspect, an SNR gap-based metric Γ_i^{SNR} may be determined for each of the streams using the measured SNR γ^{meas} of the stream as received at the receiver and the expected SNR for the stream. The average measured SNR γ^{meas} measured over the last two sub-frames of a received layer is generally available to the receiver from Channel Quality Indicator (CQI) processing. For example, the CQI processing may be performed by channel estimator 658 of UE 650, and/or channel estimator 674 of eNB 610. The measured SNR γ^{meas} and an allocated rate R_i^{alloc} of an layer may be used to form an SNR margin metric Γ_i^{SNR} as shown below: $\Gamma_i^{\text{SNR}} = \frac{\gamma_i^{\text{meas}}}{2^{R_i^{\text{alloc}}} - 1}$ (Error! No text of specified style in document . . . 1) In an aspect, the expression $2^{R_i^{\text{alloc}}} - 1$ denotes an expected SNR for the ith layer. Once the SNR margin metric Γ_i^{SNR} is determined for both layers, a layer k with the largest SNR margin metric Γ_i^{SNR} may be chosen as the Stage 1 decode layer, by comparison of the metric corresponding to each layer, as follows: $k = \underset{i}{\text{argmax}}(\Gamma_i^{\text{SNR}})$
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• **Figure 9**

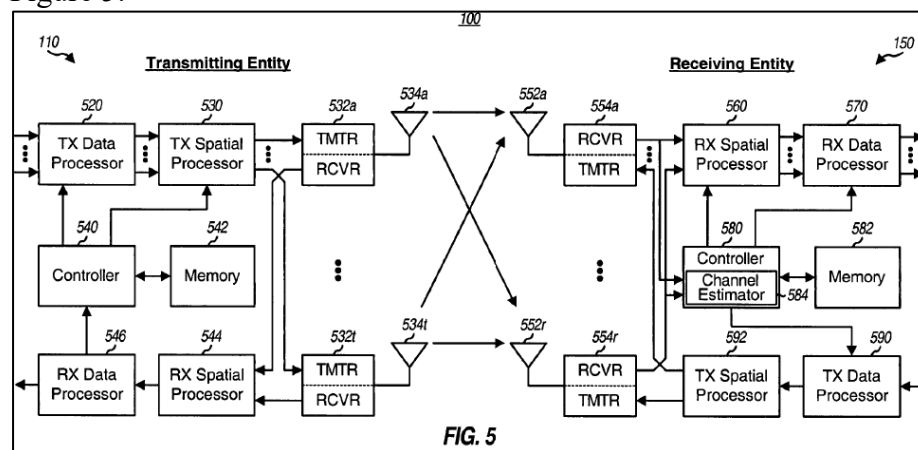


15:41-56 (“In an aspect, the receiver 900 may either be UE 650 or eNB 610, as the SIC ordering approaches discussed above may be implemented by both UE 650 and eNB 610. The receiver 900 may include a transceiver 654/618 for receiving MIMO signals via antennas 652/620. The number of antennas employed by the receiver 900 is based on the order of the MIMO system. For example, the receiver 900 may include N antennas for an NXN MIMO system. Channel estimator 658/674 may determine channel quality for each of the streams/layers received by the transceiver 654/618 for use by the SIC receiver 902 in decoding the MIMO streams. For example, the channel estimator 658/674 may determine the measured SNR γ^{meas} discussed above. The SIC receiver 902 is responsible to implement the SIC ordering approaches discussed above, including the SNR gap-based metric approach, the Rate gap-based metric approach, and the Speculative Single Code Block Based Ordering approach, to decode the received MIMO streams. The SIC receiver may include controller 659/675, RX processor 656/670, or a combination thereof.”)

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Qualcomm '042 Patent:

• **Figure 5:**



- **14:47-62** (“At receiving entity 150, N_R antennas 552 *a* through 552 *r* receive the N_T transmitted signals, and each antenna 552 provides a received signal to a respective receiver unit (RCVR) 554. Each receiver unit 554 performs processing complementary to that performed by transmitter unit 532 (including OFDM demodulation, if applicable) and provides (1) received data symbols to an RX spatial processor 560 and (2) received pilot symbols to a channel estimator 584 within a controller 580. RX spatial processor 560 performs receiver spatial processing and spatial despreading on N_R received symbol streams from N_R receiver units 554 with spatial filter matrices and steering matrices, respectively, from controller 580 and provides N_S recovered symbol streams. An RX data processor 570 then processes (e.g., demaps, deinterleaves, and decodes) the recovered symbols and provides decoded data.”)

14:63-15:16 (“Channel estimator 584 may derive $\hat{H}(m)$, which is an estimate of the channel response matrix $H(m)$, based on pilot symbols transmitted without spatial spreading. Alternatively, channel estimator 584 may directly derive $\hat{H}_{eff}(m)$, which is an estimate of the effective channel response matrix $H_{eff}(m)$, based on pilot symbols transmitted with spatial spreading. In any case, $\hat{H}(m)$ or $\hat{H}_{eff}(m)$ may be used to derive the spatial filter matrix. Channel estimator 584 further estimates the SNR of each transmission channel based on received pilot symbols and/or received data symbols. The MIMO channel includes N_S transmission channels for each subband, but these transmission

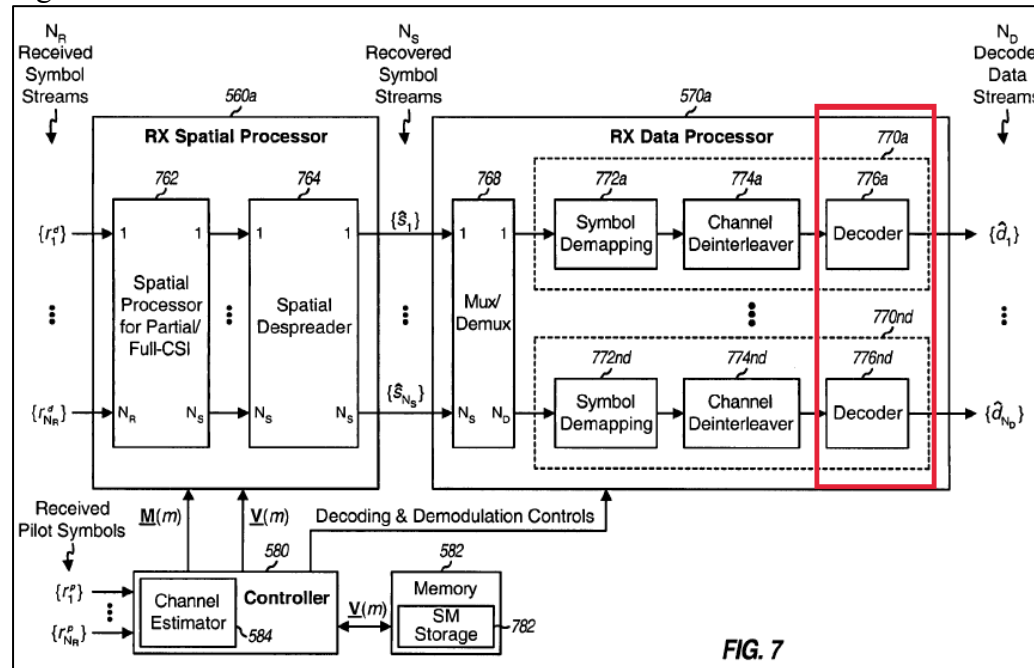
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		channels can be different depending on (1) whether full-CSI or partial-CSI transmission is used, (2) whether or not spatial spreading was performed, and (3) the specific spatial processing technique used by the receiving entity. Controller 580 selects a suitable rate for each transmission channel based on its SNR. Each selected rate is associated with a particular coding scheme and a particular modulation scheme, which collectively determine a data rate. The same or different rates may be selected for the NS transmission channels.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.c	a bank of K decoders communicating with the K MUD module outputs, the bank of K decoders producing a bn output to the MUD module from the input of K MUD module recovered signals;	The Accused ’946 Instrumentalities include a bank of K decoders communicating with the K MUD module outputs, the bank of K decoders producing a bn output to the MUD module from the input of K MUD module recovered signals. The information streams output by the MUD module (i.e., K recovered signals) are provided to a bank of K decoders (one decoder for each recovered signal). The output of the bank of decoders is used by the MUD module to provide better symbol estimates in an iterative process. <u>Qualcomm ’042 Patent:</u> • 2:66-3:12 (“A receiving entity obtains N_R received symbol streams via N_R receive antennas and performs receiver spatial processing for full-CSI or partial-CSI transmission to obtain N_S detected symbol streams, which are estimates of the N_S spread symbol streams. The receiving entity further spatially despreads the N_S detected symbol streams with the same steering matrices used by the transmitting entity and obtains N_S recovered symbol streams, which are estimates of the N_S data symbol streams. The receiver spatial processing and spatial despreading may be performed jointly or separately. The receiving entity then processes (e.g., demodulates, deinterleaves, and decodes) each block of recovered symbols in the N_S recovered symbol streams to obtain a corresponding decoded data packet.”) • 10:20-43 (“FIG. 4 shows a process 400 performed by the receiving entity to receive data transmitted with spatial spreading in the MIMO system. The receiving entity obtains N_R received symbol streams (denoted by vector r) via the N_R receive antennas (block 412).

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The receiving entity estimates the response of the MIMO channel (block 414), performs spatial processing for full-CSI or partial-CSI transmission based on the MIMO channel estimate, and obtains N_S detected symbol streams (denoted by a vector $\hat{\mathbf{w}}$ in FIG. 2) (block 416). The receiving entity further spatially despreads the N_S detected symbol streams with the same steering matrices used by the transmitting entity and obtains N_S recovered symbol streams (denoted by vector $\hat{\mathbf{s}}$) (block 418). The receiver spatial processing and spatial despreading may be performed jointly or separately, as described above. The receiving entity then processes (e.g., demodulates deinterleaves, and decodes) each block of recovered symbols in the N_S recovered symbol streams to obtain a corresponding decoded data packet (block 420). The receiving entity may also estimate the SNR of each transmission channel used for data transmission and select a suitable rate for the transmission channel based on its SNR (block 422). The same or different rates may be selected for the N_S transmission channels.”)

• Figure 7:

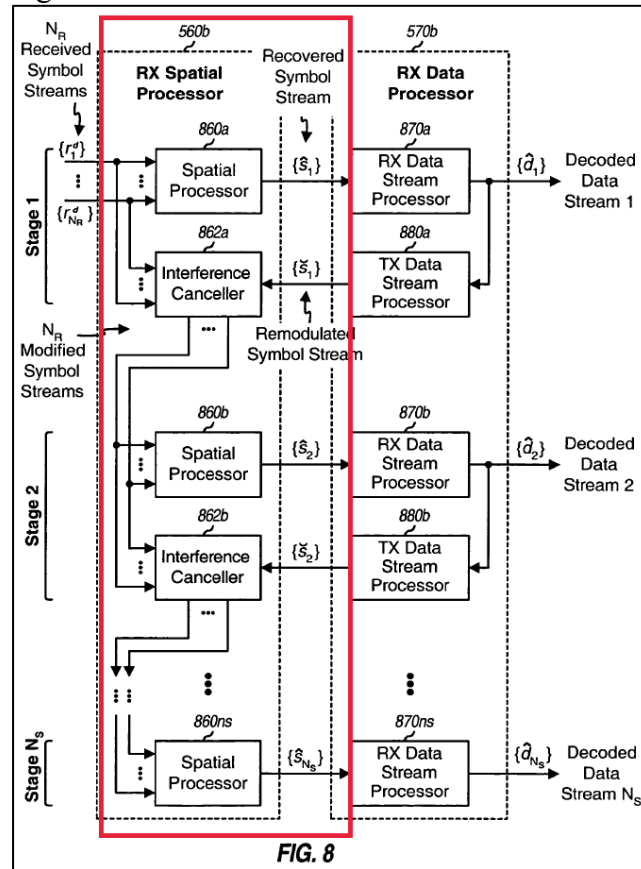


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		• 17:10-30 (“For the embodiment shown in FIG. 7, RX data processor 570 <i>a</i> includes a multiplexer/demultiplexer (Mux/Demux) 768 and N_D RX data stream processors 770 <i>a</i> through 770 <i>nd</i> for the N_D data streams. Mux/Demux 768 receives and multiplexes/demultiplexes the N_S recovered symbol streams for the N_S transmission channels into N_D recovered symbol streams for the N_D data streams. Within each RX data stream processor 770, a symbol demapping unit 772 demodulates the recovered symbols for its data stream in accordance with the modulation scheme used for that stream and provides demodulated data. A channel deinterleaver 774 deinterleaves the demodulated data in a manner complementary to the interleaving performed on that stream by transmitting entity 110. A decoder 776 decodes the deinterleaved data in a manner complementary to the encoding performed by transmitting entity 110 on that stream. For example, a Turbo decoder or a Viterbi decoder may be used for decoder 776 if Turbo or convolutional coding, respectively, is performed by transmitting entity 110. Decoder 776 provides a decoded data stream, which includes a decoded data packet for each data symbol block.”)
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• Figure 8:



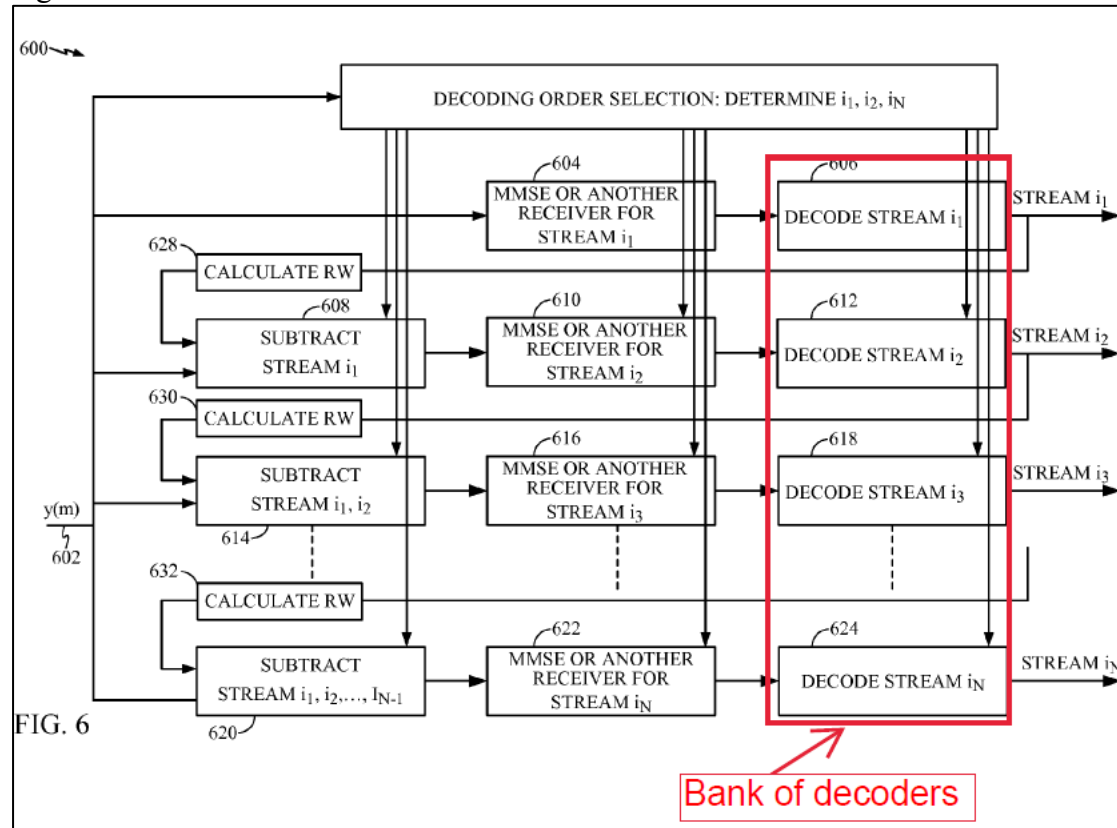
17:46-63 (“For stage 1, spatial processor 860 *a* performs receiver spatial processing on the N_R received symbol streams and provides one recovered symbol stream $\{\hat{s}_1\}$. RX data stream processor 870 *a* demodulates, deinterleaves, and decodes the recovered symbol stream $\{\hat{s}_1\}$ and provides a corresponding decoded data stream $\{\hat{d}_1\}$. TX data stream processor 880 *a* encodes, interleaves, and modulates the decoded data stream $\{\hat{d}_1\}$ in the same manner performed by transmitting entity 110 for that stream and provides a remodulated symbol stream $\{\hat{s}_1\}$. Interference canceller 862 *a* spatially spreads the remodulated symbol stream $\{\hat{s}_1\}$ with the steering matrix $V(m)$ and further multiplies

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		the results with the channel response matrix $\hat{H}(m)$ to obtain N_R interference components due to data symbol stream $\{s_1\}$. The N_R interference components are subtracted from the N_R received symbol streams to obtain N_R modified symbol streams, which are provided to stage 2.”) <u>Qualcomm ’994 Patent:</u> 7:49-65 (“FIG. 4 illustrates a MIMO receiver utilizing successive interference cancellation. A composite received signal vector $y(m)$ 402 enters a SIC system 400 of the MIMO receiver for decoding. The composite received signal $y(m)$ consists of a plurality of separately encoded blocks of data or ‘streams.’ The received signal $y(m)$ passes through a receiver 404 for estimation and detection of the symbols of a first stream of data. The receiver may employ minimum mean square error (MMSE) or any general linear or non-linear estimator/detector. The detected symbols of the first stream enter a first channel decoder 406 for decoding. In 408, the decoded stream is subtracted from the received composite signal $y(m)$, which passes through a second receiver 410 and a second decoder 412 to detect and decode the second stream, respectively. After decoding, both of the first and second streams of data are subtracted, at 414, from the received composite signal $y(m)$ to decode the third stream. The process may continue with subtraction, at 420, utilizing receiver 422 and decoder 424 until all the N streams are decoded. The decoders 406, 412 and 418 may decode any kind of error correcting code, such as turbo or convolutional codes. The decoders 406, 412 and 418 may decode a plurality of encoded streams with a plurality of types and code rates. The subtraction operation may not be performed if the decoding operation fails at any step. Each successful decode and subtract operation of the SIC system is referred to herein as one ‘iteration.’”) 8:20-29 (“As illustrated, components with similar functionality may be repeated for different iterations and configured to operate on different numbers of streams. For example, components 414 and 420 operate to subtract multiple streams, while 408 subtracts a single stream. In a given iteration, the process may subtract as many streams as successfully decoded up to that iteration. Blocks 410, 416, and 422 may perform similar MMSE operations as block 404, but on different streams. Similarly, Blocks 412, 418, and 424 may perform similar decoding operations as block 406, but on different streams.”)
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• Figure 6:



- **9:25-33** (“As illustrated in FIG. 6, a composite received signal $y(m)$ 602 enters a SIC system 600 with decoding order selection and reconstruction weight calculation. The composite received signal $y(m)$ consists of a plurality of separately encoded streams of data. The decoding order selector 626 determines a decoding order for the N streams of data based on the received SNR of each and the required SNR at the input of each decoder. Based on the selected order, the streams are decoded and subtracted from the received signal.”)
- **9:34-43** (“The received signal $y(m)$ passes through a receiver 604 for estimation and detection of the received symbols of a first stream of data. The receiver 604 may comprise a minimum

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		mean square error (MMSE) or any general linear or non-linear estimator/detector. The detected symbols of the first stream enter the channel decoder 606 for decoding. The decoded stream is re-encoded and re-modulated to reconstruct the first stream. The scale of this reconstructed stream may differ from the scale of the first transmitted stream or the scale of first stream in the received composite signal.”) • 9:56-10:2 (“After decoding, effects of both of the first and second streams of data are subtracted at 614 from the received signal to cancel the interference and condition the received signal to enter the third decoding block 618 for decoding the third stream. The process continues with subtraction 620, receiver operation 622 and decoding 624 until all the streams are decoded. The decoders 606, 612 and 618 may use any kind of error correcting code such as turbo codes. The decoders 606, 612 and 618 may decode a plurality of encoded streams with a plurality of types and code rates. The subtraction operation may not be performed if the decoding operation fails at any step. The decoding order selector may update the decoding order of the remaining streams after each successful decode and subtract operation (i.e., each SIC iteration).”) • 10:3-11 (“As illustrated, components with similar functionality may be repeated for different iterations and configured to operate on different numbers of streams. For example, components 614 and 620 operate to subtract multiple streams, while 608 subtracts a single stream. Blocks 610, 616, and 622 may perform similar MMSE operations as block 604, but on different streams. Similarly, Blocks 612, 618, and 624 may perform similar decoding operations as block 606, but on different streams.”) <u>Qualcomm ’915 Patent:</u> • 8:57-9:4 (“At the UE 120, the antennas 452 a through 452 r may receive the downlink signals from the base station 110 and may provide received signals to the demodulators (DEMODs) 454 a through 454 r, respectively. Each demodulator 454 may condition (e.g., filter, amplify, downconvert, and digitize) a respective received signal to obtain input samples. Each demodulator 454 may further process the input samples (e.g., for OFDM, etc.) to obtain received symbols. A MIMO detector 456 may obtain received symbols from all the demodulators 454 a through 454 r, perform MIMO detection on the received symbols if applicable, and provide detected symbols. A receive processor 458 may process (e.g., demodulate, deinterleave, and decode) the detected symbols, provide decoded data for the UE
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		120 to a data sink 460, and provide decoded control information to a controller/processor 480.”) 11:2-12:21 (“Certain channels, most notably Common Reference Signal (CRS) tones and/or DRS tones, have a known sequence. Thus, the channel of the cell to be cancelled can be estimated based on the CRS tones or DRS tones. For example, the UE uses the CRS and/or DRS tones transmitted from an eNB to obtain estimates of the channels between the eNB and the UE. The UE then reconstructs the CRS tones or DRS tones based on the channel estimates and the known sequence and cancels out the CRS tones or DRS tones. In this document, the CRS and/or the DRS reconstruction and cancellation procedure is referred to as “RS interference cancellation.” Control channels (PBCH, PCFICH, PHICH, PDCCH, R-PHICH (relay-PHICH), R-PDCCH (relay-PDCCH), and the like) and some data channels (PDSCH, R-PDSCH (relay-PDSCH), and the like) have unknown payloads. For control channels and data channels that do not carry a Dedicated Reference Signal (DRS) tones (e.g., Demodulation Reference Signal (DMRS) tones), the UE relies on the channel estimates obtained from the CRS tones to decode, re-encode, reconstruct, and cancel out the channels. For control channels and data channels that have embedded DRS tones (e.g., Demodulation Reference Signal (DMRS) tones), the UE may rely on the channel estimates obtained from the DRS tones (e.g., Demodulation Reference Signal (DMRS) tones) to decode, re-encode, reconstruct, and cancel out the channels. Whether to use a CRS tones or a DRS tones (e.g., Demodulation Reference Signal (DMRS) tones) to obtain a channel estimate may be based at least in part on a type of the channel, transmission mode, and/or other parameters. For example, the Dedicated Reference Signal (DRS) tones may be transmitted for each channel based at least in part on a request. For example, as described above, DRS tones may be imbedded in a same resource block with the control/data channels in order to obtain a channel estimate of a corresponding channel. In this document, the control and/or data channel re-encoding, reconstruction, and cancellation procedure is referred to as "control/data channel interference cancellation."”) 12:22-31 (“There are various techniques to perform control/data channel interference cancellation. For example, the control/data channel interference cancellation may be Cyclic Redundancy Check (CRC)-based IC, wherein the control/data channel is cancelled out only if the decoded payload of the control/data channel passes the CRC. In another example, the control/data channel IC may be soft IC, wherein the control/data channel is cancelled out even
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when it does not pass the CRC, in which case the cancellation is based on soft reconstruction of the transmitted symbols.”)

Qualcomm '341 Patent:

- Figure 6

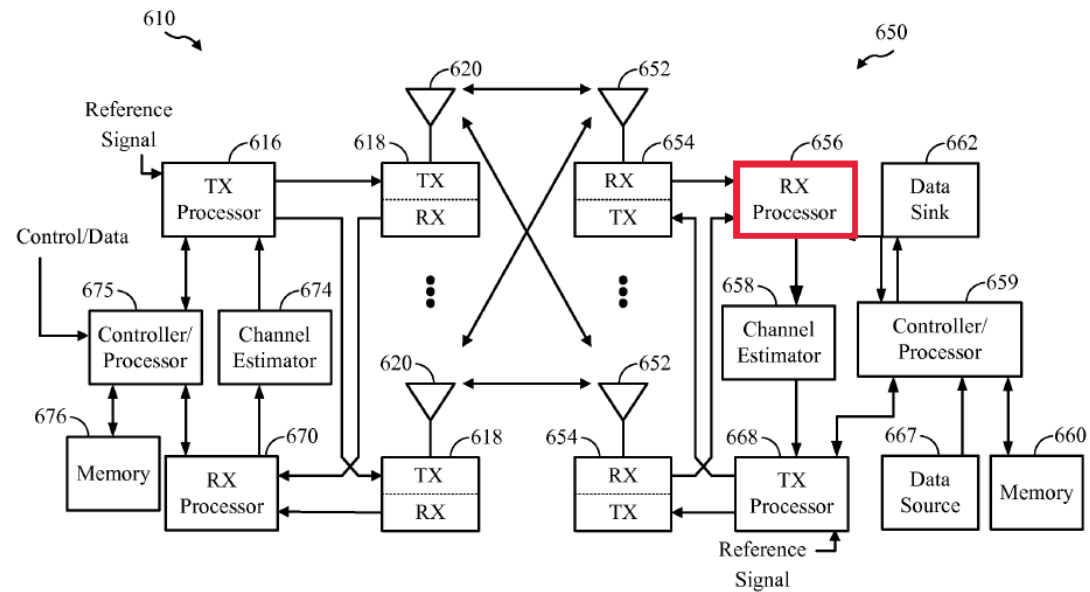


FIG. 6

9:24-46 (“At the UE 650, each receiver 654RX receives a signal through its respective antenna 652. Each receiver 654RX recovers information modulated onto an RF carrier and provides the information to the receiver (RX) processor 656. The RX processor 656 implements various signal processing functions of the L1 layer. The RX processor 656 performs spatial processing on the information to recover any spatial streams destined for the UE 650. If multiple spatial streams are destined for the UE 650, they may be combined by the RX processor 656 into a single OFDM symbol stream. The RX processor 656 then converts the OFDM symbol stream from the time-domain to the frequency domain using a Fast Fourier Transform (FFT). The frequency domain signal comprises a separate OFDM symbol stream for each subcarrier of the OFDM signal. The symbols on each subcarrier, and the reference signal, is recovered and demodulated by determining the most likely

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		signal constellation points transmitted by the eNB 610. These soft decisions may be based on channel estimates computed by the channel estimator 658. The soft decisions are then decoded and deinterleaved to recover the data and control signals that were originally transmitted by the eNB 610 on the physical channel. The data and control signals are then provided to the controller/processor 659.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.d.1	a data formatting module operatively coupled to the parallel K MUD module outputs of the MUD module, and configured to produce network data packets of the parallel K recovered signals	The Accused ’946 Instrumentalities include a data formatting module operatively coupled to the parallel K MUD module outputs of the MUD module, and configured to produce network data packets of the parallel K recovered signals. See disclosures of 1.b. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.d.2	the parallel K recovered signal data packets communicated to a demultiplexer, wherein the data formatting module supports multiple types of network packet format modes;	The parallel K recovered signal data packets of the Accused ’946 Instrumentalities are communicated to a demultiplexer, wherein the data formatting module supports multiple types of network packet format modes. See disclosures of 1.d.1; 1.d.3. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.

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10.e.1	the demultiplexer operatively coupled to the data formatting module, receiving the parallel K recovered signal data packets, and configured to select one of the recovered K wirelessly transmitted signals as a target signal intended for a user, m, associated with the modem, and to communicate m data packets of the K recovered signal data packets to a recipient,	The demultiplexer of the Accused '946 Instrumentalities is operatively coupled to the data formatting module, receiving the parallel K recovered signal data packets, and configured to select one of the recovered K wirelessly transmitted signals as a target signal intended for a user, m, associated with the modem, and to communicate m data packets of the K recovered signal data packets to a recipient. See disclosures of 1.d.1. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.e.2	where the selection <i>[of one of the recovered K wirelessly transmitted signals intended for a user]</i> is based on a control input from a control processor;	The selection of one of the recovered K wirelessly transmitted signals intended for a user by the demultiplexer of the Accused '946 Instrumentalities is based on a control input from the control processor. See disclosures of 1.d.2. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be

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		insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.f.1	the control processor operatively coupled to the demultiplexer and the data formatting module, and configured to detect with which protocol mode the at least one of the K recovered signals was transmitted , based on input from the data formatting module,	The control processor of the Accused '946 Instrumentalities is operatively coupled to the demultiplexer and the data formatting module, and configured to detect with which protocol mode the at least one of the K recovered signals was transmitted, based on input from the data formatting module. The control processor controls operations of each of the components, including the demultiplexer and data formatting module, and is therefore coupled to them. The Physical Downlink Control Channel (PDCCH) carries downlink control information (DCI) comprised of scheduling assignments and other control information to the Accused '946 Instrumentalities. The DCIs carry transport format information, scheduling assignments and other control information for the downlink shared channel (DL-SCH) and uplink shared channel (UL-SCH), among others. The DCI has various formats and describe the data transmitted to the Accused '946 Instrumentalities. After receiving and decoding the PDCCH signal, a control processor will detect with which protocol mode the K wireless signals was transmitted by reading the DCI information. The protocols may include, e.g., MIMO and SISO (non-MIMO). The data formatting module obtains the contents of the PDCCH channel for processing by the control processor. See disclosures of 1.c.1. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.f.2	<i>[the control processor ... configured to ...]</i> and to enable a	The control processor of the Accused '946 Instrumentalities is configured to enable a corresponding transmission mode including one of a legacy protocol mode and a bandwidth efficient aggressive access protocol mode that exploits co-channel demodulation capabilities of the modem.

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	corresponding transmission mode including one of a legacy protocol mode and a bandwidth efficient aggressive access protocol mode that exploits co-channel demodulation capabilities of the modem,	See disclosures of 1.c.2. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.f.3	the control processor also configured to select a network data packet formatting mode in which the data formatting operates	The control processor of the Accused '946 Instrumentalities is also configured to select a network data packet formatting mode in which the data formatting operates. See disclosures of 1.d.4. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.g	a modulator operatively coupled to the control processor, the control processor enabling the transmission mode of the modulator, the transmission mode	The Accused '946 Instrumentalities include a modulator operatively coupled to the control processor, the control processor enabling the transmission mode of the modulator, the transmission mode corresponding to the protocol mode in which the at least one of the K recovered signals was transmitted. The modulator of the Accused '946 Instrumentalities is used to modulate transmissions from the Accused '946 Instrumentalities to the base station. The transmission mode of the modulated signal (e.g., MIMO vs non-MIMO) will correspond to the protocol mode of the received signals. <u>TS 36.213:</u>

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corresponding to the protocol mode in which the at least one of the K recovered signals was transmitted; and

- § 8.0 (“If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the C-RNTI, the UE shall decode the PDCCH according to the combination defined in Table 8-3 and transmit the corresponding PUSCH if a transport block corresponding to the HARQ process of the PUSCH transmission is generated as described in [8]. The scrambling initialization of this PUSCH corresponding to these PDCCHs and the PUSCH retransmission for the same transport block is by C-RNTI.”)
- Table 8.3:

Uplink protocol corresponds to downlink protocol

Table 8-3: PDCCH and PUSCH configured by C-RNTI

Transmission mode	DCI format	Search Space	Transmission scheme of PUSCH corresponding to PDCCH
Mode 1	DCI format 0	Common and UE specific by C-RNTI	Single-antenna port, port 10 (see Subclause 8.0.1)
	DCI format 0A or 0B or 0C or 7-0A	UE specific by C-RNTI	Single-antenna port, port 10 (see Subclause 8.0.1)
Mode 2	DCI format 0	Common and UE specific by C-RNTI	Single-antenna port, port 10 (see Subclause 8.0.1)
	DCI format 0A or 0B or 0C	UE specific by C-RNTI	Single-antenna port, port 10 (see Subclause 8.0.1)
	DCI format 4 or 4A or 4B or 7-0B	UE specific by C-RNTI	Closed-loop spatial multiplexing (see Subclause 8.0.2)
- § 8.0 (“If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the SPS C-RNTI or UL-SPS-VRNTI, the UE shall decode the PDCCH according to the combination defined in Table 8-5 and transmit the corresponding PUSCH if a transport block corresponding to the HARQ process of the PUSCH transmission is generated as described in [8] except when the UE is configured with higher layer parameter *shortProcessingTime* and with DCI format 0 mapped onto the UE-specific search space.”)

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• **Table 8.5:**

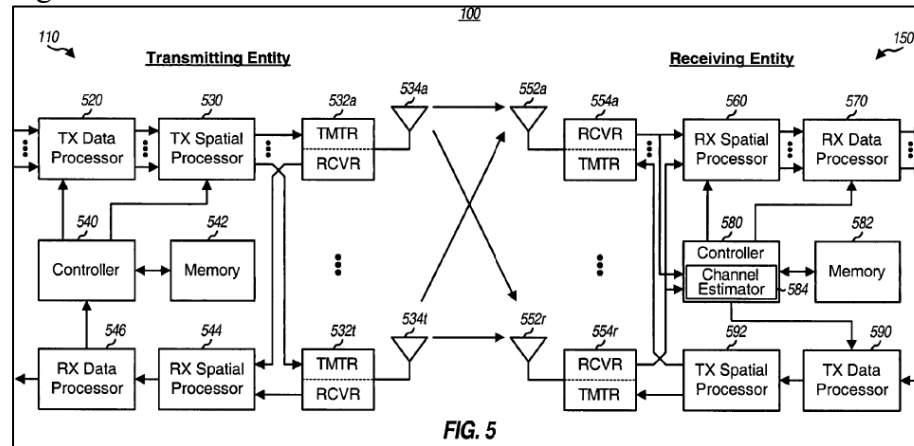
Uplink protocol corresponds
to downlink protocol

Table 8-5: PDCCH and PUSCH configured by SPS C-RNTI or UL-SPS-V-RNTI

Transmission mode	DCI format	Search Space	Transmission scheme of PUSCH corresponding to PDCCH
Mode 1	DCI format 0	Common and UE specific by C-RNTI	Single-antenna port, port 10 (see Subclause 8.0.1)
	DCI format 7-0A	UE specific by C-RNTI	
Mode 2	DCI format 0	Common and UE specific by C-RNTI	Single-antenna port, port 10 (see Subclause 8.0.1)
	DCI format 7-0B	UE specific by C-RNTI	

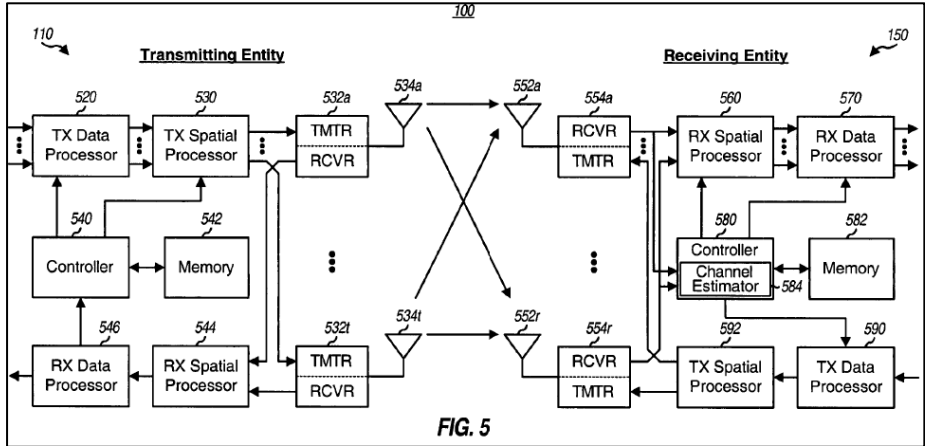
Qualcomm '042 Patent:

• **Figure 5:**



- **14:32-46** (“FIG. 5 shows a block diagram of transmitting entity **110** and receiving entity **150**. At transmitting entity **110**, a TX data processor **520** receives and processes (e.g., encodes, interleaves, and modulates) data and provides data symbols. A TX spatial processor **530** receives the data symbols, performs spatial spreading and spatial processing for full-CSI or partial-CSI transmission, multiplexes in pilot symbols, and provides N_T transmit symbol streams to N_T transmitter units (TMTR) **532 a** through **532 t**. Each transmitter unit **532** performs OFDM modulation (if applicable) and further conditions (e.g., converts to

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		analog, filters, amplifies, and frequency upconverts) a respective transmit symbol stream to generate a modulated signal. N_T transmitter units 532 a through 532 t provide N_T modulated signals for transmission from N_T antennas 534 a through 534 t, respectively.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
10.h	an amplifier operatively coupled to the modulator, the amplifier in communication with at least one antenna output port.	The Accused '946 Instrumentalities include an amplifier operatively coupled to the modulator, the amplifier in communication with at least one antenna output port. The amplifier of the Accused '946 Instrumentalities will amplify the transmission signal and provide it to one or more transmitting antennas for transmission over the air to the base station. Qualcomm '042 Patent: Figure 5:  FIG. 5 14:32-46 (“FIG. 5 shows a block diagram of transmitting entity 110 and receiving entity 150. At transmitting entity 110, a TX data processor 520 receives and processes (e.g., encodes, interleaves, and modulates) data and provides data symbols. A TX spatial processor 530 receives the data symbols, performs spatial spreading and spatial processing for full-CSI or partial-CSI transmission,

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		multiplexes in pilot symbols, and provides N_T transmit symbol streams to N_T transmitter units (TMTR) 532 a through 532 t. Each transmitter unit 532 performs OFDM modulation (if applicable) and further conditions (e.g., converts to analog, filters, amplifies, and frequency upconverts) a respective transmit symbol stream to generate a modulated signal. N_T transmitter units 532 a through 532 t provide N_T modulated signals for transmission from N_T antennas 534 a through 534 t, respectively.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
11.pre	11. The modem of claim 10, further comprising:	The Accused '946 Instrumentalities include the modem of Claim 10 (<i>see</i> Claim 10).
11.a	a front end receiver block comprising a plurality, D, of antenna diversity ports, a plurality of D tuners, and the plurality of D A/D converters;	The Accused '946 Instrumentalities further include a front end receiver block comprising a plurality, D, of antenna diversity ports, a plurality of D tuners, and the plurality of D A/D converters. See disclosures of 20.a. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
11.b	the plurality, D, of antenna diversity ports communicating, respectively, with D antennas;	The Accused '946 Instrumentalities further include the plurality, D, of antenna diversity ports communicating, respectively, with D antennas. See disclosures of 20.b. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.

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11.c	the plurality of D tuners communicating, respectively, with the D antenna diversity ports;	The Accused '946 Instrumentalities further include the plurality of D tuners communicating, respectively, with the D antenna diversity ports. See disclosures of 20.c. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
11.d	the plurality of D A/D converters communicating, respectively, with the D tuners, each outputting a baseband waveform, respectively corresponding to each of the D antenna diversity ports.	The Accused '946 Instrumentalities further include the plurality of D A/D converters communicating, respectively, with the D tuners, each outputting a baseband waveform, respectively corresponding to each of the D antenna diversity ports. See disclosures of 20.d. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
	12. The modem of claim 10, wherein the m data packets of the K recovered signal data packets are formatted for and provided to a network, where the selection is based on a control input	The Accused '946 Instrumentalities include the modem of claim 10 (<i>see</i> claim 10), wherein the m data packets of the K recovered signal data packets are formatted for and provided to a network, where the selection is based on a control input from the control processor. See disclosures of 1.d. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.

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	from the control processor.	
	13. The modem of claim 10, wherein the m data packets of the K recovered signal data packets are formatted for and provided to a backbone, where the selection is based on a control input from the control processor.	The Accused '946 Instrumentalities include the modem of claim 10 (<i>see</i> claim 10), wherein the m data packets of the K recovered signal data packets are formatted for and provided to a backbone, where the selection is based on a control input from the control processor. See disclosures of 1.d. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
	14. The modem of claim 10, wherein the m data packets of the K recovered signal data packets are formatted for and provided to a local host, where the selection is based on a control input from the control processor.	The Accused '946 Instrumentalities include the modem of claim 10 (<i>see</i> claim 10), wherein the m data packets of the K recovered signal data packets are formatted for and provided to a local host, where the selection is based on a control input from the control processor. See disclosures of 1.d. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
	15. The modem of claim 10, wherein the data formatting module provides packet header information to the control processor	The Accused '946 Instrumentalities include the modem of claim 10 (<i>see</i> claim 10), wherein the data formatting module provides packet header information to the control processor for each of received signals 1-K. See disclosures of 1b (discussing formatting module), 1.c.1 (discussing control processor), and 1.d.1 (discussing header information and target signal intended for a user).

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	for each of received signals 1-K.	If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
	16. The modem of claim 15, wherein the packet header information of a data signal comprises intended destination of that data signal, whereby the data signal intended for a particular modem can be identified, while other received data signals are ignored.	The Accused '946 Instrumentalities include the modem of claim 10 (<i>see</i> claim 10), wherein the packet header information of a data signal comprises intended destination of that data signal, whereby the data signal intended for a particular modem can be identified, while other received data signals are ignored. See disclosures of 15 and 1.d.1 (discussing header information and target signal intended for a user). If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.pre	20. A modem which enables efficient use of bandwidth in a multiuser wireless network including a plurality of modems in the presence of interference and noise, the modem comprising:	To the extent that the preamble is found to be limiting, the Accused '946 Instrumentalities include a modem which enables efficient use of bandwidth in a multiuser wireless network including a plurality of modems in the presence of interference and noise. See disclosures of 1.pre; 10.pre.

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20.a	a front end receiver block comprising a plurality, D, of antenna diversity ports, a plurality of D tuners, and a plurality of D analog to digital (A/D) converters;	The Accused '946 Instrumentalities include a front end receiver block comprising a plurality, D, of antenna diversity ports, a plurality of D tuners, and a plurality of D analog to digital (A/D) converters. The Accused '946 Instrumentalities have two or more antennas (e.g., 2 antennas for 2x2 MIMO or 4 antennas for 4x4 MIMO) that receive the data streams. Each antenna will have, in the front end receiver block of the Accused '946 Instrumentalities, an associated antenna diversity port for connecting the antenna, a tuner for tuning to the appropriate radio frequency, and an A/D converter for converting the received analog signal to a digital signal that can be further processed by the Accused '946 Instrumentalities. Qualcomm '915 Patent: Figure 4: FIG. 4
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- 8:57-9:4** (“At the UE 120, the antennas 452 a through 452 r may receive the downlink signals from the base station 110 and may provide received signals to the demodulators (DEMOMs) 454 a through 454 r, respectively. Each demodulator 454 may condition (e.g., filter, amplify, downconvert, and digitize) a respective received signal to obtain input samples. Each demodulator 454 may further process the input samples (e.g., for OFDM, etc.) to obtain received symbols. A MIMO detector 456 may obtain received symbols from all the demodulators 454 a through 454 r, perform MIMO detection on the received symbols if

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		applicable, and provide detected symbols. A receive processor 458 may process (e.g., demodulate, deinterleave, and decode) the detected symbols, provide decoded data for the UE 120 to a data sink 460, and provide decoded control information to a controller/processor 480.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.b	the plurality, D, of antenna diversity ports communicating, respectively, with D antennas;	The plurality, D, of antenna diversity ports of the Accused ’946 Instrumentalities communicate, respectively, with D antennas. The antennas provide the received signals to the antenna diversity ports of the Accused ’946 Instrumentalities. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.c	the plurality of D tuners communicating, respectively, with the D antenna diversity ports;	The plurality of D tuners of the Accused ’946 Instrumentalities communicate, respectively, with the D antenna diversity ports. The tuners of the Accused ’946 Instrumentalities are coupled to and communicate with the antenna diversity ports. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.d	the plurality of D A/D converters communicating,	The plurality of D A/D converters of the Accused ’946 Instrumentalities communicate, respectively, with the D tuners, each outputting a baseband waveform, respectively corresponding to each of the D antenna diversity ports.

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	respectively, with the D tuners, each outputting a baseband waveform, respectively corresponding to each of the D antenna diversity ports;	The tuners of the front end unit of the Accused '946 Instrumentalities downconverts the received RF signal to a baseband waveform, in analog format. Each analog baseband signal is provided to a separate A/D converter to convert the analog signal to digital. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.e	a multiuser detection (MUD) module receiving D inputs from the D A/D converters , wherein the MUD module is configured to simultaneously demodulate and recover K wirelessly transmitted signals using co-channel demodulation, simultaneously outputting K recovered signals;	The Accused '946 Instrumentalities include a multiuser detection (MUD) module receiving D inputs from the D A/D converters, wherein the MUD module is configured to simultaneously demodulate and recover K wirelessly transmitted signals using co-channel demodulation, simultaneously outputting K recovered signals. See disclosures of 10.a. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.f.1	a parameter estimator module receiving the D	The Accused '946 Instrumentalities include a parameter estimator module receiving the D inputs from the D A/D converters. See disclosures of 10.b.

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	inputs from the D A/D converters,	If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.f.2	wherein the parameter estimator estimates the relative received timing offsets, phases, received amplitudes, and multipath structure for each of the interfering signals present in the received signal, outputting parameter estimation matrix S to the MUD module;	The parameter estimator of the Accused '946 Instrumentalities estimates the relative received timing offsets, phases, received amplitudes, and multipath structure for each of the interfering signals present in the received signal, outputting parameter estimation matrix S to the MUD module. Channel estimation in the Accused '946 Instrumentalities includes estimation of timing offsets, phases, amplitudes, and multipath structure for each of the received MIMO layers. The parameter estimator outputs a channel matrix used by the MUD module to perform multiuser detection. <u>LTE–The UMTS Long Term Evolution</u> • 166 (“In order to estimate the channel as accurately as possible, all correlations between channel coefficients in time, frequency and space should be taken into account. Since RSs are sent only on particular OFDM REs (i.e. on particular OFDM symbols on particular subcarriers), channel estimates for the REs which do not bear RSs have to be computed via interpolation. The optimal interpolating channel estimator in terms of mean-squared error is based on a two-dimensional Wiener filter interpolation [4]. Due to the high complexity of such a filter, a trade-off between complexity and accuracy is achieved by using one-dimensional filters. In Sections 8.4, 8.5 and 8.6, the problem of channel estimation is approached from a theoretical point of view, and some possible solutions are described.”) • 168 (“The cell-specific RSs enable the UE to determine the phase reference for demodulating the downlink control channels (see Section 9.3) and the downlink data in most transmission modes1 of the Physical Downlink Shared Channel (PDSCH – see Section 9.2.2). If UE-specific precoding is applied to the PDSCH data symbols before transmission,2 downlink control signalling is provided to inform the UE of the corresponding phase adjustment it should apply relative to the phase reference provided by the cell-specific RSs. The cell-specific RSs are also used by the UEs to generate Channel State Information (CSI) feedback (see Sections 10.2.1 and 11.2.2.4).”)

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		184 (“It is assumed that an LTE UE has multiple receiving antennas. Consequently, whenever the channel is correlated in the spatial domain, the correlation can be exploited to provide a further means for enhancing the channel estimate.”) If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.g	a bank of K decoders communicating with the K MUD module outputs, the bank of K decoders producing a bn output to the MUD module from the input of K MUD module recovered signals;	The Accused '946 Instrumentalities include a bank of K decoders communicating with the K MUD module outputs, the bank of K decoders producing a bn output to the MUD module from the input of K MUD module recovered signals. See disclosures of 10.c. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.h.1	a data formatting module operatively coupled to the parallel K MUD module outputs of the MUD module, and configured to produce network data packets of the parallel K recovered signals,	The Accused '946 Instrumentalities include a data formatting module operatively coupled to the parallel K MUD module outputs of the MUD module, and configured to produce network data packets of the parallel K recovered signals. See disclosures of 1.b; 10.d.1. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.

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20.h.2	the parallel K recovered signal network data packets communicated to a demultiplexer, wherein the data formatting module supports multiple types of network data packet format modes;	The parallel K recovered signal network data packets of the Accused '946 Instrumentalities are communicated to a demultiplexer, wherein the data formatting module supports multiple types of network data packet format modes. See disclosures of 1.d.1; 1.d.3; 10.d.2. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.i.1	the demultiplexer operatively coupled to the data formatting module, receiving the parallel K recovered signal network data packets, and configured to select one of the recovered K wirelessly transmitted signals as a target signal intended for a user, m, associated with the modem, and to communicate m	The demultiplexer of the Accused '946 Instrumentalities is operatively coupled to the data formatting module, receiving the parallel K recovered signal network data packets, and configured to select one of the recovered K wirelessly transmitted signals as a target signal intended for a user, m, associated with the modem, and to communicate m data packets of the K recovered signal data packets to a recipient. See disclosures of 1.d.1; 10.e.1. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.

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	data packets of the K recovered signal data packets to a recipient,	
20.i.2	where the selection <i>[of one of the recovered K wirelessly transmitted signals intended for a user]</i> is based on a control input from a control processor;	The selection of one of the recovered K wirelessly transmitted signals intended for a user by the demultiplexer of the Accused '946 Instrumentalities is based on a control input from the control processor. See disclosures of 1.d.2; 10.e.2. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.j.1	the control processor operatively coupled to the demultiplexer and the data formatting module, and configured to detect with which protocol mode the at least one of the K recovered signals was transmitted , based on input from the data formatting module,	The control processor of the Accused '946 Instrumentalities is operatively coupled to the demultiplexer and the data formatting module, and configured to detect with which protocol mode the at least one of the K recovered signals was transmitted, based on input from the data formatting module. See disclosures of 10.f.1. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.

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20.j.2	<i>[the control processor ... configured to...]</i> and to enable a corresponding transmission mode including one of a legacy protocol mode and a bandwidth efficient aggressive access protocol mode that exploits co-channel demodulation capabilities of the modem,	The control processor of the Accused '946 Instrumentalities is configured to enable a corresponding transmission mode including one of a legacy protocol mode and a bandwidth efficient aggressive access protocol mode that exploits co-channel demodulation capabilities of the modem. See disclosures of 1.c.2; 10.f.2. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.j.3	wherein the signals of the one of a legacy protocol mode comprise low data rate BPSK or QPSK, or BPSK and QPSK,	The Accused '946 Instrumentalities include a legacy protocol mode wherein the signals of the one of a legacy protocol mode comprise low data rate BPSK or QPSK, or BPSK and QPSK. The modulation schemes for non-MIMO legacy protocol mode uplink signals transmitted by the Accused '946 Instrumentalities include BPSK, QPSK, GMSK, and QAM. One of these modulation schemes will be selected depending on the particular legacy protocol mode selected and channel conditions, among other factors. See disclosures of 1.c.3. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.

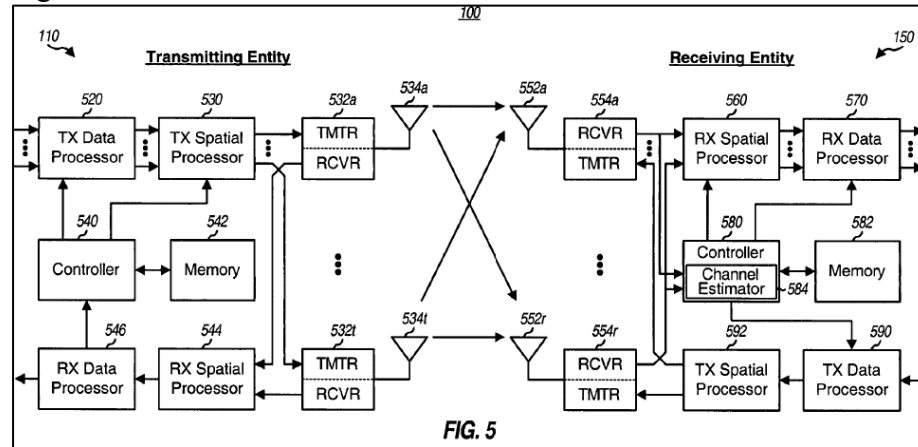
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20.j.4	the control processor also configured to select a network data packet formatting mode in which the data formatting operates;	The control processor of the Accused '946 Instrumentalities is also configured to select a network data packet formatting mode in which the data formatting operates. See disclosures of 1.d.4; 10.f.3. If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.
20.k	a modulator operatively coupled to the control processor, the control processor providing a burst control input , enabling a transmission mode of the modulator, the transmission mode corresponding to the protocol mode in which the at least one of the K recovered signals was transmitted, and an input of data from the user m from the demultiplexer; and	The Accused '946 Instrumentalities include a modulator operatively coupled to the control processor, the control processor providing a burst control input, enabling a transmission mode of the modulator, the transmission mode corresponding to the protocol mode in which the at least one of the K recovered signals was transmitted, and an input of data from the user m from the demultiplexer. The modulator of the Accused '946 Instrumentalities is used to modulate transmissions from the Accused '946 Instrumentalities to the base station. The control processor provides a burst control input to the modulator that enables the transmission mode of the modulated signal (e.g., MIMO vs non-MIMO). The transmission mode will correspond to the protocol mode of the received signals and to the data from the user that is to be transmitted.

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Qualcomm '042 Patent:

• **Figure 5:**



14:32-46 (“FIG. 5 shows a block diagram of transmitting entity **110** and receiving entity **150**. At transmitting entity **110**, a TX data processor **520** receives and processes (e.g., encodes, interleaves, and modulates) data and provides data symbols. A TX spatial processor **530** receives the data symbols, performs spatial spreading and spatial processing for full-CSI or partial-CSI transmission, multiplexes in pilot symbols, and provides N_T transmit symbol streams to N_T transmitter units (TMTR) **532 a** through **532 t**. Each transmitter unit **532** performs OFDM modulation (if applicable) and further conditions (e.g., converts to analog, filters, amplifies, and frequency upconverts) a respective transmit symbol stream to generate a modulated signal. N_T transmitter units **532 a** through **532 t** provide N_T modulated signals for transmission from N_T antennas **534 a** through **534 t**, respectively.”)

If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.

20.1

an amplifier
operatively coupled
to the modulator,

The Accused '946 Instrumentalities include an amplifier operatively coupled to the modulator, the amplifier in communication with at least one antenna output port.

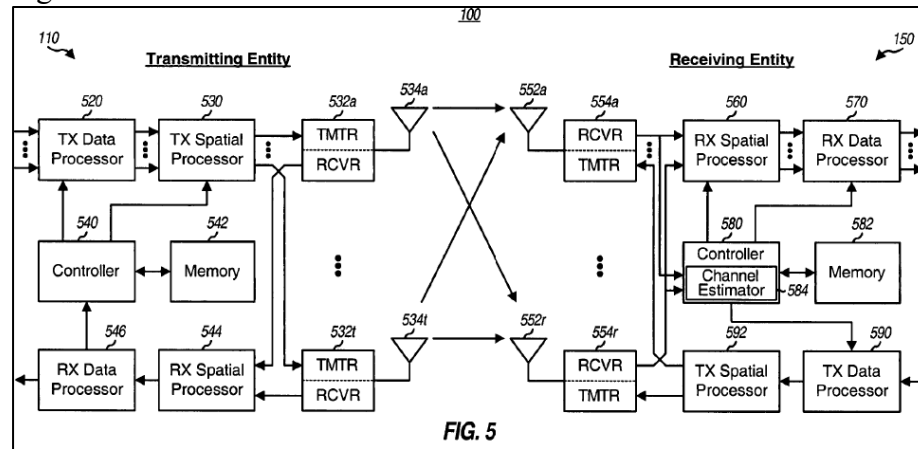
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the amplifier in communication with at least one antenna output port.

The amplifier of the Accused '946 Instrumentalities will amplify the transmission signal and provide it to one or more transmitting antennas for transmission over the air to the base station.

Qualcomm '042 Patent:

- Figure 5:



14:32-46 (“FIG. 5 shows a block diagram of transmitting entity **110** and receiving entity **150**. At transmitting entity **110**, a TX data processor **520** receives and processes (e.g., encodes, interleaves, and modulates) data and provides data symbols. A TX spatial processor **530** receives the data symbols, performs spatial spreading and spatial processing for full-CSI or partial-CSI transmission, multiplexes in pilot symbols, and provides N_T transmit symbol streams to N_T transmitter units (TMTR) **532 a** through **532 t**. Each transmitter unit **532** performs OFDM modulation (if applicable) and further conditions (e.g., converts to analog, filters, amplifies, and frequency upconverts) a respective transmit symbol stream to generate a modulated signal. N_T transmitter units **532 a** through **532 t** provide N_T modulated signals for transmission from N_T antennas **534 a** through **534 t**, respectively.”)

If this element is not literally satisfied by the disclosures cited herein, it is satisfied under the doctrine of equivalents by the disclosures cited herein because the accused functionality would be insubstantially different from or function in the same way to provide the same result as the relevant claim element.

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18. “Dynamic Host Configuration Protocol (DHCP)” (<https://learn.microsoft.com/en-us/windows-server/networking/technologies/dhcp/dhcp-top>)