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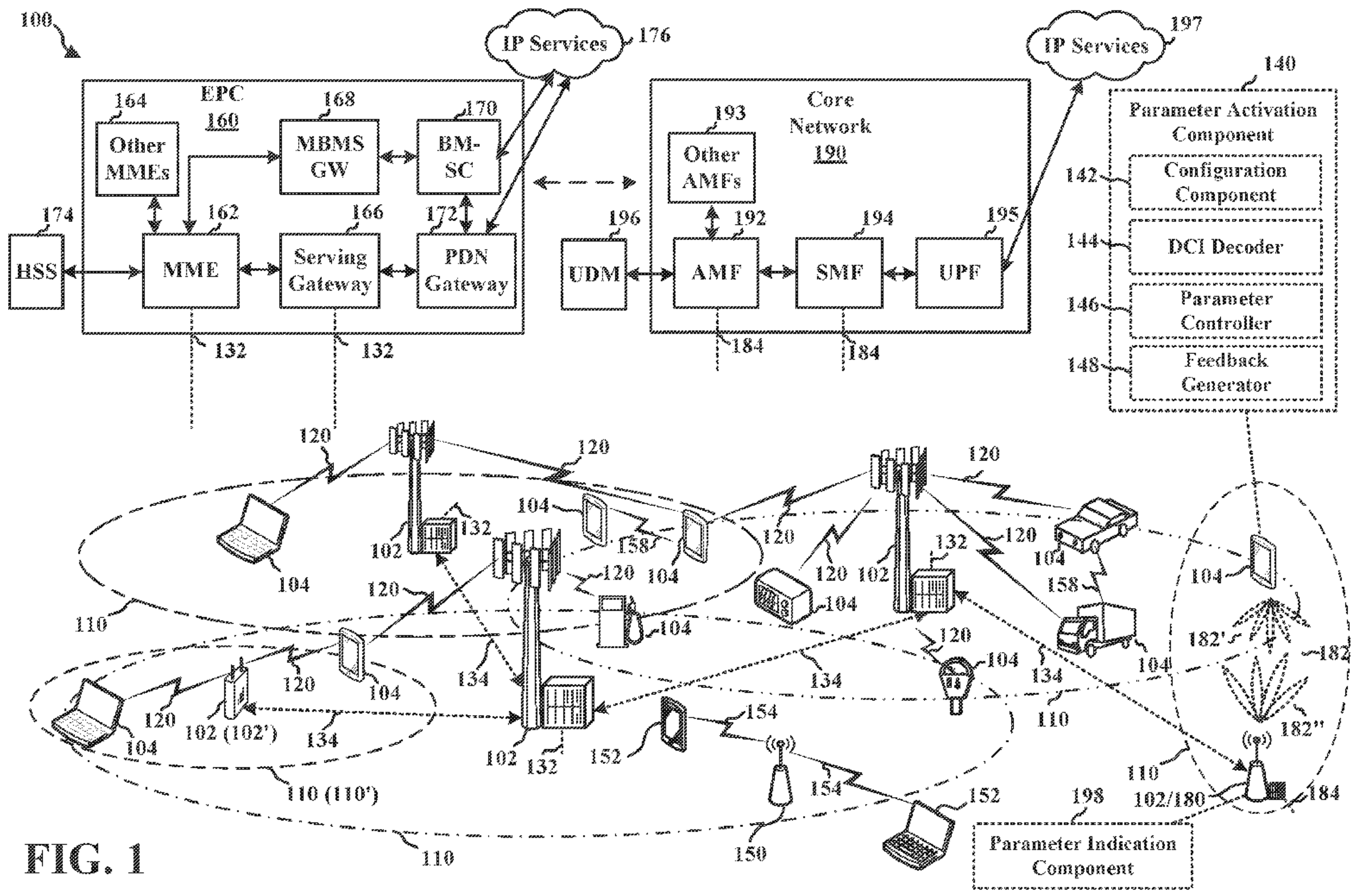

FIG. 1

(57) **Abstract:** Example implementations include a method, apparatus and computer-readable medium of wireless communication, including receiving on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers. The implementations further include receiving or transmitting on the at least two component carriers based on the updated operation parameters.

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SINGLE DCI UPDATING OPERATION PARAMETERS FOR MULTIPLE COMPONENT CARRIERS

BACKGROUND

Technical Field

[0001] The present disclosure relates generally to communication systems, and more particularly, to apparatus and methods of a single downlink control information (DCI) updating one or more operation parameters for multiple component carriers (CCs).

Introduction

[0002] Wireless communication systems are widely deployed to provide various telecommunication services such as telephony, video, data, messaging, and broadcasts. Typical wireless communication systems may employ multiple-access technologies capable of supporting communication with multiple users by sharing available system resources. Examples of such multiple-access technologies include code division multiple access (CDMA) systems, time division multiple access (TDMA) systems, frequency division multiple access (FDMA) systems, orthogonal frequency division multiple access (OFDMA) systems, single-carrier frequency division multiple access (SC-FDMA) systems, and time division synchronous code division multiple access (TD-SCDMA) systems.

[0003] These multiple access technologies have been adopted in various telecommunication standards to provide a common protocol that enables different wireless devices to communicate on a municipal, national, regional, and even global level. An example telecommunication standard is 5G New Radio (NR). 5G NR is part of a continuous mobile broadband evolution promulgated by Third Generation Partnership Project (3GPP) to meet new requirements associated with latency, reliability, security, scalability (e.g., with Internet of Things (IoT)), and other requirements. 5G NR includes services associated with enhanced mobile broadband (eMBB), massive machine type communications (mMTC), and ultra reliable low latency communications (URLLC). Some aspects of 5G NR may be based on the 4G Long Term Evolution (LTE) standard. There exists a need for further improvements in 5G NR technology. These improvements may also be applicable to other multi-access technologies and the telecommunication standards that employ these technologies.

SUMMARY

[0004] The following presents a simplified summary of one or more aspects in order to provide a basic understanding of such aspects. This summary is not an extensive overview of all contemplated aspects, and is intended to neither identify key or critical elements of all aspects nor delineate the scope of any or all aspects. Its sole purpose is to present some concepts of one or more aspects in a simplified form as a prelude to the more detailed description that is presented later.

[0005] An example implementation includes a method of wireless communication, including receiving on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers. The method further includes receiving or transmitting on the at least two component carriers based on the updated operation parameters.

[0006] Another example implementation includes an apparatus for wireless communication, including a processor and a memory in communication with the processor. The memory storing instructions which, when executed by the processor, cause the processor to receive on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers. The instructions when executed by the processor further cause the processor to receive or transmit on the at least two component carriers based on the updated operation parameters.

[0007] Another example implementation includes an apparatus for wireless communication, including means for receiving on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers. The apparatus further includes means for receiving or transmitting on the at least two component carriers based on the updated operation parameters.

[0008] Another example implementation includes a computer-readable medium storing instructions for wireless communication, executable by a processor to receive on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers. The instructions are further executable to receive or transmit on the at least two component carriers based on the updated operation parameters.

[0009] To the accomplishment of the foregoing and related ends, the one or more aspects comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative features of the one or more aspects. These features are indicative, however, of but a few of the various ways in which the principles of various aspects may be employed, and this description is intended to include all such aspects and their equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a diagram illustrating an example of a wireless communications system and an access network.

[0011] FIGs. 2A, 2B, 2C, and 2D are diagrams illustrating examples of a first 5G/NR frame, DL channels within a 5G/NR subframe, a second 5G/NR frame, and UL channels within a 5G/NR subframe, respectively.

[0012] FIG. 3 is a diagram illustrating an example of a base station and user equipment (UE) in an access network.

[0013] FIG. 4 is a diagram illustrating example communications and components of a base station and a UE.

[0014] FIG. 5 is a conceptual data flow diagram illustrating the data flow between different means/components in an example base station.

[0015] FIG. 6 is a conceptual data flow diagram illustrating the data flow between different means/components in an example UE.

[0016] FIG. 7A is diagram of an example of a single DCI updating TCI for a PDCCH on two component carriers or cells.

[0017] FIG. 7B is an diagram of an example of a single DCI updating a spatial relation for a PUCCH.

[0018] FIG. 7C is a diagram of an example of a single DCI updating a pathloss reference signal.

[0019] FIG. 8A is a diagram of an example ACK for a DCI updating operation parameters for at least two component carriers.

[0020] FIG. 8B is a diagram of an example of repeating an ACK for a DCI updating operation parameters for at least two component carriers.

[0021] FIG. 9A is a diagram of an example of a single DCI activating a SPS or CG on at least two component carriers.

[0022] FIG. 9B is a diagram of an example of a single DCI activating a CG on at least two component carriers.

[0023] FIG. 10 is a diagram of an example of a single DCI updating an operating parameter and scheduling a transmission on two or more component carriers.

[0024] FIG. 11 is a flowchart of an example of a method of wireless communication for a UE.

[0025] FIG. 12 is a flowchart of an example of a method of wireless communication for a base station.

DETAILED DESCRIPTION

[0026] The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations and is not intended to represent the only configurations in which the concepts described herein may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some instances, well known structures and components are shown in block diagram form in order to avoid obscuring such concepts.

[0027] A downlink control information (DCI) may be transmitted on a downlink control channel such as a physical downlink control channel (PDCCH) to schedule a UE to receive a physical downlink shared channel (PDSCH) or transmit on an uplink channel. A DCI may be transmitted and decoded at a physical layer, which allows for relatively quick processing compared to higher layers such as a radio resource control (RRC) layer, which is conventionally used to configuration.

[0028] In an aspect, the present disclosure provides for using a DCI to update transmission parameters for two or more component carriers. That is, a single DCI may provide an indication of updated operation parameters for two or more component carriers (CC). A UE receiving the single DCI may update the operation parameters for the two or more CCs and transmit or receive on the CCs according to the updated operation parameters. Use of a single DCI may allow dynamic reconfiguration of the operation parameters in less time than higher layer configuration messages. Updating the parameters of two or more CCs with a single DCI may reduce the signaling overhead and decoding burden on the UE.

[0029] Several aspects of telecommunication systems will now be presented with reference to various apparatus and methods. These apparatus and methods will be described in the following detailed description and illustrated in the accompanying drawings by various blocks, components, circuits, processes, algorithms, etc. (collectively referred to as "elements"). These elements may be implemented using electronic hardware, computer software, or any combination thereof. Whether such elements are implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system.

[0030] By way of example, an element, or any portion of an element, or any combination of elements may be implemented as a "processing system" that includes one or more processors. Examples of processors include microprocessors, microcontrollers, graphics processing units (GPUs), central processing units (CPUs), application processors, digital signal processors (DSPs), reduced instruction set computing (RISC) processors, systems on a chip (SoC), baseband processors, field programmable gate arrays (FPGAs), programmable logic devices (PLDs), state machines, gated logic, discrete hardware circuits, and other suitable hardware configured to perform the various functionality described throughout this disclosure. One or more processors in the processing system may execute software. Software shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software components, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise.

[0031] Accordingly, in one or more example embodiments, the functions described may be implemented in hardware, software, or any combination thereof. If implemented in software, the functions may be stored on or encoded as one or more instructions or code on a computer-readable medium. Computer-readable media includes computer storage media. Storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise a random-access memory (RAM), a read-only memory (ROM), an electrically erasable programmable ROM (EEPROM), optical disk storage, magnetic disk storage, other magnetic storage devices, combinations of the aforementioned types of computer-readable media, or any other medium that can be used to store computer executable code in the form of instructions or data structures that can be accessed by a computer.

[0032] FIG. 1 is a diagram illustrating an example of a wireless communications system and an access network 100. The wireless communications system (also referred to as a wireless wide area network (WWAN)) includes base stations 102, UEs 104, an Evolved Packet Core (EPC) 160, and another core network 190 (e.g., a 5G Core (5GC)). The base stations 102 may include macrocells (high power cellular base station) and/or small cells (low power cellular base station). The macrocells include base stations. The small cells include femtocells, picocells, and microcells.

[0033] In an aspect, one or more of the UEs 104 may include a parameter activation component 140 that receives a single DCI that updates transmission parameters for at least two component carriers. The parameter activation component may then transmit or receive according to the updated transmission parameters on the at least two component carriers. The parameter activation component 140 may include a configuration component 142 that receives an indication of a configuration of the single DCI, configuration of an acknowledgment of the single DCI, and/or configuration of repetition for uplink transmissions. The parameter activation component 140 may include a DCI decoder that receives the single DCI and determines the updated parameters for the at least two component carriers. The parameter activation component 140 may include a parameter controller 146 that activates the updated parameters and transmits or receives according to the updated parameters. The parameter activation component 140 may include a feedback generator 148 that generates an acknowledgment (ACK) for the single DCI.

[0034] In an aspect, one or more of the base station 102 may include a parameter indication component 198 that transmits a single DCI that updates transmission parameters for at least two component carriers and transmits or receives according to the updated parameters. As illustrated in FIGs. 4 and 5, the parameter indication component 198 may include a parameter manager 440, a DL signal generator 442, a retransmission controller 444, a receiver component 446, and a transmitter component 448.

[0035] The base stations 102 configured for 4G LTE (collectively referred to as Evolved Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network (E-UTRAN)) may interface with the EPC 160 through first backhaul links 132 (e.g., S1 interface). The base stations 102 configured for 5G NR (collectively referred to as Next Generation RAN (NG-RAN)) may interface with core network

190 through second backhaul links 184. In addition to other functions, the base stations 102 may perform one or more of the following functions: transfer of user data, radio channel ciphering and deciphering, integrity protection, header compression, mobility control functions (e.g., handover, dual connectivity), inter-cell interference coordination, connection setup and release, load balancing, distribution for non-access stratum (NAS) messages, NAS node selection, synchronization, radio access network (RAN) sharing, multimedia broadcast multicast service (MBMS), subscriber and equipment trace, RAN information management (RIM), paging, positioning, and delivery of warning messages. The base stations 102 may communicate directly or indirectly (e.g., through the EPC 160 or core network 190) with each other over third backhaul links 134 (e.g., X2 interface). The third backhaul links 134 may be wired or wireless.

[0036] The base stations 102 may wirelessly communicate with the UEs 104. Each of the base stations 102 may provide communication coverage for a respective geographic coverage area 110. There may be overlapping geographic coverage areas 110. For example, the small cell 102' may have a coverage area 110' that overlaps the coverage area 110 of one or more macro base stations 102. A network that includes both small cell and macrocells may be known as a heterogeneous network. A heterogeneous network may also include Home Evolved Node Bs (eNBs) (HeNBs), which may provide service to a restricted group known as a closed subscriber group (CSG). The communication links 120 between the base stations 102 and the UEs 104 may include uplink (UL) (also referred to as reverse link) transmissions from a UE 104 to a base station 102 and/or downlink (DL) (also referred to as forward link) transmissions from a base station 102 to a UE 104. The communication links 120 may use multiple-input and multiple-output (MIMO) antenna technology, including spatial multiplexing, beamforming, and/or transmit diversity. The communication links may be through one or more carriers. The base stations 102 / UEs 104 may use spectrum up to Y MHz (e.g., 5, 10, 15, 20, 100, 400, etc. MHz) bandwidth per carrier allocated in a carrier aggregation of up to a total of Yx MHz (x component carriers) used for transmission in each direction. The carriers may or may not be adjacent to each other. Allocation of carriers may be asymmetric with respect to DL and UL (e.g., more or fewer carriers may be allocated for DL than for UL). The component carriers may include a primary component carrier and one or more secondary component carriers. A primary component carrier may be referred to as a primary cell (PCell) and a secondary component carrier may be referred to as a secondary cell (SCell).

[0037] Certain UEs 104 may communicate with each other using device-to-device (D2D) communication link 158. The D2D communication link 158 may use the DL/UL WWAN spectrum. The D2D communication link 158 may use one or more sidelink channels, such as a physical sidelink broadcast channel (PSBCH), a physical sidelink discovery channel (PSDCH), a physical sidelink shared channel (PSSCH), and a physical sidelink control channel (PSCCH). D2D communication may be through a variety of wireless D2D communications systems, such as for example, FlashLinQ, WiMedia, Bluetooth, ZigBee, Wi-Fi based on the IEEE 802.11 standard, LTE, or NR.

[0038] The wireless communications system may further include a Wi-Fi access point (AP) 150 in communication with Wi-Fi stations (STAs) 152 via communication links 154 in a 5 GHz unlicensed frequency spectrum. When communicating in an unlicensed frequency spectrum, the STAs 152 / AP 150 may perform a clear channel assessment (CCA) prior to communicating in order to determine whether the channel is available.

[0039] The small cell 102' may operate in a licensed and/or an unlicensed frequency spectrum. When operating in an unlicensed frequency spectrum, the small cell 102' may employ NR and use the same 5 GHz unlicensed frequency spectrum as used by the Wi-Fi AP 150. The small cell 102', employing NR in an unlicensed frequency spectrum, may boost coverage to and/or increase capacity of the access network.

[0040] A base station 102, whether a small cell 102' or a large cell (e.g., macro base station), may include and/or be referred to as an eNB, gNodeB (gNB), or another type of base station. Some base stations, such as gNB 180 may operate in a traditional sub 6 GHz spectrum, in millimeter wave (mmW) frequencies, and/or near mmW frequencies in communication with the UE 104. When the gNB 180 operates in mmW or near mmW frequencies, the gNB 180 may be referred to as an mmW base station. Extremely high frequency (EHF) is part of the RF in the electromagnetic spectrum. EHF has a range of 30 GHz to 300 GHz and a wavelength between 1 millimeter and 10 millimeters. Radio waves in the band may be referred to as a millimeter wave. Near mmW may extend down to a frequency of 3 GHz with a wavelength of 100 millimeters. The super high frequency (SHF) band extends between 3 GHz and 30 GHz, also referred to as centimeter wave. Communications using the mmW / near mmW radio frequency band (e.g., 3 GHz – 300 GHz) has extremely high path loss and a short range. The mmW base station 180 may utilize beamforming 182 with the

UE 104 to compensate for the extremely high path loss and short range. The base station 180 and the UE 104 may each include a plurality of antennas, such as antenna elements, antenna panels, and/or antenna arrays to facilitate the beamforming.

[0041] The base station 180 may transmit a beamformed signal to the UE 104 in one or more transmit directions 182'. The UE 104 may receive the beamformed signal from the base station 180 in one or more receive directions 182". The UE 104 may also transmit a beamformed signal to the base station 180 in one or more transmit directions. The base station 180 may receive the beamformed signal from the UE 104 in one or more receive directions. The base station 180 / UE 104 may perform beam training to determine the best receive and transmit directions for each of the base station 180 / UE 104. The transmit and receive directions for the base station 180 may or may not be the same. The transmit and receive directions for the UE 104 may or may not be the same.

[0042] The EPC 160 may include a Mobility Management Entity (MME) 162, other MMEs 164, a Serving Gateway 166, a Multimedia Broadcast Multicast Service (MBMS) Gateway 168, a Broadcast Multicast Service Center (BM-SC) 170, and a Packet Data Network (PDN) Gateway 172. The MME 162 may be in communication with a Home Subscriber Server (HSS) 174. The MME 162 is the control node that processes the signaling between the UEs 104 and the EPC 160. Generally, the MME 162 provides bearer and connection management. All user Internet protocol (IP) packets are transferred through the Serving Gateway 166, which itself is connected to the PDN Gateway 172. The PDN Gateway 172 provides UE IP address allocation as well as other functions. The PDN Gateway 172 and the BM-SC 170 are connected to the IP Services 176. The IP Services 176 may include the Internet, an intranet, an IP Multimedia Subsystem (IMS), a PS Streaming Service, and/or other IP services. The BM-SC 170 may provide functions for MBMS user service provisioning and delivery. The BM-SC 170 may serve as an entry point for content provider MBMS transmission, may be used to authorize and initiate MBMS Bearer Services within a public land mobile network (PLMN), and may be used to schedule MBMS transmissions. The MBMS Gateway 168 may be used to distribute MBMS traffic to the base stations 102 belonging to a Multicast Broadcast Single Frequency Network (MBSFN) area broadcasting a particular service, and may be responsible for session management (start/stop) and for collecting eMBMS related charging information.

[0043] The core network 190 may include a Access and Mobility Management Function (AMF) 192, other AMFs 193, a Session Management Function (SMF) 194, and a User Plane Function (UPF) 195. The AMF 192 may be in communication with a Unified Data Management (UDM) 196. The AMF 192 is the control node that processes the signaling between the UEs 104 and the core network 190. Generally, the AMF 192 provides QoS flow and session management. All user Internet protocol (IP) packets are transferred through the UPF 195. The UPF 195 provides UE IP address allocation as well as other functions. The UPF 195 is connected to the IP Services 197. The IP Services 197 may include the Internet, an intranet, an IP Multimedia Subsystem (IMS), a PS Streaming Service, and/or other IP services.

[0044] The base station may include and/or be referred to as a gNB, Node B, eNB, an access point, a base transceiver station, a radio base station, a radio transceiver, a transceiver function, a basic service set (BSS), an extended service set (ESS), a transmit reception point (TRP), or some other suitable terminology. The base station 102 provides an access point to the EPC 160 or core network 190 for a UE 104. Examples of UEs 104 include a cellular phone, a smart phone, a session initiation protocol (SIP) phone, a laptop, a personal digital assistant (PDA), a satellite radio, a global positioning system, a multimedia device, a video device, a digital audio player (e.g., MP3 player), a camera, a game console, a tablet, a smart device, a wearable device, a vehicle, an electric meter, a gas pump, a large or small kitchen appliance, a healthcare device, an implant, a sensor/actuator, a display, or any other similar functioning device. Some of the UEs 104 may be referred to as IoT devices (e.g., parking meter, gas pump, toaster, vehicles, heart monitor, etc.). The UE 104 may also be referred to as a station, a mobile station, a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a wireless communications device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless terminal, a remote terminal, a handset, a user agent, a mobile client, a client, or some other suitable terminology.

[0045] Although the following description may be focused on 5G NR, the concepts described herein may be applicable to other similar areas, such as LTE, LTE-A, CDMA, GSM, and other wireless technologies.

[0046] FIG. 2A is a diagram 200 illustrating an example of a first subframe within a 5G/NR frame structure. FIG. 2B is a diagram 230 illustrating an example of DL channels within a 5G/NR subframe. FIG. 2C is a diagram 250 illustrating an example of a second subframe within a 5G/NR frame structure. FIG. 2D is a diagram 280 illustrating an example of UL channels within a 5G/NR subframe. The 5G/NR frame structure may be FDD in which for a particular set of subcarriers (carrier system bandwidth), subframes within the set of subcarriers are dedicated for either DL or UL, or may be TDD in which for a particular set of subcarriers (carrier system bandwidth), subframes within the set of subcarriers are dedicated for both DL and UL. In the examples provided by FIGs. 2A, 2C, the 5G/NR frame structure is assumed to be TDD, with subframe 4 being configured with slot format 28 (with mostly DL), where D is DL, U is UL, and X is flexible for use between DL/UL, and subframe 3 being configured with slot format 34 (with mostly UL). While subframes 3, 4 are shown with slot formats 34, 28, respectively, any particular subframe may be configured with any of the various available slot formats 0-61. Slot formats 0, 1 are all DL, UL, respectively. Other slot formats 2-61 include a mix of DL, UL, and flexible symbols. UEs are configured with the slot format (dynamically through DL control information (DCI), or semi-statically/statically through radio resource control (RRC) signaling) through a received slot format indicator (SFI). Note that the description *infra* applies also to a 5G/NR frame structure that is TDD.

[0047] Other wireless communication technologies may have a different frame structure and/or different channels. A frame (10 ms) may be divided into 10 equally sized subframes (1 ms). Each subframe may include one or more time slots. Subframes may also include mini-slots, which may include 7, 4, or 2 symbols. Each slot may include 7 or 14 symbols, depending on the slot configuration. For slot configuration 0, each slot may include 14 symbols, and for slot configuration 1, each slot may include 7 symbols. The symbols on DL may be cyclic prefix (CP) OFDM (CP-OFDM) symbols. The symbols on UL may be CP-OFDM symbols (for high throughput scenarios) or discrete Fourier transform (DFT) spread OFDM (DFT-s-OFDM) symbols (also referred to as single carrier frequency-division multiple access (SC-FDMA) symbols) (for power limited scenarios; limited to a single stream transmission). The number of slots within a subframe is based on the slot configuration and the numerology. For slot configuration 0, different numerologies μ 0 to 5 allow for 1, 2, 4, 8, 16, and 32 slots, respectively, per subframe. For slot configuration 1, different numerologies 0 to 2 allow for 2, 4, and 8 slots, respectively, per subframe. Accordingly, for slot configuration 0 and numerology μ, there are 14 symbols/slot and 2^{μ} slots/subframe. The subcarrier spacing and symbol length/duration are a function of the numerology. The subcarrier spacing may be equal to $2^{\mu} * 15$ kHz, where μ is the numerology 0 to 5. As such, the numerology μ=0 has a subcarrier spacing of 15 kHz and the numerology μ=5 has a subcarrier spacing of 480 kHz. The symbol length/duration is inversely related to the subcarrier spacing. FIGs. 2A-2D provide an example of slot configuration 0 with 14 symbols per slot and numerology μ=2 with 4 slots per subframe. The slot duration is 0.25 ms, the subcarrier spacing is 60 kHz, and the symbol duration is approximately 16.67 μs.

[0048] A resource grid may be used to represent the frame structure. Each time slot includes a resource block (RB) (also referred to as physical RBs (PRBs)) that extends 12 consecutive subcarriers. The resource grid is divided into multiple resource elements (REs). The number of bits carried by each RE depends on the modulation scheme.

[0049] As illustrated in FIG. 2A, some of the REs carry reference (pilot) signals (RS) for the UE. The RS may include demodulation RS (DM-RS) (indicated as R_x for one particular configuration, where 100x is the port number, but other DM-RS configurations are possible) and channel state information reference signals (CSI-RS) for channel estimation at the UE. The RS may also include beam measurement RS (BRS), beam refinement RS (BRRS), and phase tracking RS (PT-RS).

[0050] FIG. 2B illustrates an example of various DL channels within a subframe of a frame. The physical downlink control channel (PDCCH) carries DCI within one or more control channel elements (CCEs), each CCE including nine RE groups (REGs), each REG including four consecutive REs in an OFDM symbol. A primary synchronization signal (PSS) may be within symbol 2 of particular subframes of a frame. The PSS is used by a UE 104 to determine subframe/symbol timing and a physical layer identity. A secondary synchronization signal (SSS) may be within symbol 4 of particular subframes of a frame. The SSS is used by a UE to determine a physical layer cell identity group number and radio frame timing. Based on the physical layer identity and the physical layer cell identity group number, the UE can determine a physical cell identifier (PCI). Based on the PCI, the UE can determine the locations of the aforementioned DM-RS. The physical broadcast channel (PBCH), which carries a master information block (MIB), may be logically grouped with the PSS and SSS to form a synchronization signal (SS)/PBCH block. The MIB provides a number of RBs in the system bandwidth and a system frame number (SFN). The physical downlink shared channel (PDSCH) carries user data, broadcast system information not transmitted through the PBCH such as system information blocks (SIBs), and paging messages.

[0051] As illustrated in FIG. 2C, some of the REs carry DM-RS (indicated as R for one particular configuration, but other DM-RS configurations are possible) for channel estimation at the base station. The UE may transmit DM-RS for the physical uplink control channel (PUCCH) and DM-RS for the physical uplink shared channel (PUSCH). The PUSCH DM-RS may be transmitted in the first one or two symbols of the PUSCH. The PUCCH DM-RS may be transmitted in different configurations depending on whether short or long PUCCHs are transmitted and depending on the particular PUCCH format used. The UE may transmit sounding reference signals (SRS). The SRS may be transmitted in the last symbol of a subframe. The SRS may have a comb structure, and a UE may transmit SRS on one of the combs. The SRS may be used by a base station for channel quality estimation to enable frequency-dependent scheduling on the UL.

[0052] FIG. 2D illustrates an example of various UL channels within a subframe of a frame. The PUCCH may be located as indicated in one configuration. The PUCCH carries uplink control information (UCI), such as scheduling requests, a channel quality indicator (CQI), a precoding matrix indicator (PMI), a rank indicator (RI), and HARQ ACK/NACK feedback. The PUSCH carries data, and may additionally be used to carry a buffer status report (BSR), a power headroom report (PHR), and/or UCI.

[0053] FIG. 3 is a block diagram of a base station 310 in communication with a UE 350 in an access network. In the DL, IP packets from the EPC 160 may be provided to a controller/processor 375. The controller/processor 375 implements layer 3 and layer 2 functionality. Layer 3 includes a radio resource control (RRC) layer, and layer 2 includes a service data adaptation protocol (SDAP) layer, a packet data convergence protocol (PDCP) layer, a radio link control (RLC) layer, and a medium access control (MAC) layer. The controller/processor 375 provides RRC layer functionality associated with broadcasting of system information (e.g., MIB, SIBs), RRC connection control (e.g., RRC connection paging, RRC connection establishment, RRC connection modification, and RRC connection release), inter radio access technology (RAT) mobility, and measurement configuration for UE measurement reporting; PDCP layer functionality associated with header compression / decompression, security (ciphering, deciphering, integrity protection, integrity verification), and handover support functions; RLC layer functionality associated with the transfer of upper layer packet data units (PDUs), error correction through ARQ, concatenation, segmentation, and reassembly of RLC service data units (SDUs), re-segmentation of RLC data PDUs, and reordering of RLC data PDUs; and MAC layer functionality associated with mapping between logical channels and transport channels, multiplexing of MAC SDUs onto transport blocks (TBs), demultiplexing of MAC SDUs from TBs, scheduling information reporting, error correction through HARQ, priority handling, and logical channel prioritization.

[0054] The transmit (TX) processor 316 and the receive (RX) processor 370 implement layer 1 functionality associated with various signal processing functions. Layer 1, which includes a physical (PHY) layer, may include error detection on the transport channels, forward error correction (FEC) coding/decoding of the transport channels, interleaving, rate matching, mapping onto physical channels, modulation/demodulation of physical channels, and MIMO antenna processing. The TX processor 316 handles 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 may then be split into parallel streams. Each stream may then be 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 374 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 350. Each spatial stream may then be provided to a different antenna 320 via a separate transmitter 318TX. Each transmitter 318TX may modulate an RF carrier with a respective spatial stream for transmission.

[0055] At the UE 350, each receiver 354RX receives a signal through its respective antenna 352. Each receiver 354RX recovers information modulated onto an RF carrier and provides the information to the receive (RX) processor 356. The TX processor 368 and the RX processor 356 implement layer 1 functionality associated with various signal processing functions. The RX processor 356 may perform spatial processing on the information to recover any spatial streams destined for the UE 350. If multiple spatial streams are destined for the UE 350, they may be combined by the RX processor 356 into a single OFDM symbol stream. The RX processor 356 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, are recovered and demodulated by determining the most likely signal constellation points transmitted by the base station 310. These soft decisions may be based on channel estimates computed by the channel estimator 358. The soft decisions are then decoded and deinterleaved to recover the data and control signals that were originally transmitted by the base station 310 on the physical channel. The data and control signals are then provided to the controller/processor 359, which implements layer 3 and layer 2 functionality.

[0056] The controller/processor 359 can be associated with a memory 360 that stores program codes and data. The memory 360 may be referred to as a computer-readable medium. In the UL, the controller/processor 359 provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, and control signal processing to recover IP packets from the EPC 160. The controller/processor 359 is also responsible for error detection using an ACK and/or NACK protocol to support HARQ operations.

[0057] Similar to the functionality described in connection with the DL transmission by the base station 310, the controller/processor 359 provides RRC layer functionality associated with system information (e.g., MIB, SIBs) acquisition, RRC connections, and measurement reporting; PDCP layer functionality associated with header compression / decompression, and security (ciphering, deciphering, integrity protection, integrity verification); RLC layer functionality associated with the transfer of upper layer PDUs, error correction through ARQ, concatenation, segmentation, and reassembly of RLC SDUs, re-segmentation of RLC data PDUs, and reordering of RLC data PDUs; and MAC layer functionality associated with mapping between logical channels and transport channels, multiplexing of MAC SDUs onto TBs, demultiplexing of MAC SDUs from TBs, scheduling information reporting, error correction through HARQ, priority handling, and logical channel prioritization.

[0058] Channel estimates derived by a channel estimator 358 from a reference signal or feedback transmitted by the base station 310 may be used by the TX processor 368 to select the appropriate coding and modulation schemes, and to facilitate spatial processing. The spatial streams generated by the TX processor 368 may be provided to different antenna 352 via separate transmitters 354TX. Each transmitter 354TX may modulate an RF carrier with a respective spatial stream for transmission.

[0059] The UL transmission is processed at the base station 310 in a manner similar to that described in connection with the receiver function at the UE 350. Each receiver 318RX receives a signal through its respective antenna 320. Each receiver 318RX recovers information modulated onto an RF carrier and provides the information to a RX processor 370.

[0060] The controller/processor 375 can be associated with a memory 376 that stores program codes and data. The memory 376 may be referred to as a computer-readable medium. In the UL, the controller/processor 375 provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, control signal processing to recover IP packets from the UE 350. IP packets from the controller/processor 375 may be provided to the EPC 160. The controller/processor 375 is also responsible for error detection using an ACK and/or NACK protocol to support HARQ operations.

[0061] At least one of the TX processor 368, the RX processor 356, and the controller/processor 359 may be configured to perform aspects in connection with the parameter activation component 140 of FIG. 1.

[0062] At least one of the TX processor 316, the RX processor 370, and the controller/processor 375 may be configured to perform aspects in connection with the parameter indication component 198 of FIG. 1.

[0063] FIG. 4 is a diagram 400 illustrating example communications and components of a base station 102 and a UE 104. The UE 104 may include the parameter activation component 140. The base station 102 may include the parameter indication component 198.

[0064] The parameter indication component 198 may transmit a DCI 460 that updates operation parameters for at least two component carriers. For example, the DCI 460 may include a first parameter P1 for a first component carrier 450 and a second parameter P2 for a second component carrier 452. The parameters P1 and P2 may be an indication of one or more configured parameters to be activated. In another implementation, the DCI 460 may include an indication of a parameter and an indication of two or more components carriers for which to activate the indicated parameter. In an aspect, the DCI 460 may additionally schedule a transmission on the respective component carriers (e.g., $PDSCH_1$ and $PDSCH_2$).

[0065] The parameter indication component 198 may include a parameter manager 440 that determines one or more operation parameters for the base station 102 and the UE 104. For example, the operation parameters may include uplink and downlink beams, which may be indicated as a transmission configuration indicator (TCI) state or a spatial relation, a pathloss reference signal, and scheduling parameters for semi-persistent scheduling (SPS) or a configured grant (CG). The parameter indication component 198 may include a downlink signal generator 442 that may generate one or more signals for configuration or activation of operation parameters. For example, as discussed above, the DCI 460 may indicate an update of operation parameters and/or schedule a transmission. A PDSCH 462 may be scheduled by the DCI 460 and may include downlink data for the UE 104.

[0066] In an aspect, the DL signal generator 442 may transmit configuration information such as an indication of a DCI configuration, an indication of whether to acknowledge a DCI, or an indication of whether to repeat the transmission of an uplink message such as an ACK. In an aspect, the DCI configuration may indicate how a DCI format is to be decoded. For example, the DCI field may indicate an interpretation of a configurable or reserved field of a DCI format. For instance, the DCI configuration may indicate that reserved bits of a DCI format are to be interpreted as an index for an updated parameter of a second component carrier. The DCI configuration may be indicated by a MAC-CE 464 or an RRC message 466, which may be generated by the DL signal generator 442. Similarly, a MAC-CE 464 or an RRC message 466 may indicate whether the UE 104 is to transmit a dedicated ACK for the DCI 460 or repeat an uplink transmission, which may be associated with the ACK. In an aspect, the DCI 460 itself may indicate whether to transmit and/or repeat the ACK.

[0067] The parameter indication component 198 may include a retransmission controller 444 that determines whether to retransmit a DCI 460. Since the DCI 460 may change operation parameters of the UE 104, if the UE 104 does not receive the DCI 460, the base station 102 and the UE 104 may not know whether to activate the indicated operation parameters. Accordingly, the retransmission controller 444 may receive an ACK 470 that indicates reception of the DCI 460. In an aspect, the ACK 470 may be based on a HARQ codebook 472 and may be treated as an additional transmission such as a PDSCH. In other cases, when the DCI 460 schedules another transmission, the ACK 470 may be the scheduled transmission or an acknowledgment thereof. For instance, if the DCI 460 schedules an uplink transmission, receipt of the uplink transmission at the base station 102 may be the ACK 470. As another example, if the DCI 460 schedules a PDSCH, receipt of an ACK of the PDSCH may also be considered the ACK 470 for the DCI 460. By receiving the ACK 470, the parameter indication component 198 may determine that the UE 104 has received the updated operation parameters indicated in the DCI 460 and may activate the corresponding operation parameters for the base station 102.

[0068] The base station 102 may include a receiver component 446, which may include, for example, a radio frequency (RF) receiver for receiving the signals described herein. The base station 102 may include a transmitter component 448, which may include, for example, an RF transmitter for transmitting the signals described herein. In an aspect, the receiver component 446 and the transmitter component 448 may be implemented by a transceiver.

[0069] As discussed above regarding FIG. 1, the UE 104 may include the DCI decoder 144, the parameter controller 146, and the feedback generator 148. The UE 104 may also include a receiver component 410 and a transmitter component 412. The receiver component 410 may include, for example, a RF receiver for receiving the signals described herein. The transmitter component 412 may include for example, an RF transmitter for transmitting the signals described herein. In an aspect, the receiver component 410 and the transmitter component 412 may be implemented by a transceiver.

[0070] The parameter controller 146 may set various UL parameters 414 for transmitting and various DL parameters 416 for receiving.

[0071] The feedback generator 148 may transmit the ACK 470. For example, the feedback generator 148 may generate a PUCCH 418 or a PUSCH 420 to carry the ACK 470. In an aspect, the feedback generator 148 may include a repetition controller 422 to repeating a transmission of the ACK 470. For example, the repetition controller 422 may generate multiple ACK/NACK indications 424 for transmission in multiple PUCCHs 418 or PUSCHs 420.

[0072] FIG. 5 is a conceptual data flow diagram 500 illustrating the data flow between different means/components in an example base station 502, which may be an example of the base station 102 including the parameter indication component 198.

[0073] The parameter manager 440 may determine operation parameters for a UE 104 for two or more component carriers 510. For example, for each component carrier, the parameter manager 440 may determine one or more of a PDCCH TCI state, a PDSCH/CSI-RS TCI state, a spatial relation, a UL TCI state, a pathloss reference signal (PL RS), or one or more active SRS or CG. For example, the parameter manager 440 may determine a TCI state or spatial relation based on beam training. The parameter manager may determine the PL RS and the active SRS or CG based on scheduling needs. When the parameter manager 440 determines to update an operation parameter for a UE 104, the parameter manager 440 may provide the updated parameters to the DL signal generator 442.

[0074] The DL signal generator 442 may generate a DCI 560, which may be an example of the single DCI 460. The DCI 560 may include indications of parameters for at least two component carriers. For example, the indications may be one or more indices. The DCI 560 may optionally include scheduling information for scheduling a transmission for the UE on the at least two component carriers. The DL signal generator may transmit the DCI via the transmitter component 448.

[0075] The receiver component 446 may optionally receive the ACK 470 and provide the ACK 470 to the retransmission controller 444. The retransmission controller 444 may include an ACK/NACK manager that tracks HARQ processes. The retransmission controller 444 may process the UL signal including the ACK 470 according to a codebook to determine whether the ACK 470 indicates successful receipt of the DCI 560. If the DCI 560 is successfully received, the retransmission controller 444 may indicate the successful parameter update to the parameter manager 440. If the DCI 560 is not successfully received, the retransmission controller may indicate a retransmission to the DL signal generator 442.

[0076] In an aspect, the parameter indication component 198 may also include the configuration controller 542. The configuration controller 542 may indicate a configuration of a DCI format, an indication of whether to transmit an ACK, or an indication of whether to repeat an ACK. The configuration controller 542 may provide the configuration to the DL signal generator 442, which may generate a DCI, MAC-CE, or RRC message for transmitting the configuration.

[0077] FIG. 6 is a conceptual data flow diagram 600 illustrating the data flow between different means/components in an example UE 604, which may be an example of the UE 104 and include the parameter activation component 140.

[0078] The receiver component 410 may receive a DCI 460 indicating updated parameters for at least two component carriers and provide the DCI 460 to the DL signal processor 610, which may implement the DCI decoder 144 and the configuration component 142. The DCI decoder 144 may decode the DCI 460 to determine the updated parameters for the at least two component carriers. The DCI decoder 144 may provide the updated parameters to the parameter controller 146, which may store the updated parameters. The DCI decoder 144 may also provide an indication of the successful receipt of the DCI 460 to the feedback generator 148.

[0079] The receiver component 410 may also receive a configuration message such as an RRC message or MAC-CE. The receiver component 410 may provide the configuration message to the configuration component 142. The configuration component 142 may configure the DCI decoder 144 with a configuration of a DCI format for indicating operation parameters of multiple component carriers. The configuration component 142 may provide the feedback generator 148 with the configuration for ACK. The configuration component 142 may provide the parameter controller with a configuration of parameters (e.g., a mapping of index values to parameter values).

[0080] The parameter controller 146 may track the same parameters for the component carriers 510 as the parameter manager 440 at the base station 502. The parameter manager 440 may provide uplink parameters to the UL signal generator 520 and the transmitter component 412 for transmitting UL signals. The parameter manager 440 may provide downlink parameters to the DL signal processor 610 and the receiver component 410 for receiving DL signals.

[0081] The feedback generator 148 may generate the ACK 470 in response to receiving the DCI. The ACK 470 may be based on a configuration for ACK and the content of the DCI 460. For example, if the configuration for ACK indicates a dedicated ACK for the DCI 460, the feedback generator 148 may generate an ACK for transmission within a PUCCH. If the DCI schedules a transmission, the feedback generator 148 may not generate a dedicated ACK because the transmission or an ACK for the transmission may serve as the ACK 470. The repetition controller 422 may transmit the ACK 470 on multiple PUCCH or PUSCH if the configuration for ACK indicates repetition.

[0082] FIG. 7A is diagram 700 of an example of a single DCI updating TCI for a PDCCH on two component carriers or cells. A first DCI (DCI1) may indicate a TCI index with a value of x. The UE may later receive PDCCH1 on cell 1 according to a first TCI indicated by the value of x and receive the PDCCH2 on cell 2 according to a second TCI indicated by the value of x. In an aspect, the first TCI and the second TCI may depend on a configuration of the respective component carriers, and the index x may refer to a different TCI for each component carrier. A second DCI (DCI2) may indicate a TCI index with a value of y. The UE may receive PDCCH 3 on cell 1 according to a third TCI indicated by the value of y for cell 1and receive a PDCCH 4 on cell 2 according to a fourth TCI indicated by the value of y for cell 2.

[0083] FIG. 7B is an diagram 710 of an example of a single DCI updating a spatial relation for a PUCCH. For example a first DCI (DCI1) may indicate a spatial relation information value of x. The UE may transmit the PUCCH1 to cell 1 using a beam selected based on the value of x. The UE may transmit the PUCCH2 to cell 2 using a beam selected based on the value of x. The UE may select different beams for cell 1 and cell 2 based on the respective configurations.

[0084] FIG. 7C is a diagram 720 of an example of a single DCI updating a pathloss reference signal. The first DCI (DCI1) may indicate an index of a pathloss reference signal with a value of x. The UE may transmit an SRS1 selected based on the value of x to cell 1. The UE may transmit an SRS2 selected based on the value of x to cell 2. The UE may select different SRS cell 1 and cell 2 based on the respective configurations.

[0085] FIG. 8A is a diagram 800 of an example ACK 470 for a DCI updating operation parameters for at least two component carriers. In this example, the DCI may update the TCI for PDCCH on cell 1 and cell 2. Since the operation parameters may affect the reception of the PDCCH, the base station may confirm receipt of the DCI before changing the operation parameters at the base station. The UE may transmit the ACK 470 as a dedicated ACK for the DCI on a PUCCH (e.g., in uplink control information according to a HARQ codebook). Accordingly, the base station may confirm receipt of the DCI when the PUCCH indicates an ACK for the DCI. The base station may then transmit the PDCCH1 on cell 1 and the PDCCH2 on cell 2 based on the updated TCI.

[0086] FIG. 8B is a diagram 810 of an example of repeating an ACK 470 for a DCI updating operation parameters for at least two component carriers. In this example, the DCI may update the TCI for PDCCH on cell 1 and cell 2. The UE may transmit the ACK 470 indicating receipt of the DCI as a dedicated ACK for the DCI on a PUCCH. The PUCCH carrying the ACK may be repeated on two different beams in order to increase the probability that the base station receives the ACK 470. For example, if the base station has determined to change the beam configuration, a currently configured beam configuration may be experiencing poor channel conditions. Accordingly, by retransmitting the PUCCH on a second beam, the UE may improve the probability that the ACK 470 is received and the new beam configuration will be used. The base station may transmit the PDCCH1 on cell 1 and the PDCCH2 on cell 2 based on the TCI index of x after receiving the ACK.

[0087] FIG. 9A is a diagram 900 of an example of a single DCI activating a SPS or CG on at least two component carriers. The DCI may activate a first SPS or configured grant for cell 1 and a second SPS or CG for cell 2. The UE may then receive a PDCCH1 on cell 1 and a PDCCH2 on cell 2 each period of the respective SPS or CG.

[0088] FIG. 9B is a diagram 910 of an example of a single DCI activating a CG on at least two component carriers. The DCI may activate a first SPS or configured grant for cell 1 and a second SPS or CG for cell 2. The UE may then transmit a PUSCH1 on cell 1 and a PUSCH2 on cell2 each period of the respective CG.

[0089] FIG. 10 is a diagram 1000 of an example of a single DCI updating an operating parameter and scheduling a transmission on two or more component carriers. The DCI may indicate a TCI index with a value of x and resources y for a PDSCH. The base station may transmit the PDSCH1 on cell 1 and the PDSCH2 on cell 2, and the UE may receive the same according to the scheduled resources y. The UE may transmit a PUCCH indicating an ACK of the PDSCH1 and PDSCH2. The PUCCH may also serve as an ACK 470 of the DCI because the PDSCH1 and PDSCH2 would not be received correctly if the DCI was not received correctly. Accordingly, the base station may determine that the DCI 460 is received correctly when an ACK/NACK bit in the PUCCH for one or both of PDSCH1 or PDSCH2 indicates ACK. The base station may then transmit the PDCCH1 on cell 1 and the PDCCH2 on cell 2 according to the TCI index x for each respective component carrier.

[0090] FIG. 11 is a flowchart of an example method 1100 for updating operation parameters based on a DCI. The method 1100 may be performed by a UE (such as the UE 104, which may include the memory 360 and which may be the entire UE 104 or a component of the UE 104 such as the parameter activation component 140, TX processor 368, the RX processor 356, or the controller/processor 359). The method 1100 may be performed by the parameter activation component 140 in communication with the parameter indication component 198 of the base station 102.

[0091] At block 1110, the method 1100 may optionally include receiving a RRC configuration message or a MAC-CE indicating a configuration of a DCI format for the single DCI. In an aspect, for example, the UE 104, the RX processor 356 and/or the controller/processor 359 may execute the parameter activation component 140 and/or the configuration component 142 to receive the RRC message 466 or the MAC-CE 464 indicating a configuration of a DCI format for the single DCI 460. Accordingly, the UE 104, RX processor 356, and/or the controller/processor 359 executing the parameter activation component 140 and/or the configuration component 142 may provide means for receiving a RRC configuration message or a MAC-CE indicating a configuration of a DCI format for the single DCI.

[0092] At block 1120, the method 1100 may optionally include receiving a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH. In an aspect, for example, the UE 104, the RX processor 356 and/or the controller/processor 359 may execute the parameter activation component 140 and/or the configuration component 142 to receive a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH. Accordingly, the UE 104, RX processor 356, and/or the controller/processor 359 executing the parameter activation component 140 and/or the configuration component 142 may provide means for receiving a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH.

[0093] At block 1130, the method 1100 may optionally include receiving an indication of whether to transmit an ACK for the single DCI. In an aspect, for example, the UE 104, the RX processor 356 and/or the controller/processor 359 may execute the parameter activation component 140 and/or the configuration component 142 to receive an indication of whether to transmit an ACK for the single DCI. Accordingly, the UE 104, RX processor 356, and/or the controller/processor 359 executing the parameter activation component 140 and/or the configuration component 142 may provide means for receiving an indication of whether to transmit an ACK for the single DCI.

[0094] At block 1140, the method 1100 may include receiving on a PDCCH a single DCI that updates operation parameters for at least two component carriers. In an aspect, for example, the UE 104, the RX processor 356 and/or the controller/processor 359 may execute the parameter activation component 140 and/or the DCI decoder 144 to receive on the PDCCH 454 a single DCI 460 that updates operation parameters for at least two component carriers 450, 452. For example, the operation parameters may be one or more of: activated PDCCH TCI state; activated PDSCH and CSI-RS TCI state; activated spatial relation for PUCCH or SRS; activated uplink TCI state for PUCCH, PUSCH, PRACH, or SRS; activated pathloss reference signal for PUCCH, SRS, or PUSCH; or SPS or CG activation or deactivation. In an aspect, the DCI 460 may indicate repetition of an ACK 470 for the DCI 460, for example, to improve the reliability of the ACK 470. Accordingly, the UE 104, RX processor 356, and/or the controller/processor 359 executing the parameter activation component 140 and/or the DCI decoder 144 may provide means for receiving on a PDCCH a single DCI that updates operation parameters for at least two component carriers.

[0095] At block 1150, the method 1100 may include optionally include transmitting an ACK of the single DCI. In an aspect, for example, the UE 104, the TX processor 368 and/or the controller/processor 359 may execute the parameter activation component 140 and/or the feedback generator 148 to transmit an ACK 470 of the single DCI 460. The ACK of the DCI may be based on a configured HARQ-ACK codebook 472 type, for example, as a dedicated ACK for the DCI 460 as illustrated in FIG. 8A. For instance, where the single DCI 460 activates semi-persistent scheduling or a configured grant, the ACK of the DCI may be a dedicated ACK for the single DCI. Further, transmitting the ACK may include repeating a PUCCH or a PUSCH carrying the ACK across one or more beams, for example, as illustrated in FIG. 8B. Repeating the PUCCH or the PUSCH may include transmitting multiple copies of the PUCCH or the PUSCH via space division multiplexing, frequency division multiplexing, or time division multiplexing. In another aspect, where the single DCI schedules a transmission, the transmission or an acknowledgment of the transmission may be considered the ACK 470 of the DCI 460. Accordingly, the UE 104, TX processor 368, and/or the controller/processor 359 executing the parameter activation component 140 and/or the feedback generator 148 may provide means for transmitting an ACK of the single DCI.

[0096] At block 1160, the method 1100 may include receiving or transmitting on the at least two component carriers based on the updated operation parameters. In an aspect, for example, the UE 104, the RX processor 356, TX processor 368 and/or the controller/processor 359 may execute the parameter activation component 140 and/or the parameter controller 146 to receive or transmit on the at least two component carriers 450, 452 based on the updated operation parameters. Accordingly, the UE

104, RX processor 356, TX processor 368 and/or the controller/processor 359 executing the parameter activation component 140 and/or the parameter controller 146 may provide means receiving or transmitting on the at least two component carriers based on the updated operation parameters.

[0097] FIG. 12 is a flowchart of an example method 1200 for updating operation parameters based on a DCI. The method 1200 may be performed by a base station (such as the base station 102, which may include the memory 360 and which may be the entire UE 104 or a component of the UE 104 such as the parameter indication component 198, TX processor 316, the RX processor 370, or the controller/processor 375). The method 1200 may be performed by the parameter indication component 198 in communication with the parameter activation component 140 of the UE 104.

[0098] At block 1210, the method 1200 may optionally include transmitting a RRC configuration message or a MAC-CE indicating a configuration of a DCI format for the single DCI. In an aspect, for example, the base station 102, the controller/processor 375, and/or the TX processor 316 may execute the parameter indication component 198 and/or the configuration controller 542 to transmit the RRC message 466 or the MAC-CE 464 indicating a configuration of a DCI format for the single DCI 460. Accordingly, the base station 102, the controller/processor 375, and/or the TX processor 316 executing the parameter indication component 198 and/or the configuration controller 542 may provide means for transmitting a RRC configuration message or a MAC-CE indicating a configuration of a DCI format for the single DCI.

[0099] At block 1220, the method 1200 may optionally include transmitting a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH. In an aspect, for example, the base station 102, the controller/processor 375, and/or the TX processor 316 may execute the parameter indication component 198 and/or the configuration controller 542 to transmit a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH. Accordingly, the base station 102, the controller/processor 375, and/or the TX processor 316 executing the parameter indication component 198 and/or the configuration controller 542 may provide means for transmitting a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH.

[00100] At block 1230, the method 1200 may optionally include transmitting an indication of whether to transmit an ACK for the single DCI. In an aspect, for example, the base

station 102, the controller/processor 375, and/or the TX processor 316 may execute the parameter indication component 198 and/or the configuration controller 542 to transmit an indication of whether to transmit an ACK for the single DCI. Accordingly, the base station 102, the controller/processor 375, and/or the TX processor 316 executing the parameter indication component 198 and/or the configuration controller 542 may provide means for transmitting an indication of whether to transmit an ACK for the single DCI.

[00101] At block 1240, the method 1200 may include transmitting on a PDCCH a single DCI that updates operation parameters for at least two component carriers. In an aspect, for example, the base station 102, the controller/processor 375, and/or the TX processor 316 may execute the parameter indication component 198 and/or the DL signal generator 442 to transmit on the PDCCH 454 a single DCI 460 that updates operation parameters for at least two component carriers 450, 452. For example, the operation parameters may be one or more of: activated PDCCH TCI state; activated PDSCH and CSI-RS TCI state; activated spatial relation for PUCCH or SRS; activated uplink TCI state for PUCCH, PUSCH, PRACH, or SRS; activated pathloss reference signal for PUCCH, SRS, or PUSCH; or SPS or CG activation or deactivation. In an aspect, the DCI 460 may indicate repetition of an ACK 470 for the DCI 460, for example, to improve the reliability of the ACK 470. Accordingly, the base station 102, the controller/processor 375, and/or the TX processor 316 executing the parameter indication component 198 and/or the DL signal generator 442 may provide means for transmitting on a PDCCH a single DCI that updates operation parameters for at least two component carriers.

[00102] At block 1250, the method 1200 may include optionally include receiving an ACK of the single DCI. In an aspect, for example, the base station 102, the controller/processor 375, and/or the TX processor 316 may execute the parameter indication component 198 may execute the parameter activation component 140 and/or the retransmission controller 444 to receive an ACK 470 of the single DCI 460. The ACK of the DCI may be based on a configured HARQ-ACK codebook 472 type, for example, as a dedicated ACK for the DCI 460 as illustrated in FIG. 8A. For instance, where the single DCI 460 activates semi-persistent scheduling or a configured grant, the ACK of the DCI may be a dedicated ACK for the single DCI. Further, receiving the ACK may include receiving a PUCCH or a PUSCH carrying the ACK across one or more beams, for example, as illustrated in FIG. 8B. Receiving

the PUCCH or the PUSCH may include receiving multiple copies of the PUCCH or the PUSCH via space division multiplexing, frequency division multiplexing, or time division multiplexing. In another aspect, where the single DCI schedules a transmission, the transmission or an acknowledgment of the transmission may be considered the ACK 470 of the DCI 460. Accordingly, the base station 102, the controller/processor 375, and/or the TX processor 316 executing the parameter indication component 198 and/or the retransmission controller 444 may provide means for receiving an ACK of the single DCI.

[00103] At block 1260, the method 1200 may include transmitting or receiving on the at least two component carriers based on the updated operation parameters. In an aspect, for example, the base station 102, the controller/processor 375, and/or the TX processor 316 may execute the parameter indication component 198 and/or the parameter manager 440 to transmit or receive on the at least two component carriers 450, 452 based on the updated operation parameters. Accordingly, the base station 102, the controller/processor 375, and/or the TX processor 316 executing the parameter indication component 198 and/or the parameter manager 440 may provide means for transmitting or receiving on the at least two component carriers based on the updated operation parameters.

[00104] It is understood that the specific order or hierarchy of blocks in the processes / flowcharts disclosed is an illustration of example approaches. Based upon design preferences, it is understood that the specific order or hierarchy of blocks in the processes / flowcharts may be rearranged. Further, some blocks may be combined or omitted. The accompanying method claims present elements of the various blocks in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

[00105] The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." The word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any aspect described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other aspects. Unless specifically stated otherwise, the term “some” refers to one or more. Combinations such as “at least one of A, B, or C,” “one or more of A, B, or C,” “at least one of A, B, and C,” “one or more of A, B, and C,” and “A, B, C, or any combination thereof” include any combination of A, B, and/or C, and may include multiples of A, multiples of B, or multiples of C. Specifically, combinations such as “at least one of A, B, or C,” “one or more of A, B, or C,” “at least one of A, B, and C,” “one or more of A, B, and C,” and “A, B, C, or any combination thereof” may be A only, B only, C only, A and B, A and C, B and C, or A and B and C, where any such combinations may contain one or more member or members of A, B, or C. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. The words “module,” “mechanism,” “element,” “device,” and the like may not be a substitute for the word “means.” As such, no claim element is to be construed as a means plus function unless the element is expressly recited using the phrase “means for.”

CLAIMS

What is claimed is:

1. A method of wireless communication, comprising:

receiving on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers; and

receiving or transmitting on the at least two component carriers based on the updated operation parameters.

2. The method of claim 1, wherein the operation parameters are at least one of:

activated physical downlink control channel (PDCCH) transmission configuration indication (TCI) state;

activated physical downlink shared channel (PDSCH) and channel state information reference signals (CSI-RS) TCI state;

activated spatial relation for physical uplink control channel (PUCCH) or sounding reference signal (SRS);

activated uplink TCI state for PUCCH, physical uplink shared channel (PUSCH), physical random access channel (PRACH), or SRS;

activated pathloss reference signal for PUCCH, SRS, or PUSCH; or

semi-persistent scheduling or configured grant activation or deactivation.

3. The method of claim 1, further comprising receiving a radio resource control (RRC) configuration message or a media access control (MAC) control element (CE) indicating a configuration of a DCI format for the single DCI.

4. The method of claim 1, further comprising transmitting an acknowledgment (ACK) of the single DCI.

5. The method of claim 4, wherein the ACK of the DCI is based on a configured HARQ-ACK codebook type.

6. The method of claim 4, wherein transmitting the ACK comprises repeating a PUCCH or a PUSCH carrying the ACK across one or more beams.

7. The method of claim 6, wherein the single DCI indicates repetition of the ACK.

8. The method of claim 6, further comprising receiving a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH.

9. The method of claim 6, wherein repeating the PUCCH or the PUSCH comprises transmitting multiple copies of the PUCCH or the PUSCH via space division multiplexing, frequency division multiplexing, or time division multiplexing.

10. The method of claim 4, wherein the single DCI schedules a transmission, and wherein the transmission or an acknowledgment of the transmission is the ACK of the DCI.

11. The method of claim 4, wherein the single DCI activates semi-persistent scheduling or a configured grant, and wherein the ACK of the DCI is a dedicated ACK for the single DCI.

12. The method of claim 1, further comprising receiving an indication of whether to transmit an ACK for the single DCI.

13. An apparatus for wireless communication, comprising:

a processor; and

a memory in communication with the processor and storing instructions which, when executed by the processor, cause the processor to:

receive on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers; and

receive or transmit on the at least two component carriers based on the updated operation parameters.

14. The apparatus of claim 13, wherein the operation parameters are at least one of:

activated physical downlink control channel (PDCCH) transmission configuration indication (TCI) state;

activated physical downlink shared channel (PDSCH) and channel state information reference signals (CSI-RS) TCI state;

activated spatial relation for physical uplink control channel (PUCCH) or sounding reference signal (SRS);

activated uplink TCI state for PUCCH, physical uplink shared channel (PUSCH), physical random access channel (PRACH), or SRS;

activated pathloss reference signal for PUCCH, SRS, or PUSCH; or

semi-persistent scheduling or configured grant activation or deactivation.

15. The apparatus of claim 13, wherein the processor is further configured to receive a radio resource control (RRC) configuration message or a media access control (MAC) control element (CE) indicating a configuration of a DCI format for the single DCI.

16. The apparatus of claim 13, wherein the processor is further configured to transmit an acknowledgment (ACK) of the single DCI.

17. The apparatus of claim 16, wherein the ACK of the DCI is based on a configured HARQ-ACK codebook type.

18. The apparatus of claim 16, wherein to transmit the ACK comprises repeating a PUCCH or a PUSCH carrying the ACK across one or more beams.

19. The apparatus of claim 18, wherein the single DCI indicates repetition of the ACK.

20. The apparatus of claim 18, wherein the processor is further configured to receive a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH.

21. The apparatus of claim 18, wherein repeating the PUCCH or the PUSCH comprises to transmit multiple copies of the PUCCH or the PUSCH via space division multiplexing, frequency division multiplexing, or time division multiplexing.

22. The apparatus of claim 16, wherein the single DCI schedules a transmission, and wherein the transmission or an acknowledgment of the transmission is the ACK of the DCI.

23. The apparatus of claim 16, wherein the single DCI activates semi-persistent scheduling or a configured grant, and wherein the ACK of the DCI is a dedicated ACK for the single DCI.

24. The apparatus of claim 13, wherein the processor is further configured to receive an indication of whether to transmit an ACK for the single DCI.

25. An apparatus for wireless communication, comprising:

means for receiving on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers; and

means for receiving or transmitting on the at least two component carriers based on the updated operation parameters.

26. The apparatus of claim 25, wherein the operation parameters are at least one of:

activated physical downlink control channel (PDCCH) transmission configuration indication (TCI) state;

activated physical downlink shared channel (PDSCH) and channel state information reference signals (CSI-RS) TCI state;

activated spatial relation for physical uplink control channel (PUCCH) or sounding reference signal (SRS);

activated uplink TCI state for PUCCH, physical uplink shared channel (PUSCH), physical random access channel (PRACH), or SRS;

activated pathloss reference signal for PUCCH, SRS, or PUSCH; or

semi-persistent scheduling or configured grant activation or deactivation.

27. The apparatus of claim 25, further comprising means for receiving a radio resource control (RRC) configuration message or a media access control (MAC) control element (CE) indicating a configuration of a DCI format for the single DCI.

28. The apparatus of claim 25, further comprising means for transmitting an acknowledgment (ACK) of the single DCI.

29. The apparatus of claim 28, wherein the ACK of the DCI is based on a configured HARQ-ACK codebook type.

30. The apparatus of claim 28, wherein the means for transmitting the ACK comprises repeating a PUCCH or a PUSCH carrying the ACK across one or more beams.

31. The apparatus of claim 30, wherein the single DCI indicates repetition of the ACK.

32. The apparatus of claim 30, further comprising means for receiving a second DCI, a MAC-CE, or an RRC message means for indicating repetition of the PUCCH or the PUSCH.

33. The apparatus of claim 30, wherein the means for repeating the PUCCH or the PUSCH is configured to transmit multiple copies of the PUCCH or the PUSCH via space division multiplexing, frequency division multiplexing, or time division multiplexing.

34. The apparatus of claim 28, wherein the single DCI schedules a transmission, and wherein the transmission or an acknowledgment of the transmission is the ACK of the DCI.

35. The apparatus of claim 28, wherein the single DCI activates semi-persistent means for scheduling or a configured grant, and wherein the ACK of the DCI is a dedicated ACK for the single DCI.

36. The apparatus of claim 25, further comprising means for receiving an indication of whether to transmit an ACK for the single DCI.

37. A computer-readable medium storing instructions for wireless communication, executable by a processor to:

receive on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers; and

receive or transmit on the at least two component carriers based on the updated operation parameters.

38. The computer-readable medium of claim 37, wherein the operation parameters are at least one of:

activated physical downlink control channel (PDCCH) transmission configuration indication (TCI) state;

activated physical downlink shared channel (PDSCH) and channel state information reference signals (CSI-RS) TCI state;

activated spatial relation for physical uplink control channel (PUCCH) or sounding reference signal (SRS);

activated uplink TCI state for PUCCH, physical uplink shared channel (PUSCH), physical random access channel (PRACH), or SRS;

activated pathloss reference signal for PUCCH, SRS, or PUSCH; or

semi-persistent scheduling or configured grant activation or deactivation.

39. The computer-readable medium of claim 37, wherein the instructions are further executable by the processor to receive a radio resource control (RRC) configuration message or a media access control (MAC) control element (CE) indicating a configuration of a DCI format for the single DCI.

40. The computer-readable medium of claim 37, wherein the instructions are further executable by the processor to transmit an acknowledgment (ACK) of the single DCI.

41. The computer-readable medium of claim 40, wherein the ACK of the DCI is based on a configured HARQ-ACK codebook type.

42. The computer-readable medium of claim 40, wherein to transmit the ACK comprises repeating a PUCCH or a PUSCH carrying the ACK across one or more beams.

43. The computer-readable medium of claim 42, wherein the single DCI indicates repetition of the ACK.

44. The computer-readable medium of claim 42, wherein the instructions are further executable by the processor to receive a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH.

45. The computer-readable medium of claim 42, wherein repeating the PUCCH or the PUSCH comprises to transmit multiple copies of the PUCCH or the PUSCH via space division multiplexing, frequency division multiplexing, or time division multiplexing.

46. The computer-readable medium of claim 40, wherein the single DCI schedules a transmission, and wherein the transmission or an acknowledgment of the transmission is the ACK of the DCI.

47. The computer-readable medium of claim 40, wherein the single DCI activates semi-persistent scheduling or a configured grant, and wherein the ACK of the DCI is a dedicated ACK for the single DCI.

48. The computer-readable medium of claim 37, wherein the instructions are further executable by the processor to receive an indication of whether to transmit an ACK for the single DCI.

49. A method of wireless communication, comprising:

transmitting on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers; and transmitting or receiving on the at least two component carriers based on the updated operation parameters.

50. The method of claim 49, wherein the operation parameters are at least one of:

activated physical downlink control channel (PDCCH) transmission configuration indication (TCI) state;

activated physical downlink shared channel (PDSCH) and channel state information reference signals (CSI-RS) TCI state;

activated spatial relation for physical uplink control channel (PUCCH) or sounding reference signal (SRS);

activated uplink TCI state for PUCCH, physical uplink shared channel (PUSCH), physical random access channel (PRACH), or SRS;

activated pathloss reference signal for PUCCH, SRS, or PUSCH; or

semi-persistent scheduling or configured grant activation or deactivation.

51. The method of claim 49, further comprising transmitting a radio resource control (RRC) configuration message or a media access control (MAC) control element (CE) indicating a configuration of a DCI format for the single DCI.

52. The method of claim 49, further comprising transmitting an acknowledgment (ACK) of the single DCI.

53. The method of claim 52, wherein the ACK of the DCI is based on a configured HARQ-ACK codebook type.

54. The method of claim 52, wherein receiving the ACK comprises receiving a PUCCH or a PUSCH carrying the ACK on two or more beams.

55. The method of claim 54, wherein the single DCI indicates repetition of the ACK.

56. The method of claim 54 further comprising transmitting a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH.

57. The method of claim 54, wherein receiving the ACK comprises receiving multiple copies of the PUCCH or the PUSCH via space division multiplexing, frequency division multiplexing, or time division multiplexing.

58. The method of claim 52, wherein the single DCI schedules a transmission, and wherein the transmission or an acknowledgment of the transmission is the ACK of the DCI.

59. The method of claim 52, wherein the single DCI activates semi-persistent scheduling or a configured grant, and wherein the ACK of the DCI is a dedicated ACK for the single DCI.

60. The method of claim 49, further comprising transmitting an indication of whether to receive an ACK for the single DCI.

61. An apparatus for wireless communication, comprising:

a processor; and

a memory in communication with the processor and storing instructions which, when executed by the processor, cause the processor to:

transmit on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers; and

transmit or receive on the at least two component carriers based on the updated operation parameters.

62. The apparatus of claim 61, wherein the operation parameters are at least one of:

activated physical downlink control channel (PDCCH) transmission configuration indication (TCI) state;

activated physical downlink shared channel (PDSCH) and channel state information reference signals (CSI-RS) TCI state;

activated spatial relation for physical uplink control channel (PUCCH) or sounding reference signal (SRS);

activated uplink TCI state for PUCCH, physical uplink shared channel (PUSCH), physical random access channel (PRACH), or SRS;

activated pathloss reference signal for PUCCH, SRS, or PUSCH; or

semi-persistent scheduling or configured grant activation or deactivation.

63. The apparatus of claim 61, wherein the processor is further configured to transmit a radio resource control (RRC) configuration message or a media access control (MAC) control element (CE) indicating a configuration of a DCI format for the single DCI.

64. The apparatus of claim 61, wherein the processor is further configured to receive an acknowledgment (ACK) of the single DCI.

65. The apparatus of claim 64, wherein the ACK of the DCI is based on a configured HARQ-ACK codebook type.

66. The apparatus of claim 64, wherein to receive the ACK comprises receiving a PUCCH or a PUSCH carrying the ACK across two or more beams.

67. The apparatus of claim 66, wherein the single DCI indicates repetition of the ACK.

68. The apparatus of claim 66, wherein the processor is further configured to transmit a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH.

69. The apparatus of claim 66, wherein to receive the PUCCH or the PUSCH comprises to receive multiple copies of the PUCCH or the PUSCH via space division multiplexing, frequency division multiplexing, or time division multiplexing.

70. The apparatus of claim 64, wherein the single DCI schedules a transmission, and wherein the transmission or an acknowledgment of the transmission is the ACK of the DCI.

71. The apparatus of claim 64, wherein the single DCI activates semi-persistent scheduling or a configured grant, and wherein the ACK of the DCI is a dedicated ACK for the single DCI.

72. The apparatus of claim 61, wherein the processor is further configured to transmit an indication of whether to receive an ACK for the single DCI.

73. An apparatus for wireless communication, comprising:

means for transmitting on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers; and

means for transmitting or receiving on the at least two component carriers based on the updated operation parameters.

74. The apparatus of claim 73, wherein the operation parameters are at least one of:

activated physical downlink control channel (PDCCH) transmission configuration indication (TCI) state;

activated physical downlink shared channel (PDSCH) and channel state information reference signals (CSI-RS) TCI state;

activated spatial relation for physical uplink control channel (PUCCH) or sounding reference signal (SRS);

activated uplink TCI state for PUCCH, physical uplink shared channel (PUSCH), physical random access channel (PRACH), or SRS;

activated pathloss reference signal for PUCCH, SRS, or PUSCH; or

semi-persistent scheduling or configured grant activation or deactivation.

75. The apparatus of claim 73, further comprising means for transmitting a radio resource control (RRC) configuration message or a media access control (MAC) control element (CE) indicating a configuration of a DCI format for the single DCI.

76. The apparatus of claim 73, further comprising means for transmitting an acknowledgment (ACK) of the single DCI.

77. The apparatus of claim 76, wherein the ACK of the DCI is based on a configured HARQ-ACK codebook type.

78. The apparatus of claim 76, wherein the means for receiving the ACK comprises receiving a PUCCH or a PUSCH carrying the ACK across two or more beams.

79. The apparatus of claim 78, wherein the single DCI indicates repetition of the ACK.

80. The apparatus of claim 78, further comprising means for transmitting a second DCI, a MAC-CE, or an RRC message means for indicating repetition of the PUCCH or the PUSCH.

81. The apparatus of claim 78, wherein the means for receiving the PUCCH or the PUSCH is configured to receive multiple copies of the PUCCH or the PUSCH via space division multiplexing, frequency division multiplexing, or time division multiplexing.

82. The apparatus of claim 76, wherein the single DCI schedules a transmission, and wherein the transmission or an acknowledgment of the transmission is the ACK of the DCI.

83. The apparatus of claim 76, wherein the single DCI activates semi-persistent means for scheduling or a configured grant, and wherein the ACK of the DCI is a dedicated ACK for the single DCI.

84. The apparatus of claim 73, further comprising means for transmitting an indication of whether to receive an ACK for the single DCI.

85. A computer-readable medium storing instructions for wireless communication, executable by a processor to:

transmit on a physical downlink control channel (PDCCH) a single downlink control information (DCI) that updates operation parameters for at least two component carriers; and transmit or receive on the at least two component carriers based on the updated operation parameters.

86. The computer-readable medium of claim 85, wherein the operation parameters are at least one of:

activated physical downlink control channel (PDCCH) transmission configuration indication (TCI) state;

activated physical downlink shared channel (PDSCH) and channel state information reference signals (CSI-RS) TCI state;

activated spatial relation for physical uplink control channel (PUCCH) or sounding reference signal (SRS);

activated uplink TCI state for PUCCH, physical uplink shared channel (PUSCH), physical random access channel (PRACH), or SRS;

activated pathloss reference signal for PUCCH, SRS, or PUSCH; or

semi-persistent scheduling or configured grant activation or deactivation.

87. The computer-readable medium of claim 85, wherein the instructions are further executable by the processor to transmit a radio resource control (RRC) configuration message or a media access control (MAC) control element (CE) indicating a configuration of a DCI format for the single DCI.

88. The computer-readable medium of claim 85, wherein the instructions are further executable by the processor to receive an acknowledgment (ACK) of the single DCI.

89. The computer-readable medium of claim 88, wherein the ACK of the DCI is based on a configured HARQ-ACK codebook type.

90. The computer-readable medium of claim 88, wherein to receive the ACK comprises to receive a PUCCH or a PUSCH carrying the ACK across one or more beams.

91. The computer-readable medium of claim 90, wherein the single DCI indicates repetition of the ACK.

92. The computer-readable medium of claim 90, wherein the instructions are further executable by the processor to transmit a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH.

93. The computer-readable medium of claim 90, wherein to receive the PUCCH or the PUSCH comprises to receive multiple copies of the PUCCH or the PUSCH via space division multiplexing, frequency division multiplexing, or time division multiplexing.

94. The computer-readable medium of claim 88, wherein the single DCI schedules a transmission, and wherein the transmission or an acknowledgment of the transmission is the ACK of the DCI.

95. The computer-readable medium of claim 88, wherein the single DCI activates semi-persistent scheduling or a configured grant, and wherein the ACK of the DCI is a dedicated ACK for the single DCI.

96. The computer-readable medium of claim 85, wherein the instructions are further executable by the processor to transmit an indication of whether to receive an ACK for the single DCI.

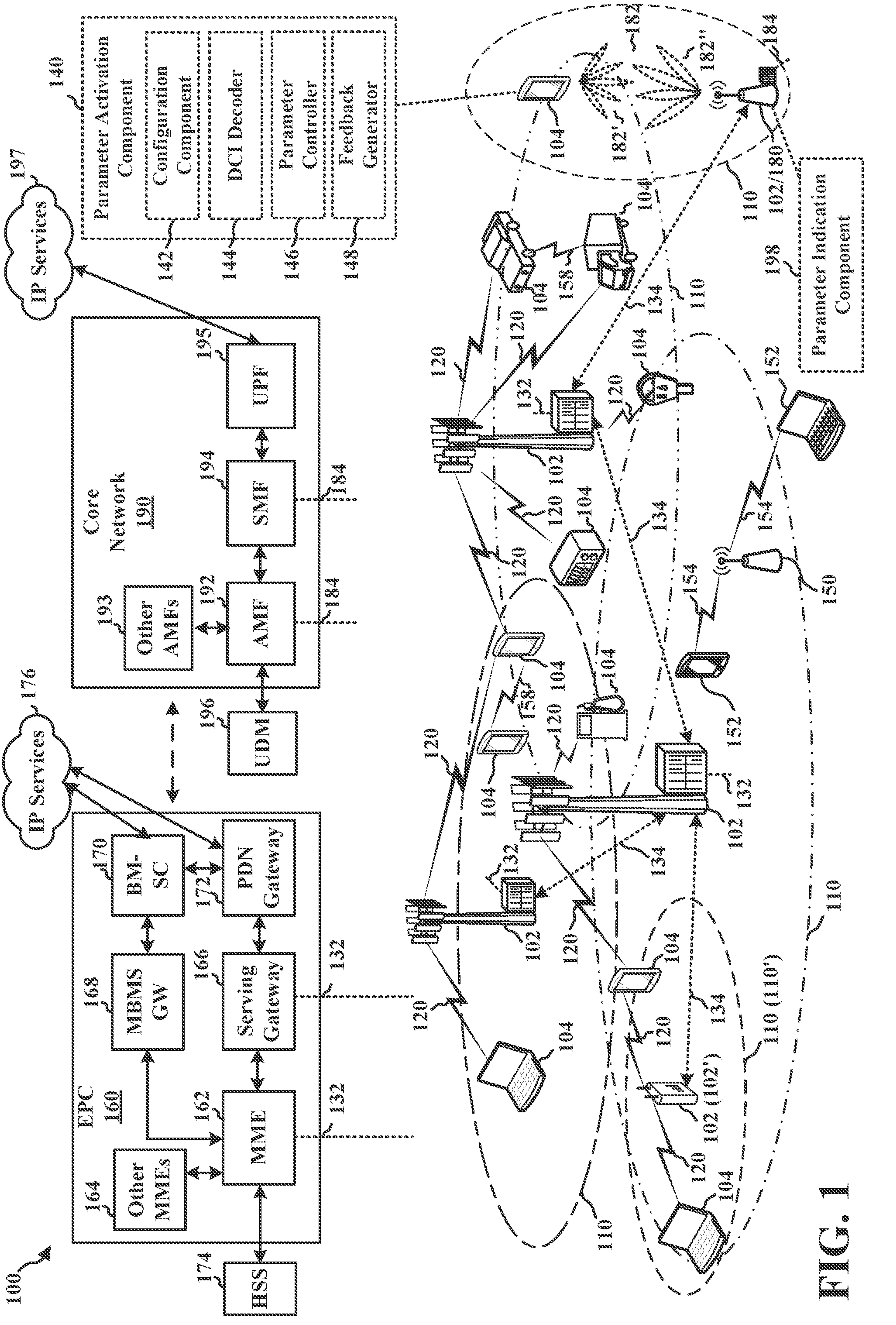
100
EPC
160
Other MMEs
164
MME
162
MBMS GW
168
BM-SC
170
Serving Gateway
166
PDN Gateway
172
HSS
174
IP Services
176
Core Network
190
Other AMFs
193
AMF
192
SMF
194
UPF
195
UDM
196
IP Services
197
Parameter Activation Component
140
Configuration Component
142
DCI Decoder
144
Parameter Controller
146
Feedback Generator
148
Parameter Indication Component
198
102/180
182'
182''
182
184
132
134
120
158
152
154
150
110
110 (110')
102 (102')
104

FIG. 1

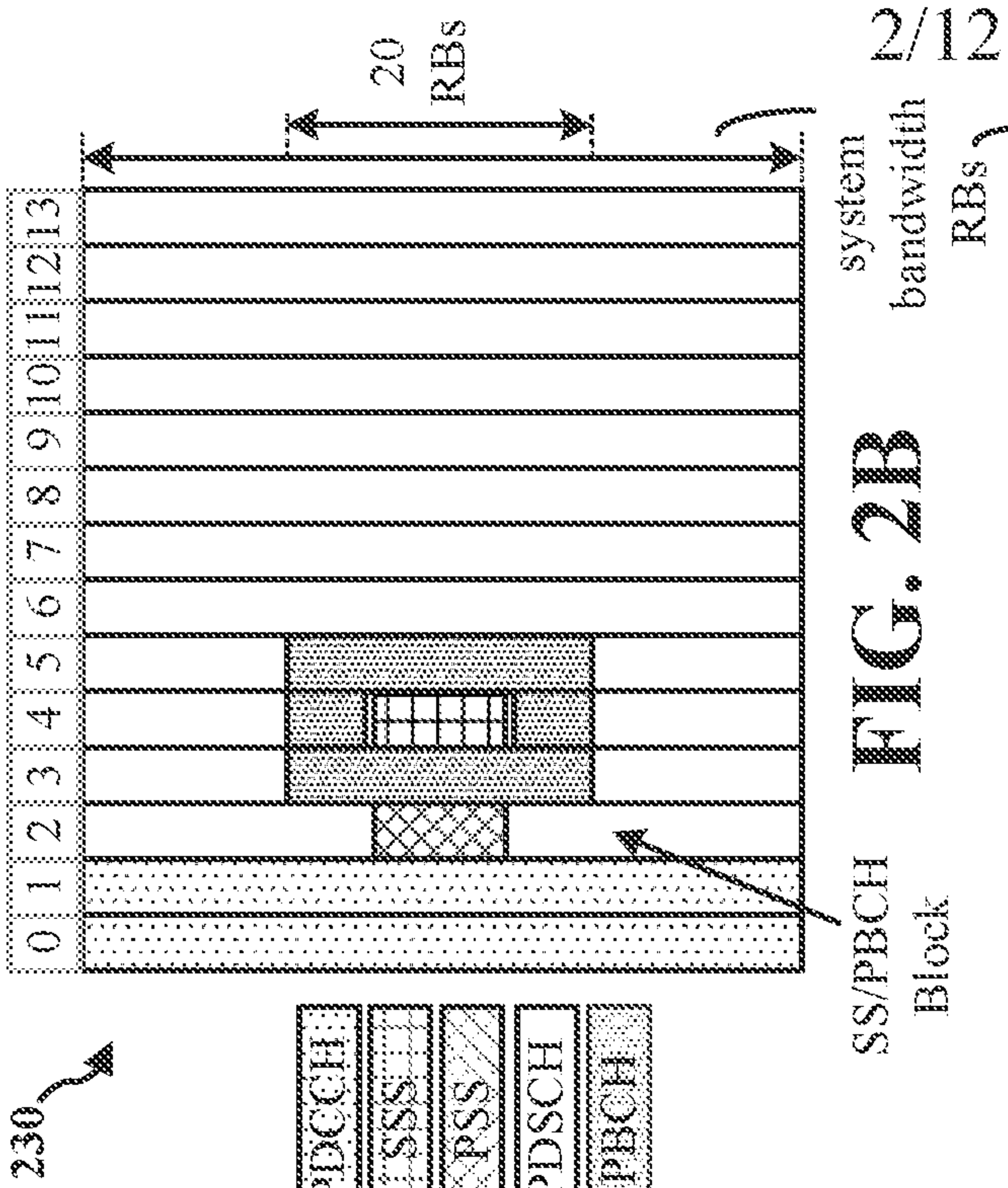

FIG. 2B

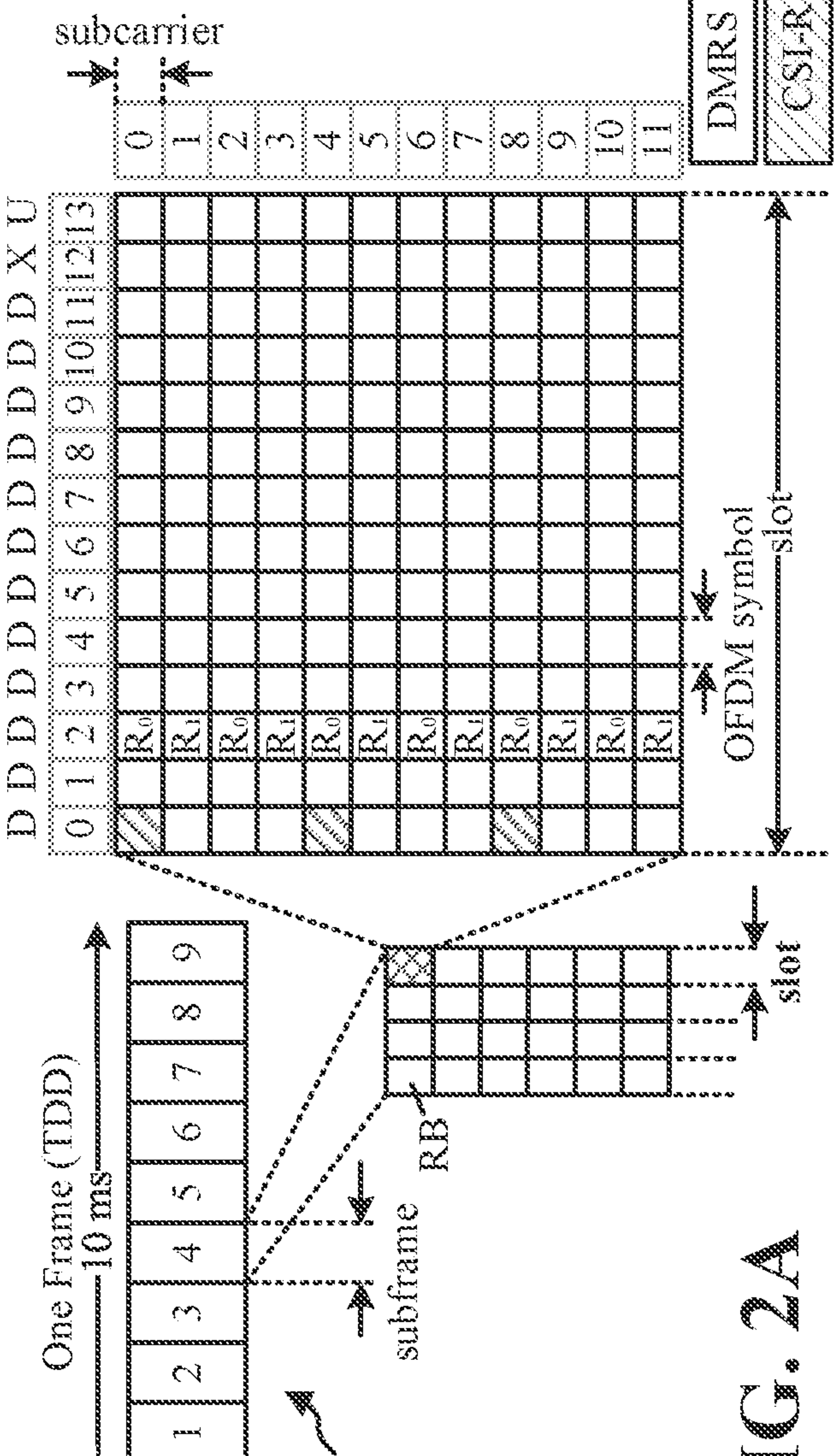

FIG. 2A

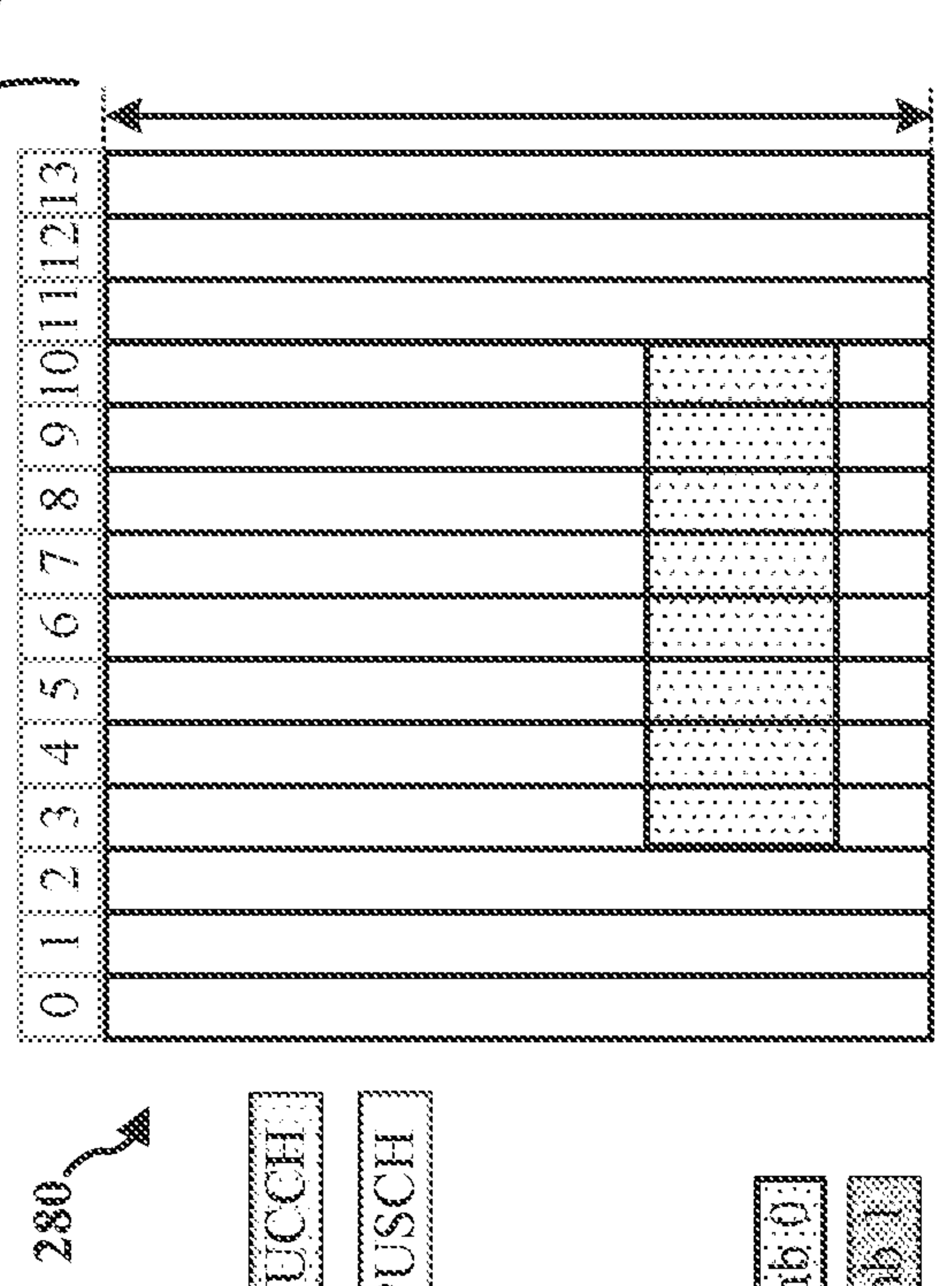

FIG. 2D

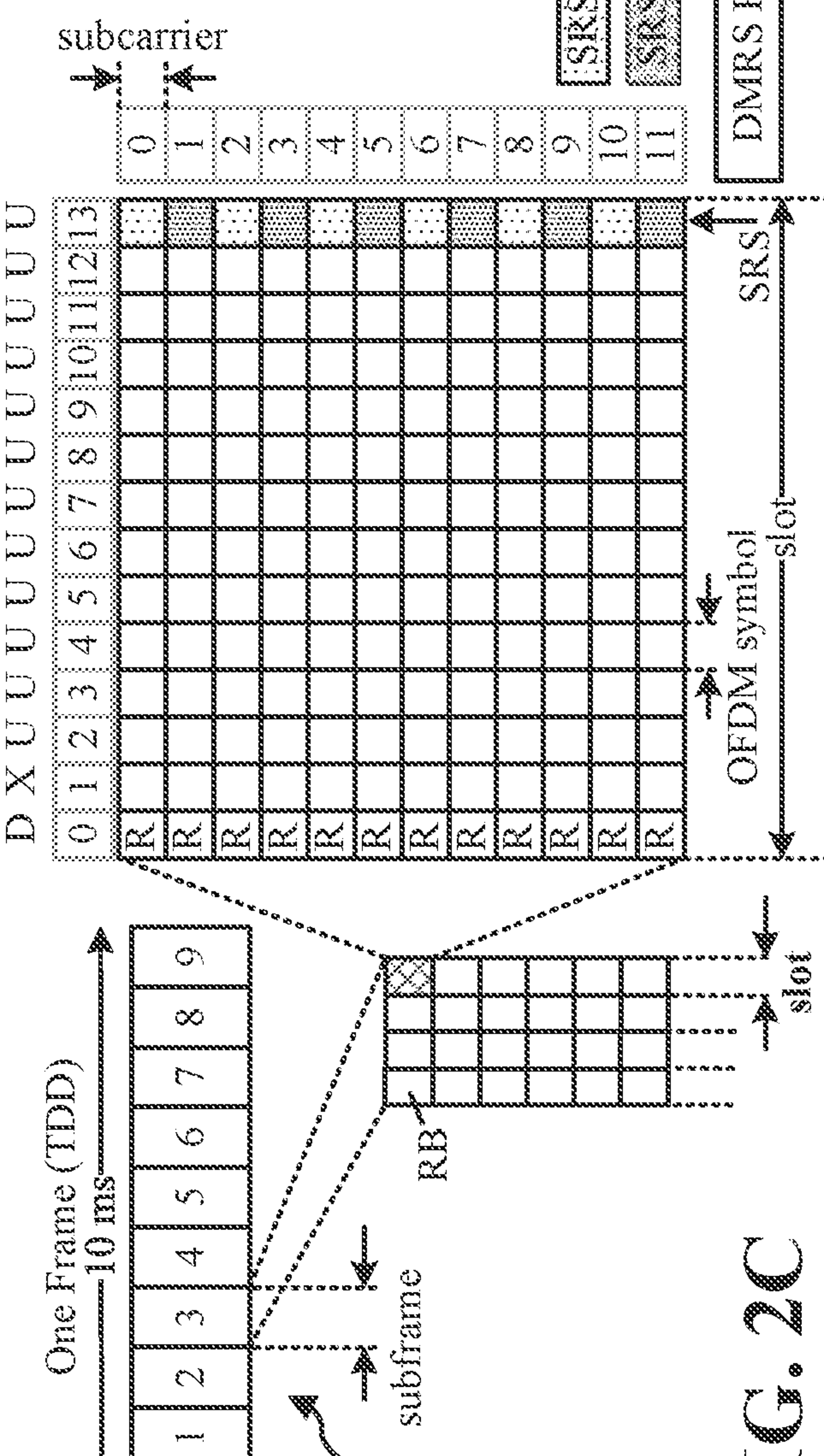

FIG. 2C

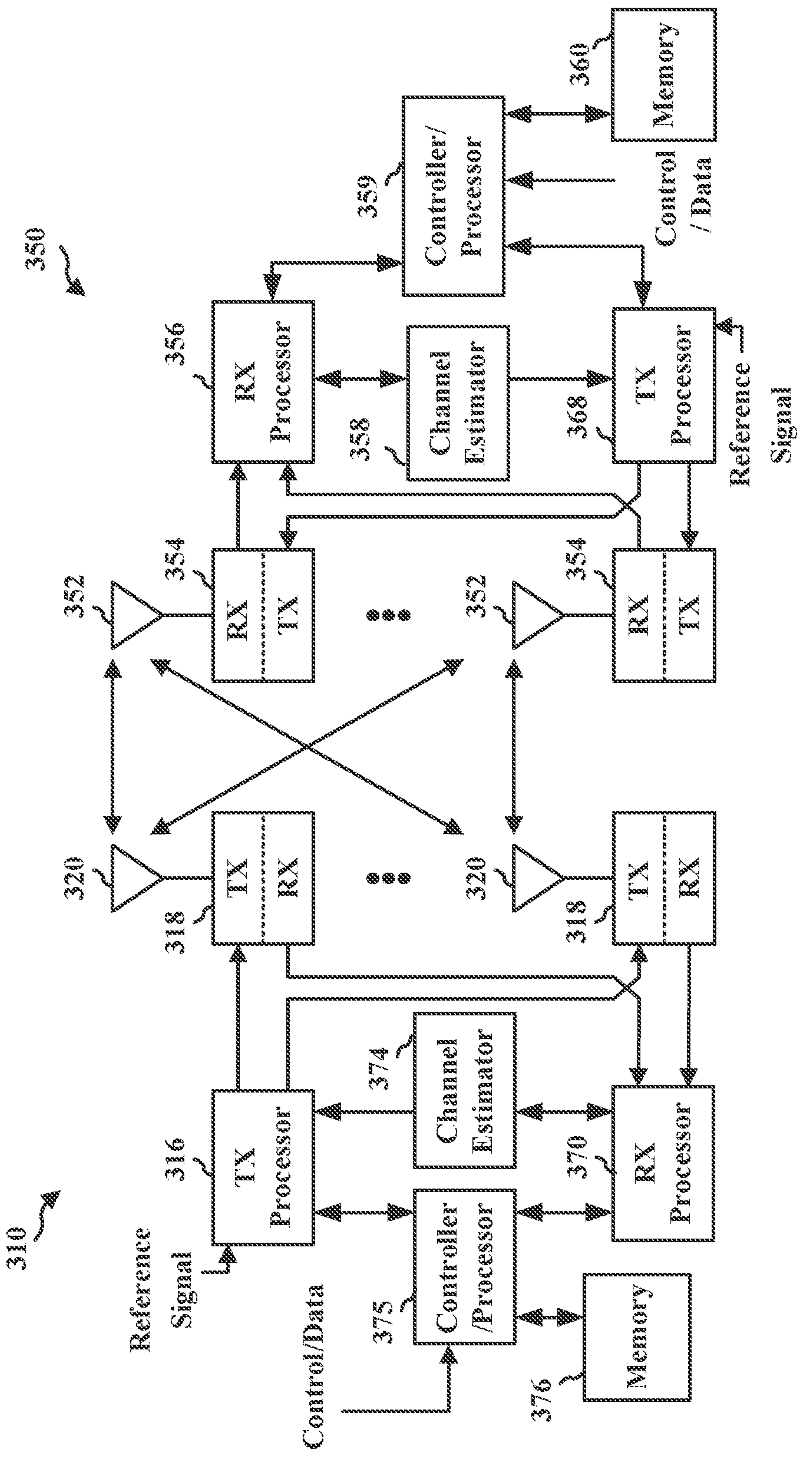
350
359
Controller/ Processor
360
Memory
Control / Data
356
RX Processor
358
Channel Estimator
368
TX Processor
Reference Signal
352
354
RX
TX
320
318
TX
RX
310
316
TX Processor
374
Channel Estimator
370
RX Processor
375
Controller /Processor
376
Memory
Reference Signal
Control/Data

FIG. 3

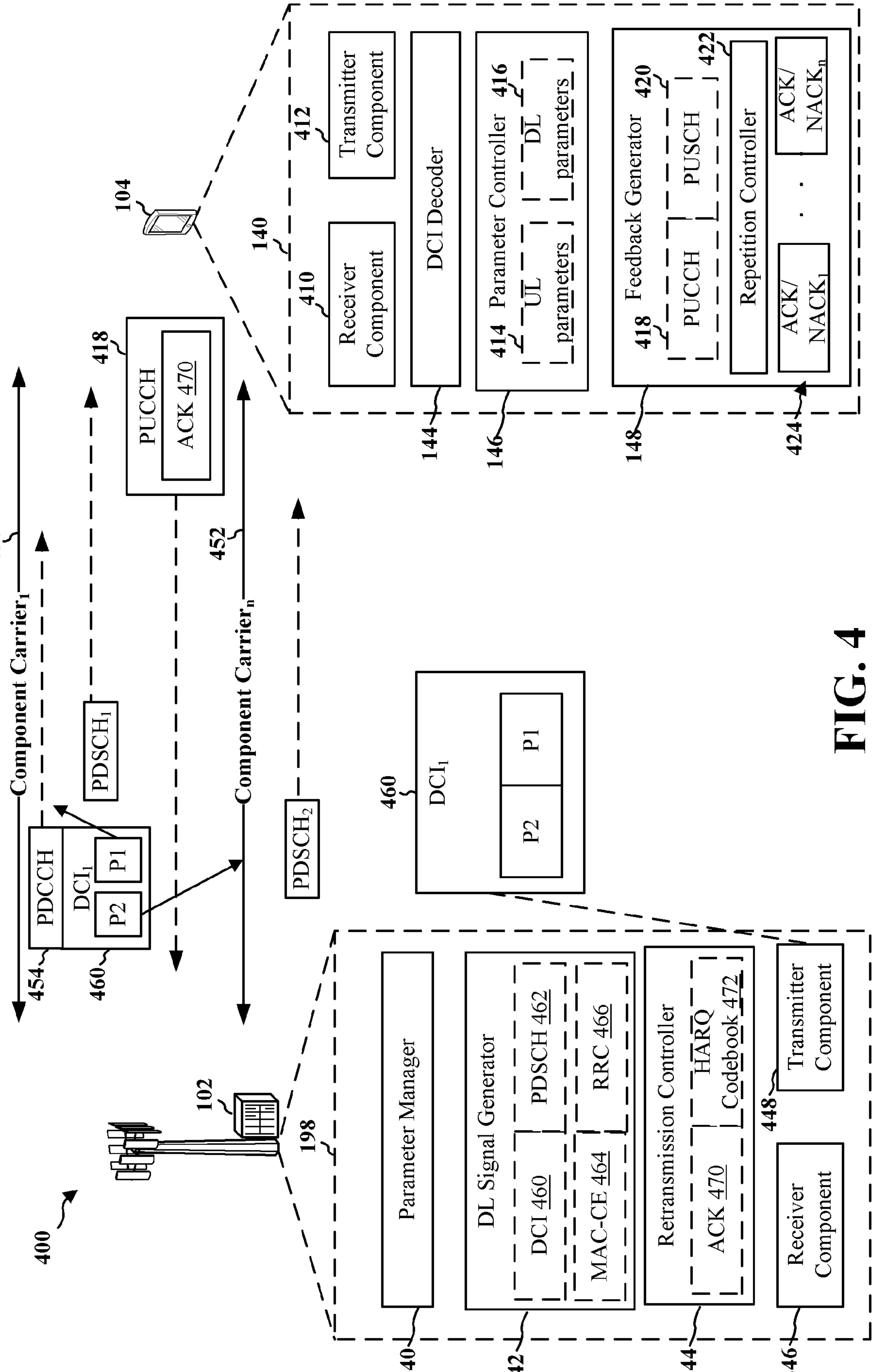
400
102
198
104
Component Carrier1
Component Carriern
450
452
454
460
418
PDCCH
DCI1
P1
P2
PDSCH1
PDSCH2
PUCCH
ACK 470
DCI1
P1
P2
460
140
410
Receiver Component
412
Transmitter Component
DCI Decoder
144
146
414
Parameter Controller
416
UL parameters
DL parameters
148
Feedback Generator
418
420
PUCCH
PUSCH
422
Repetition Controller
ACK/NACK1
ACK/NACKn
424
440
Parameter Manager
442
DL Signal Generator
DCI 460
PDSCH 462
MAC-CE 464
RRC 466
444
Retransmission Controller
ACK 470
HARQ Codebook 472
446
Receiver Component
448
Transmitter Component

FIG. 4

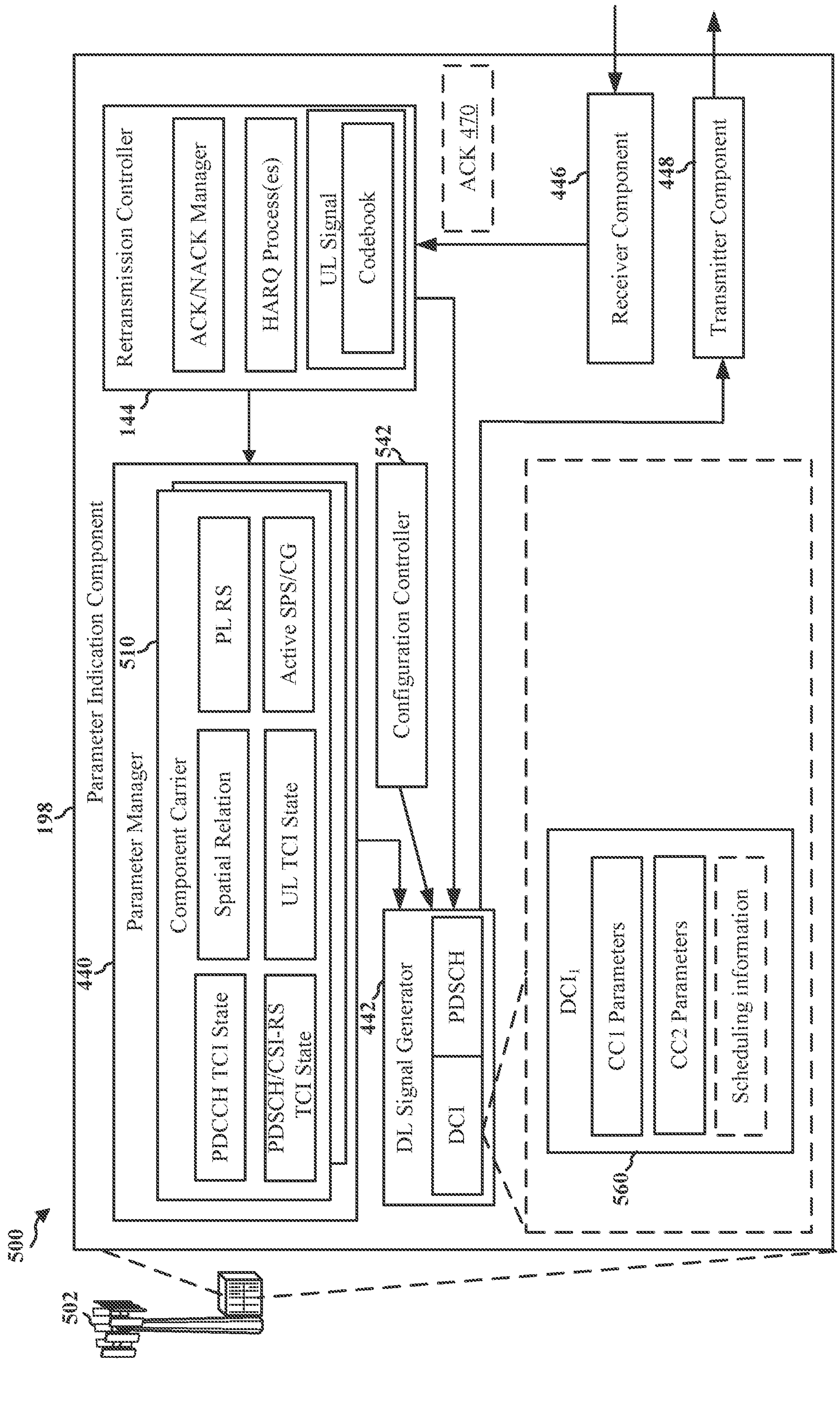
500
502
198
Parameter Indication Component
144
Retransmission Controller
ACK/NACK Manager
HARQ Process(es)
UL Signal
Codebook
ACK 470
446
Receiver Component
448
Transmitter Component
440
Parameter Manager
510
Component Carrier
PDCCH TCI State
PDSCH/CSI-RS TCI State
Spatial Relation
UL TCI State
PL RS
Active SPS/CG
542
Configuration Controller
442
DL Signal Generator
DCI
PDSCH
560
DCI_1
CC1 Parameters
CC2 Parameters
Scheduling information

FIG. 5

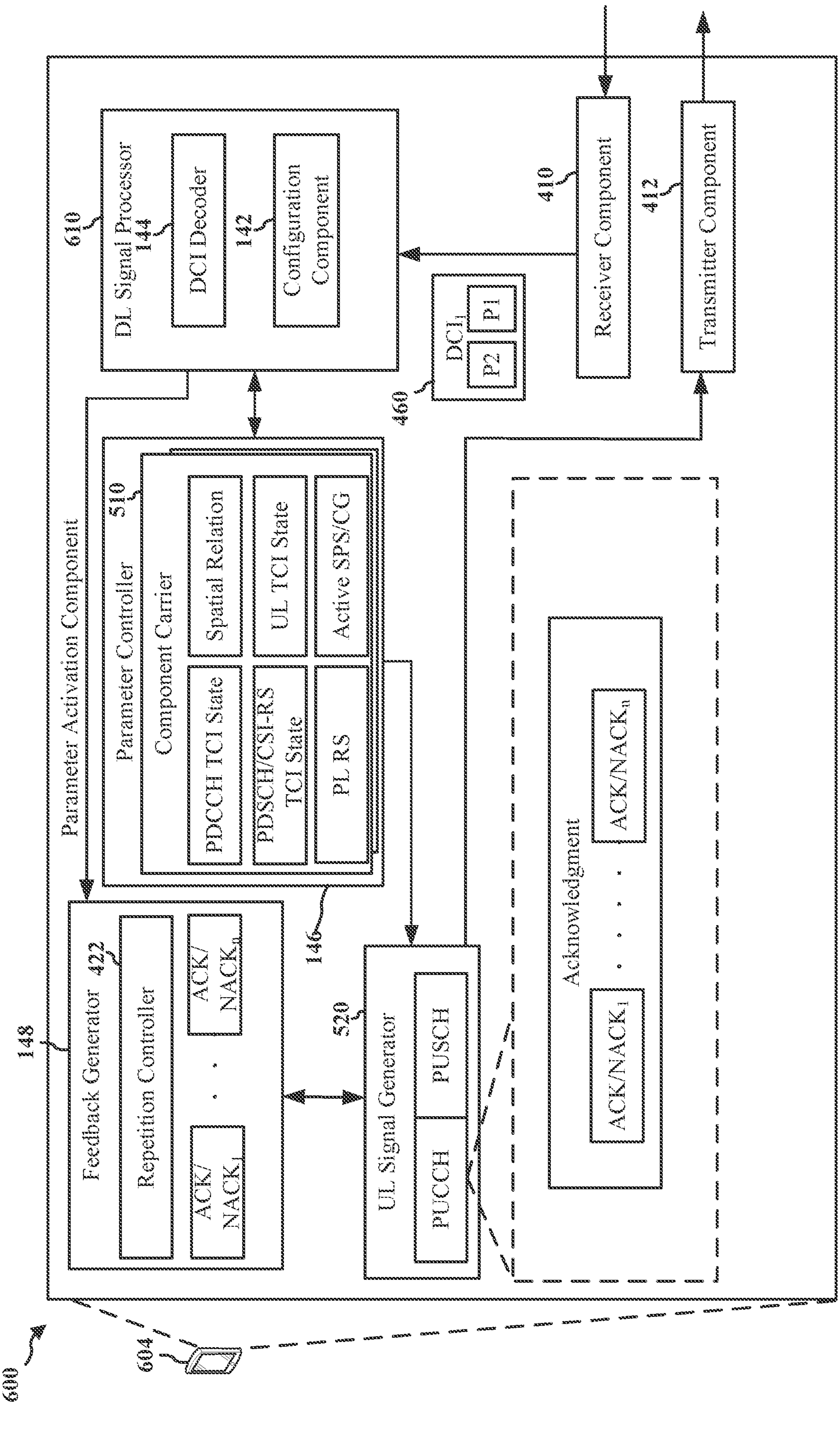
600
604
Parameter Activation Component
610
DL Signal Processor
144
DCI Decoder
142
Configuration Component
410
Receiver Component
412
Transmitter Component
460
DCI1
P1
P2
510
Parameter Controller
Component Carrier
Spatial Relation
UL TCI State
Active SPS/CG
PDCCH TCI State
PDSCH/CSI-RS TCI State
PL RS
146
148
Feedback Generator
422
Repetition Controller
ACK/NACK1
ACK/NACKn
520
UL Signal Generator
PUCCH
PUSCH
Acknowledgment
ACK/NACK1
ACK/NACKn

FIG. 6

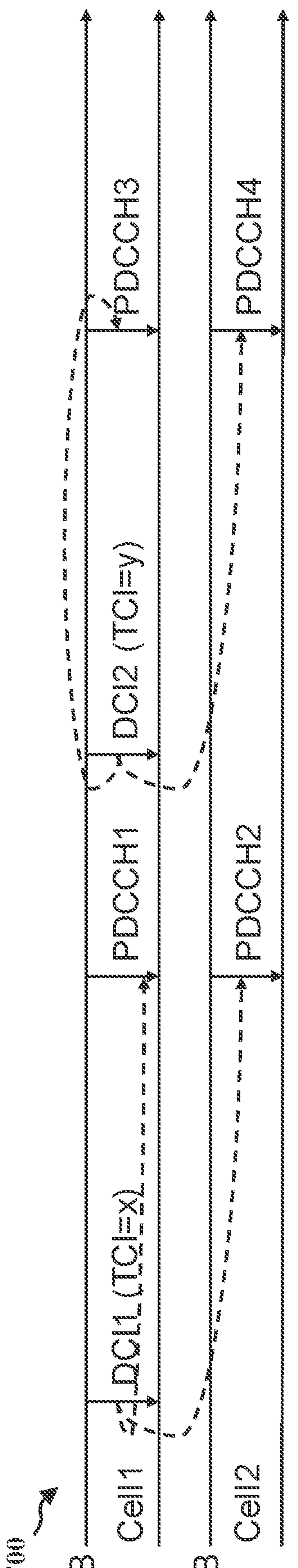

FIG. 7A

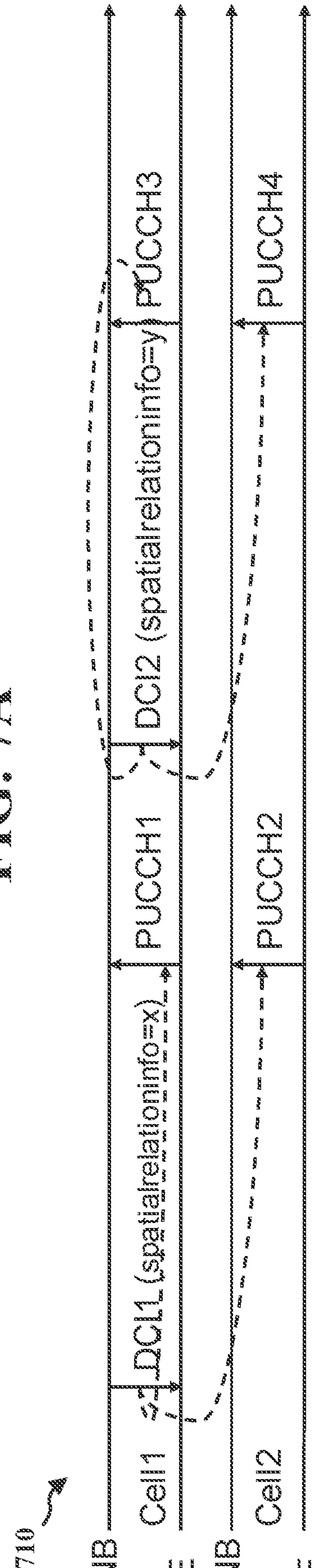

FIG. 7B

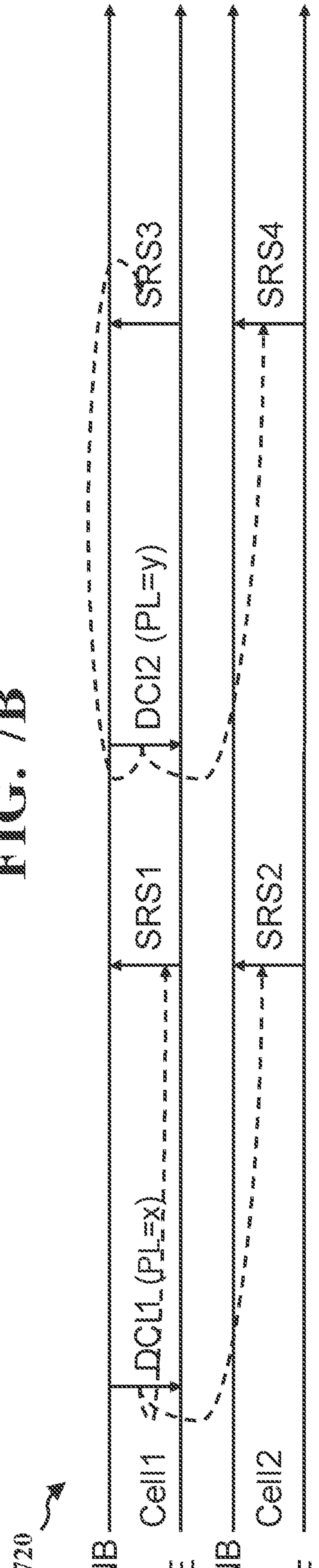

FIG. 7C

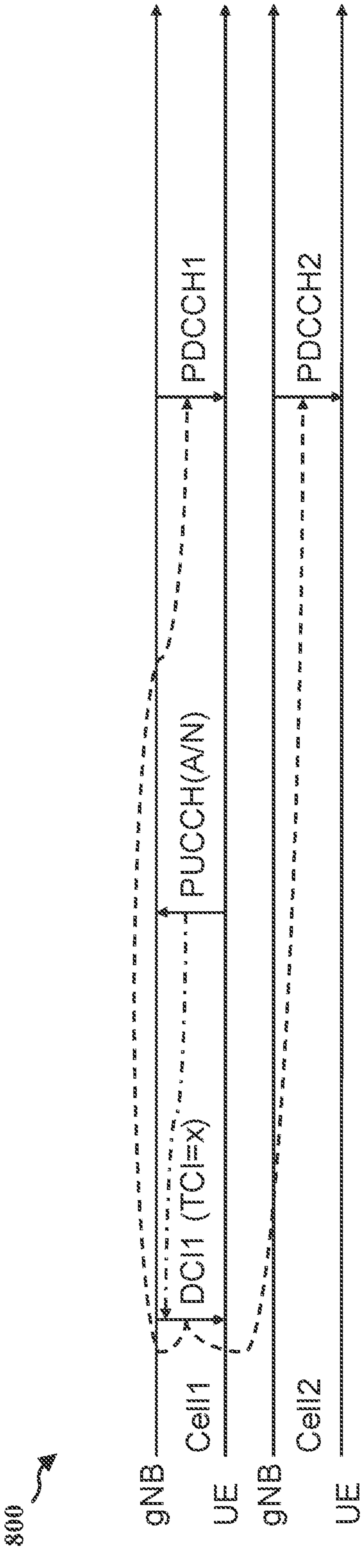
800
gNB
UE
gNB
UE
Cell1
Cell2
DCI1 (TCI=x)
PUCCH(A/N)
PDCCH1
PDCCH2

FIG. 8A

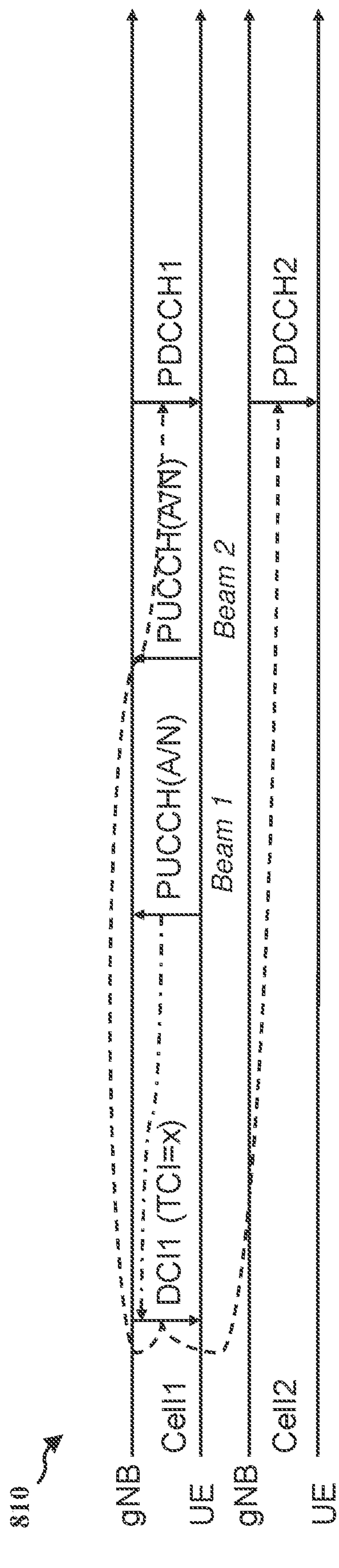
810
gNB
UE
gNB
UE
Cell1
Cell2
DCI1 (TCI=x)
PUCCH(A/N)
Beam 1
PUCCH(A/N)
Beam 2
PDCCH1
PDCCH2

FIG. 8B

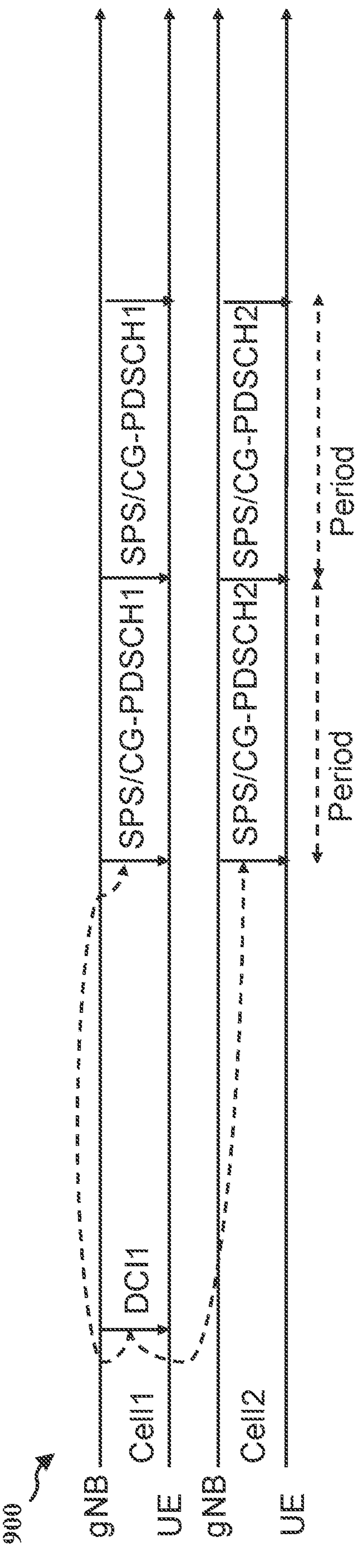
900
gNB
UE
gNB
UE
Cell1
Cell2
DCI1
SPS/CG-PDSCH1
SPS/CG-PDSCH1
SPS/CG-PDSCH2
SPS/CG-PDSCH2
Period
Period

FIG. 9A

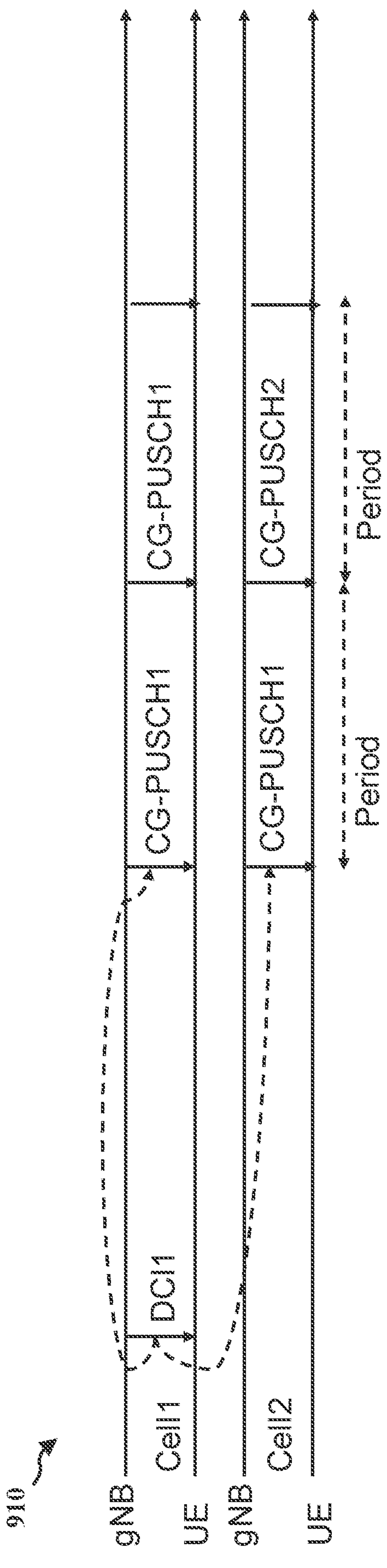
910
gNB
UE
gNB
UE
Cell1
Cell2
DCI1
CG-PUSCH1
CG-PUSCH1
CG-PUSCH1
CG-PUSCH2
Period
Period

FIG. 9B

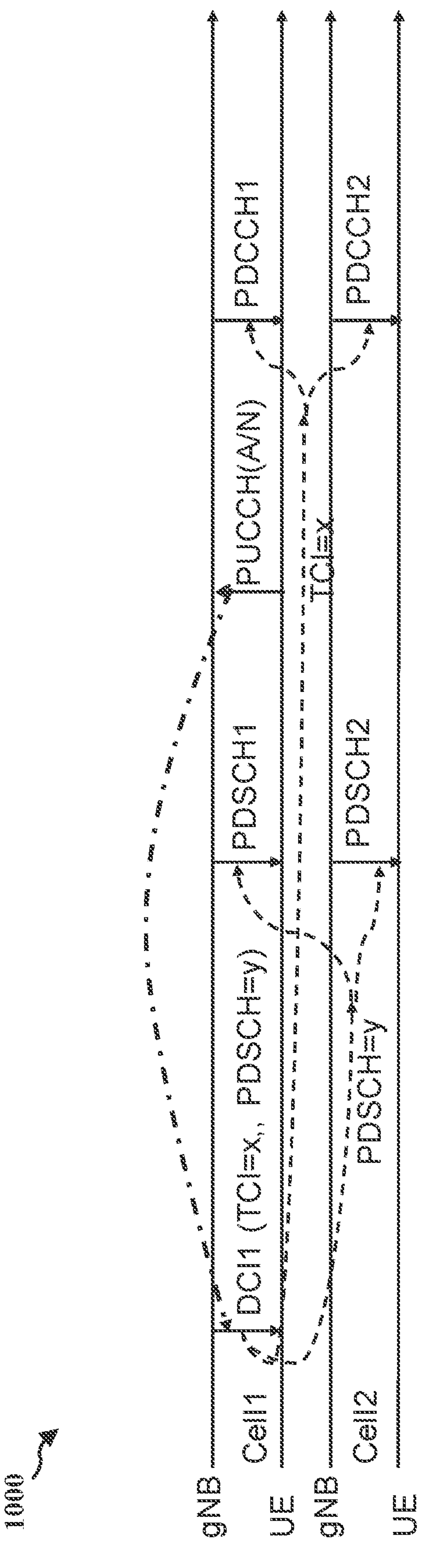
1000
gNB
UE
gNB
UE
Cell1
Cell2
DCI1 (TCI=x,, PDSCH=y)
PDSCH1
PUCCH(A/N)
PDCCH1
PDSCH2
PDCCH2
TCI=x
PDSCH=y

FIG. 10

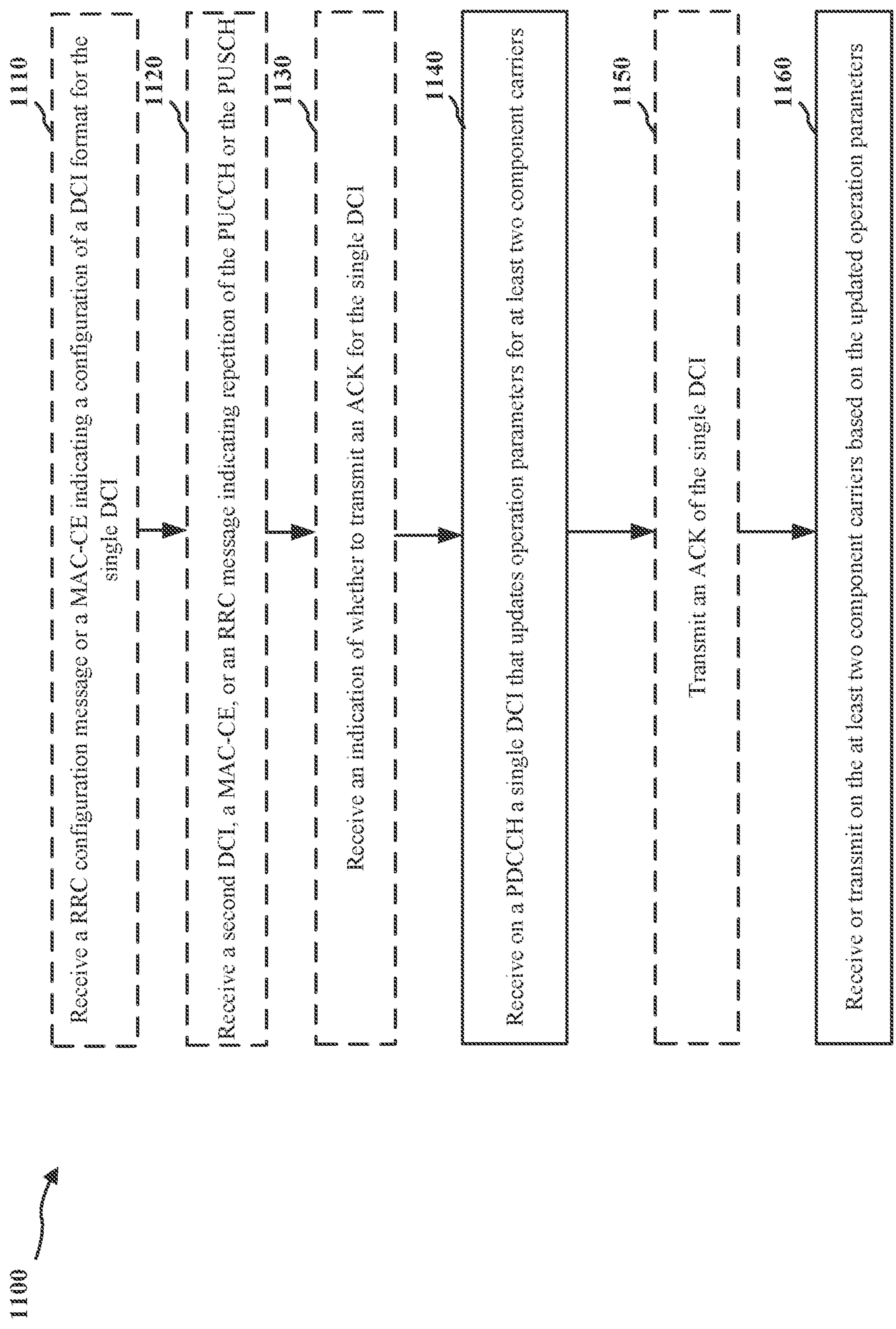
1100
1110
Receive a RRC configuration message or a MAC-CE indicating a configuration of a DCI format for the single DCI
1120
Receive a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH
1130
Receive an indication of whether to transmit an ACK for the single DCI
1140
Receive on a PDCCH a single DCI that updates operation parameters for at least two component carriers
1150
Transmit an ACK of the single DCI
1160
Receive or transmit on the at least two component carriers based on the updated operation parameters

FIG. 11

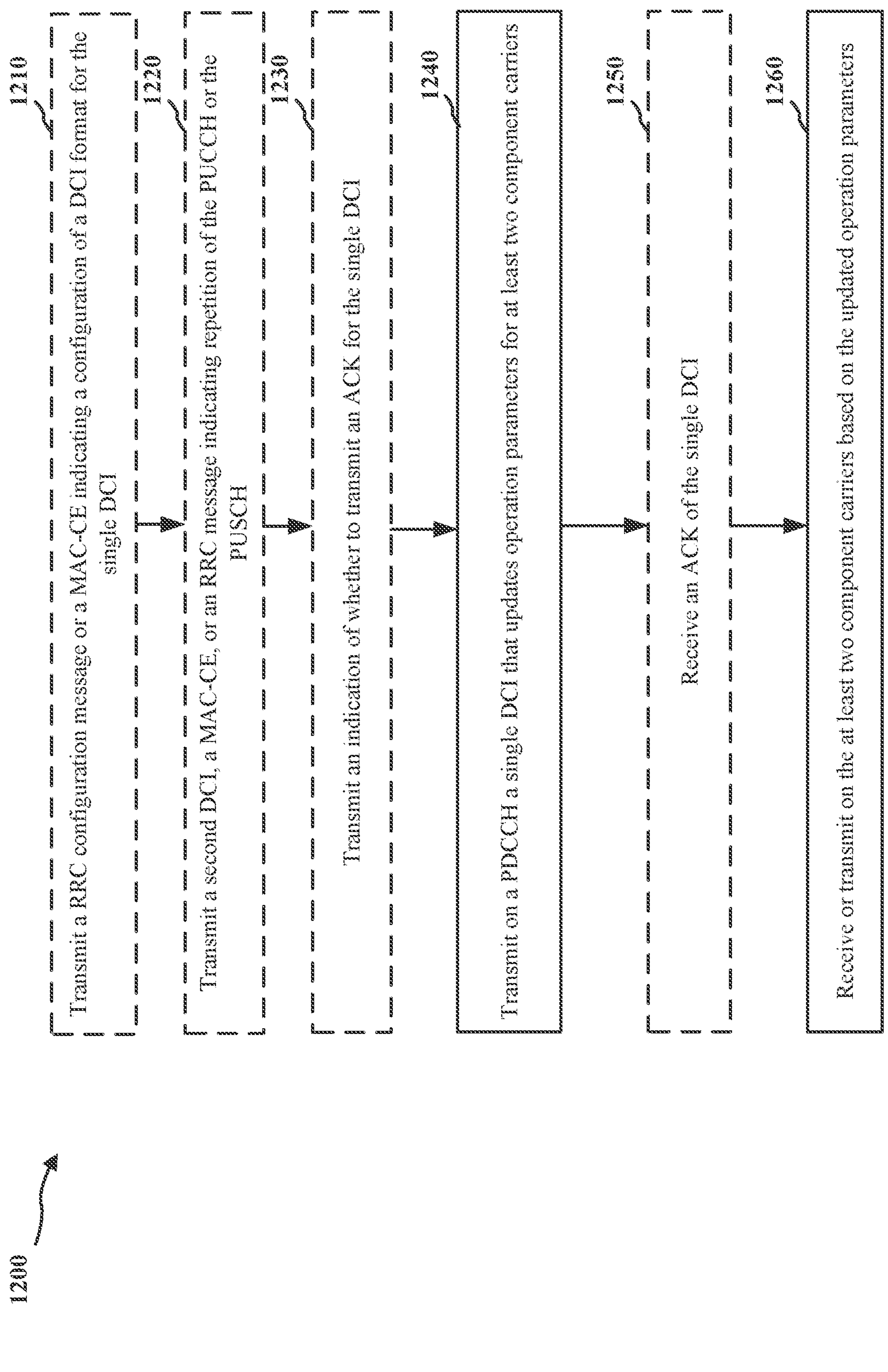
1200
1210
Transmit a RRC configuration message or a MAC-CE indicating a configuration of a DCI format for the single DCI
1220
Transmit a second DCI, a MAC-CE, or an RRC message indicating repetition of the PUCCH or the PUSCH
1230
Transmit an indication of whether to transmit an ACK for the single DCI
1240
Transmit on a PDCCH a single DCI that updates operation parameters for at least two component carriers
1250
Receive an ACK of the single DCI
1260
Receive or transmit on the at least two component carriers based on the updated operation parameters

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/072674

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(2009.01)i； H04L 5/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W; H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS;CNTXT;CNKI;VEN;WOTXT;USTXT;EPTXT;3GPP:single, one, DCI, downlink control information, parameter?, PDCCH, PDSCH, CSI-RS, SRS, TCI state, spatial relation, two, more, CC?, component carrier?, primary, secondary, cell?, PCell, SCell, ACK

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016227523 A1 (FUTUREWEI TECHNOLOGIES INC) 04 August 2016 (2016-08-04) see claims 15, 20; description, paragraphs [0032]-[0102]; figures 3-5	1-96
A	US 2014079008 A1 (PANTECH CO LTD) 20 March 2014 (2014-03-20) see the whole document	1-96
A	Huawei et al. "R1-1706904, Power control for CA and DC" *3GPP TSG RAN WG1 Meeting #89,* 19 May 2017 (2017-05-19), see the whole document	1-96
A	MediaTek Inc. "R1-1908379, Enhancements on multi-TRP/panel transmission" *3GPP TSG RAN WG1 #98,* 30 August 2019 (2019-08-30), see the whole document	1-96

☐ Further documents are listed in the continuation of Box C.　☑ See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 October 2020	**21 October 2020**

Name and mailing address of the ISA/CN	Authorized officer
National Intellectual Property Administration, PRC **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**WU,Xu**
Facsimile No. **(86-10)62019451**	Telephone No. **86-010-62089859**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2020/072674

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2016227523	A1	04 August 2016	US	10264564	B2	16 April 2019
				WO	2016119752	A1	04 August 2016
US	2014079008	A1	20 March 2014	WO	2012150771	A3	21 March 2013
				WO	2012150771	A2	08 November 2012
				KR	20120123989	A	12 November 2012