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(54) **Title:** METHODS AND APPARATUS FOR SWITCHING PERIOD LOCATIONS

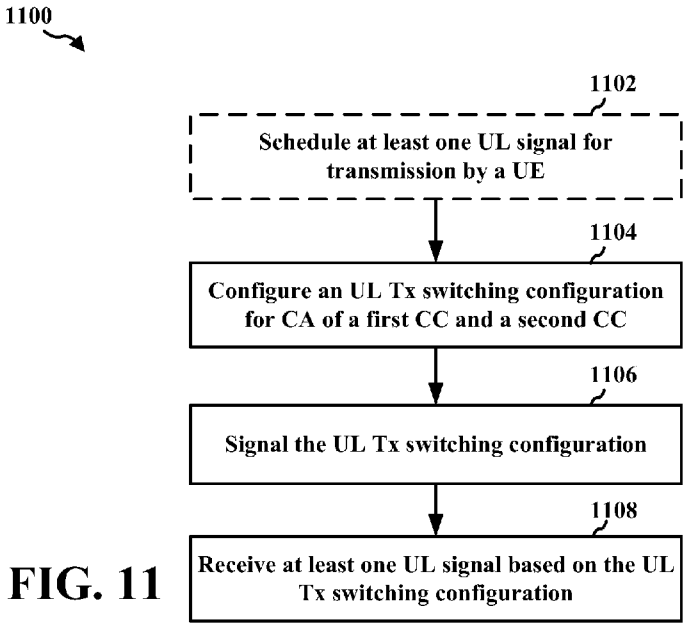

FIG. 11

(57) **Abstract:** The present disclosure relates to methods and devices for wireless communication including an apparatus, e.g., a user equipment (UE) and/or base station. In one aspect, the apparatus can configure an UL Tx switching configuration for CA of a first CC and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC. The apparatus can also signal the UL Tx switching configuration for CA of the first CC and the second CC. Additionally, the apparatus can receive at least one UL signal based on the UL Tx switching configuration.

[Continued on next page]

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METHODS AND APPARATUS FOR SWITCHING PERIOD LOCATIONS

BACKGROUND

Technical Field

[0001] The present disclosure relates generally to communication systems, and more particularly, to carrier aggregation (CA) in wireless communication systems.

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] In an aspect of the disclosure, a method, a computer-readable medium, and an apparatus are provided. The apparatus may be a base station. The apparatus may schedule uplink (UL) data for a transmission by a user equipment (UE). The apparatus may also configure an UL transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC. Additionally, the apparatus may signal the UL Tx switching configuration for CA of the first CC and the second CC. The apparatus may also receive at least one UL signal based on the UL Tx switching configuration.

[0006] In another aspect of the disclosure, a method, a computer-readable medium, and an apparatus are provided. The apparatus may be a user equipment (UE). The apparatus may receive a transmission schedule for uplink (UL) data from a base station. The apparatus may also receive an UL transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC. Further, the apparatus may implement the UL Tx switching configuration for CA of the first CC and the second CC. The apparatus may also transmit at least one UL signal based on the UL Tx switching configuration.

[0007] 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

[0008] FIG. 1 is a diagram illustrating an example of a wireless communications system and an access network.

[0009] 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.

[0010] FIG. 3 is a diagram illustrating an example of a base station and user equipment (UE) in an access network.

[0011] FIGs. 4A and 4B are diagrams illustrating example frame structures in accordance with one or more techniques of the present disclosure.

[0012] FIG. 5 is a diagram illustrating an example frame structure in accordance with one or more techniques of the present disclosure.

[0013] FIGs. 6A and 6B are diagrams illustrating example frame structures in accordance with one or more techniques of the present disclosure.

[0014] FIGs. 7A and 7B are diagrams illustrating example frame structures in accordance with one or more techniques of the present disclosure.

[0015] FIG. 8 is a diagram illustrating an example frame structure in accordance with one or more techniques of the present disclosure.

[0016] FIGs. 9A and 9B are diagrams illustrating example frame structures in accordance with one or more techniques of the present disclosure.

[0017] FIG. 10 is a diagram illustrating example communication between a UE and a base station in accordance with one or more techniques of the present disclosure.

[0018] FIG. 11 is a flowchart of a method of wireless communication.

[0019] FIG. 12 is a flowchart of a method of wireless communication.

DETAILED DESCRIPTION

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] 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).

[0027] 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 Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard, LTE, or NR.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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 packet switched (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.

[0033] The core network 190 may include an 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.

[0034] 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.

[0035] Referring again to FIG. 1, in certain aspects, the base station 180 may include a transmission component 199 configured to schedule uplink (UL) data for a transmission by a user equipment (UE). Transmission component 199 may also be configured to configure an UL transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC. Transmission component 199 may also be configured to signal the UL Tx switching configuration for CA of the first CC and the second CC. Transmission component 199 may also be configured to receive at least one UL signal based on the UL Tx switching configuration.

[0036] Referring again to FIG. 1, in certain aspects, the UE 104 may include a reception component 198 configured to receive a transmission schedule for uplink (UL) data from a base station. Reception component 198 may also be configured to receive an

UL transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC. Reception component 198 may also be configured to implement the UL Tx switching configuration for CA of the first CC and the second CC. Reception component 198 may also be configured to transmit at least one UL signal based on the UL Tx switching configuration.

[0037] 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.

[0038] 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 frequency division duplexed (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 time division duplexed (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.

[0039] 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.

[0040] 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.

[0041] 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).

[0042] 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.

[0043] 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.

[0044] 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 hybrid

automatic repeat request (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.

[0045] 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.

[0046] 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 a radio frequency (RF) carrier with a respective spatial stream for transmission.

[0047] 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.

[0048] 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 which may store computer executable code for wireless communication of a user equipment (UE), the code when executed by a processor (e.g., one or more of RX processor 356, TX processor 368, and/or controller/processor 359) instructs the

processor to perform aspects of FIGs. 9, 10, and/or 11. 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.

[0049] 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.

[0050] 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.

[0051] 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.

[0052] 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 which may store computer executable code for wireless communication of base station, the code when executed by a processor (e.g., one or more of RX processor 370, TX processor 316, and/or controller/processor 375) instructs the

processor to perform aspects of FIGs. 9, 10, and/or 11. 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.

[0053] 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 198 of FIG. 1.

[0054] 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 199 of FIG. 1.

[0055] Aspects of wireless communication can include uplink (UL) one transmit (1Tx) to two transmit (2Tx) (1Tx-2Tx) switching where there is at least one new radio (NR) time division duplex (TDD) carrier, e.g., a high frequency band with a large bandwidth. The 1Tx-2Tx switching can also include at least one NR frequency division duplex (FDD) UL carrier, e.g., a low frequency band with a smaller bandwidth compared to TDD, of a different carrier frequency. For instance, when a UE is configured with UL 1Tx-2Tx switching, time switching of a NR TDD UL carrier and a NR FDD UL carrier may be utilized. So the uplink transmission can be time switched across multiple carriers when the UE is configured with an UL switching capability. The location of a switching period or switching gap may be configured or semi-statically configured by radio resource control (RRC) signaling on a specific carrier of the two uplink carriers.

[0056] FIGs. 4A and 4B are diagrams 400 and 450, respectively, illustrating example frame structures. As shown in FIG. 4A, the frame structure in diagram 400 includes an FDD CC 401, a TDD CC 402, UL Tx switching periods or gaps 410, DL Rx interruption periods 420, and UL transmission periods 430. The frame structure in diagram 400 displays a number of slots in a subframe. FIG. 4A displays that the switching periods 410 are configured on CC 401. More generally, FIG. 4A displays RRC signaling configuring the carrier switch period on a first component carrier, e.g., CC 401.

[0057] As shown in FIG. 4B, the frame structure in diagram 450 includes an FDD CC 451, a TDD CC 452, UL Tx switching periods or gaps 460, DL Rx interruption periods 470,

and UL transmission periods 480. The frame structure in diagram 450 displays a number of slots in a subframe. FIG. 4B displays that the switching periods 460 are configured on CC 452. Also, FIG. 4B displays RRC configuring the carrier switch period on a second component carrier, e.g., CC 452. In some aspects, if the switching periods or gaps are located on a first CC, then the switching periods or gaps may overlap with the uplink signal in the corresponding uplink slot of a first CC.

[0058] Additionally, there may be a downlink (DL) receive (Rx) interruption due to shared phase lock loop (PLL) for UL and DL. In some aspects, UL Tx switching may need to re-tune the PLL on the frequency of the target CC. However, the DL Rx interruption may occur as well during the PLL retuning, e.g., based on a shared PLL for UL and DL.

[0059] FIG. 5 is a diagram 500 illustrating an example frame structure. As shown in FIG. 5, the frame structure in diagram 500 includes an FDD CC 501, a TDD CC 502, UL Tx switching periods or gaps 510, DL Rx interruption periods 520, and UL transmission periods 530. The frame structure in diagram 500 displays a number of slots in a subframe. FIG. 5 displays that the switching periods 510 are configured on CC 501. As shown in FIG. 5, DL interruption analysis may occur for both switching periods on CC1 and switching periods on CC2. The DL interruption length may depend on the switching length and the time misalignment between the Tx switching carrier and the sub-carrier spacing (SCS) of the victim DL carrier.

[0060] As shown in FIG. 5, the DL Rx interruptions 520 at the beginning of a DL slot may need to be avoided. For instance, as this is the location of the CORESET or PDCCH, and an interruption of the CORESET or PDCCH Rx may lead to significant DL performance degradation, the DL Rx interruptions 520 at these locations may need to be avoided. In some aspects, such DL Rx interruptions may not be able to be avoided due to UL Tx switching.

[0061] FIGs. 6A and 6B are diagrams 600 and 650, respectively, illustrating example frame structures. As shown in FIG. 6A, the frame structure in diagram 600 includes a TDD CC 601, a TDD CC 602, UL Tx switching periods or gaps 610, and UL transmission periods 620. The frame structure in diagram 600 displays a number of slots in a subframe. FIG. 6A displays that the switching periods 610 are configured on CC 602. FIG. 6A displays asynchronous TDD and TDD (T+T) carrier aggregation (CA). As shown in FIGs. 6A, a 1.5 ms offset for two aggregated TDD CCs may be used to

stagger the UL slots across two carriers. So the UL Tx switching can be applied across the two TDD carriers.

[0062] As shown in FIG. 6B, the frame structure in diagram 650 includes a TDD CC 651, a TDD CC 652, UL Tx switching periods or gaps 660, and UL transmission periods 670. The frame structure in diagram 650 displays a number of slots in a subframe. FIG. 6B displays that the switching periods 660 are configured on CC 651. FIG. 6B also displays asynchronous TDD and TDD (T+T) CA, as well as a 1.5 ms offset for two aggregated TDD CCs which may be used to stagger the UL slots across the two carriers.

[0063] As mentioned herein, once the switching period is configured on one CC, the switching period may overlap with the UL symbols in the UL phase of the CC. Accordingly, there may be no overlapping UL symbols across multiple CCs. This can result in an unnecessary waste of UL symbols being used as the switching period for T+T CA, since the available DL symbols between each UL phase can be used as the switching period or gap. In this case, there may be additional UL symbols that can be utilized to improve UL performance. As such, there is a present need to reduce the amount of wasted UL symbols being used as the switching period for T+T CA.

[0064] Aspects of the present disclosure may reduce the amount of wasted UL symbols being used as the switching periods for CA, e.g., T+T CA. For instance, the present disclosure may utilize additional UL symbols in order to improve UL performance. Additionally, aspects of the present disclosure may avoid DL Rx interruption at the beginning of a DL slot, such as by avoiding the UL Tx switching in this location. In some aspects, avoiding the beginning of a DL slot for UL Tx switching may be utilized for TDD and TDD (T+T) CA, as well as TDD and FDD (T+F) CA.

[0065] In some aspects, the present disclosure can include a new switching period location of UL Tx switching for TDD and FDD (T+F) or TDD and TDD (T+T) CA. A new switching period location configuration may be used by default if the location of the switching period is not semi-statically configured by RRC signaling. So if a base station does not explicitly configure the location of the switching period, then a default configuration may be utilized. If the switching period is present, the switching period may be located at the last UL symbol preceding the UL transmission on one CC and immediately preceding the UL transmission on another CC.

[0066] FIGs. 7A and 7B are diagrams 700 and 750, respectively, illustrating example frame structures in accordance with one or more techniques of the present disclosure. As

shown in FIG. 7A, the frame structure in diagram 700 includes an FDD CC 701, a TDD CC 702, UL Tx switching periods or gaps 710, DL Rx interruption periods 720, and UL transmission periods 730. The frame structure in diagram 700 displays a number of slots in a subframe. FIG. 7A displays that the switching periods 710 are configured on CC 701 and CC 702. As shown in FIG. 7A, a switching period may be located at the last UL symbols preceding the UL transmission on FDD CC 701 and immediately preceding the UL transmission on TDD CC 702. For instance, the switching period on CC 701 may be located prior to the SRS transmission on CC 702, and prior to the UL transmission on CC 702. This switching period or gap 710 can also precede the UL transmission on CC 701.

[0067] As shown in FIG. 7B, frame structure in diagram 750 includes a TDD CC 751, a TDD CC 752, UL Tx switching periods or gaps 760, and UL transmission periods 770. The frame structure in diagram 750 displays a number of slots in a subframe. FIG. 7B displays that the switching periods 760 are configured on CC 751 and CC 752. As shown in FIG. 7B, for T+T CA, the switching period may be located at the last UL symbols preceding the UL transmission on TDD CC 751 and immediately preceding the UL transmission on TDD CC 752. So for T+T CA, the switching gap can be located at the last UL symbols which precede the UL transmission on the opposite CC.

[0068] In some aspects, there can be an exception for the aforementioned switching gap location for T+F CA, as there is a smaller bandwidth for FDD compared to TDD. For example, there may be a smaller bandwidth on FDD, e.g., 20-30 MHz, compared to a bandwidth on TDD, e.g., 100 MHz. Accordingly, if the switching gap is located on the FDD carrier, the performance loss due to the switching gap may be reduced.

[0069] FIG. 8 is a diagram 800 illustrating an example frame structure in accordance with one or more techniques of the present disclosure. As shown in FIG. 8, frame structure in diagram 800 includes an FDD CC 801, a TDD CC 802, UL Tx switching periods or gaps 810, DL Rx interruption periods 820, and UL transmission periods 830. The frame structure in diagram 800 displays a number of slots in a subframe. FIG. 8 displays that the switching periods 810 are configured on CC 801 and CC 802.

[0070] As shown in FIG. 8, the present disclosure can include an exception for switching period locations of UL Tx switching for T+F CA, as the bandwidth of FDD carrier is smaller than that of TDD carrier. For example, there may be a certain sub-carrier spacing (SCS) for FDD, e.g., 30 SCS, and a certain SCS for TDD, e.g., 15 SCS. If a

switching period would be located between two consecutive UL slots on the CC with a larger SCS, e.g., TDD CC 802, the subsequent switching period may be located at the first UL symbol in the subsequent UL transmission on the CC with a smaller SCS, e.g., FDD CC 801. In this instance, as TDD has a larger bandwidth, placing the switching gap in TDD CC 802 may lead to a performance loss. Because there is a smaller bandwidth in FDD, locating the switching period in FDD CC 801 may not result in any performance loss.

[0071] Aspects of the present disclosure can also include a new switching period location of UL Tx switching for asynchronous T+T CA. For asynchronous T+T CA with UL Tx switching, the location of the switching periods may be semi-statically configured by RRC signaling on one carrier of the two uplink carriers. If the switching period is present in one CC, the switching period may be located at the last DL symbols and/or the guard symbols in a special slot immediately preceding the UL transmission phase. The switching period can also be located in the last UL symbols in the UL transmission phase on the specific CC by RRC configuration. By doing so, more UL symbols can be achieved in the corresponding CC.

[0072] FIGs. 9A and 9B are diagrams 900 and 950, respectively, illustrating example frame structures in accordance with one or more techniques of the present disclosure. As shown in FIG. 9A, the frame structure in diagram 900 includes a TDD CC 901, a TDD CC 902, UL Tx switching periods or gaps 910, and UL transmission periods 920. The frame structure in diagram 900 displays a number of slots in a subframe. FIG. 9A displays that the switching periods 910 are configured on CC 902. As shown in FIG. 9B, frame structure in diagram 950 includes a TDD CC 951, a TDD CC 952, UL Tx switching periods or gaps 960, and UL transmission periods 970. The frame structure in diagram 950 displays a number of slots in a subframe. FIG. 9B displays that the switching periods 960 are configured on CC 951.

[0073] FIGs. 9A and 9B display UL Tx switching for T+T CA. In FIGs. 9A and 9B, one switching gap may be located at the last UL symbols on one CC which corresponds to the last DL symbol on the other CC. For the configurations in FIGs. 9A and 9B, the switching gaps may be located on one of the two TDD CCs, e.g., CC 902 and CC 951. As such, the present disclosure can specify that the switching gap be scheduled at the last UL symbols on one CC, e.g., CC 902, as well as located at the guard symbol preceding the SRS and the UL transmission period on that same CC, e.g., CC 902. As such, one switching gap can be located in the guard symbol preceding the SRS on

TDD CC 902 and TDD CC 951, as well as be located at the last UL symbols on TDD CC 902 and TDD CC 951 (which can correspond to the last DL symbols on TDD CC 901 and TDD CC 952).

[0074] In some instances, if a switching period is longer than the guard symbols, then a portion of the switching period may be included in a portion of the DL symbols that immediately precede the guard symbols. For example, if the switching period corresponds to five (5) symbols and the guard symbol has two (2) symbols, the switching period may correspond to three (3) DL symbols preceding the guard symbols, as well as the two (2) guard symbols. Also, the switching period may correspond to either of the two TDD CCs.

[0075] FIG. 10 is a diagram 1000 illustrating example communication between a UE 1002 and a base station 1004. At 1010, base station 1004 may schedule a transmission of at least one UL signal, e.g., transmission schedule 1012, by a UE, e.g., UE 1002. At 1020, UE 1002 may receive a transmission schedule for at least one UL signal, e.g., transmission schedule 1012, from a base station, e.g., base station 1004.

[0076] At 1030, base station 1004 may configure an UL transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC.

[0077] In some aspects, a second switching period of the one or more switching periods may correspond to one or more UL symbols at an end of an uplink transmission period on the second CC. Also, the first frame structure may be a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure may be a TDD frame structure or a FDD frame structure. In some instances, a second switching period of the one or more switching periods may correspond to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC. Further, the uplink transmission period on the first CC may correspond to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots.

[0078] In some instances, a second switching period of the one or more switching periods may correspond to one or more UL symbols at a beginning of a subsequent uplink

transmission period on the first CC, where the subsequent uplink transmission may occur after the uplink transmission period. The second switching period may occur during or between two adjacent UL slots on the second CC. In addition, the first frame structure may be a FDD frame structure and the second frame structure may be a TDD frame structure.

[0079] In some aspects, a second switching period of the one or more switching periods may correspond to one or more guard symbols prior to the uplink transmission period on the first CC. The second switching period may further correspond to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC. Moreover, the first frame structure may be a TDD frame structure and the second frame structure may be a TDD frame structure. The UL Tx switching configuration may be configured via radio resource control (RRC) signaling.

[0080] At 1040, base station 1004 may signal the UL Tx switching configuration for CA of the first CC and the second CC, e.g., UL Tx switching configuration 1042. At 1050, UE 1002 may receive an UL transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, e.g., UL Tx switching configuration 1042, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC.

[0081] At 1060, UE 1002 may implement the UL Tx switching configuration for CA of the first CC and the second CC, e.g., UL Tx switching configuration 1042.

[0082] At 1070, UE 1002 may transmit at least one UL signal, e.g., UL signal 1072, based on the UL Tx switching configuration. At 1080, base station 1004 may receive at least one UL signal, e.g., UL signal 1072, based on the UL Tx switching configuration. In some aspects, the at least one UL signal may be transmitted or received via at least one of the first CC and the second CC. Also, the at least one UL signal may be switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods.

[0083] FIG. 11 is a flowchart 1100 of a method of wireless communication. The method may be performed by a base station or a component of a base station (e.g., the base station 102, 180, 310, 1004; an apparatus; a processing system, which may include the memory 376 and which may be the entire base station or a component of the base

station, such as the antenna(s) 320, receiver 318RX, the RX processor 370, the controller/processor 375, and/or the like). Optional aspects are illustrated with a dashed line. The methods described herein can provide a number of benefits, such as improving communication signaling, resource utilization, and/or power savings.

[0084] At 1102, the apparatus may schedule a transmission of at least one UL signal by a UE, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0085] At 1104, the apparatus may configure an UL transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0086] In some aspects, a second switching period of the one or more switching periods may correspond to one or more UL symbols at an end of an uplink transmission period on the second CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. Also, the first frame structure may be a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure may be a TDD frame structure or a FDD frame structure, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. In some instances, a second switching period of the one or more switching periods may correspond to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. Further, the uplink transmission period on the first CC may correspond to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0087] In some instances, a second switching period of the one or more switching periods may correspond to one or more UL symbols at a beginning of a subsequent uplink transmission period on the first CC, where the subsequent uplink transmission may occur after the uplink transmission period, as described in connection with the

examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. The second switching period may occur during two adjacent UL slots on the second CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. In addition, the first frame structure may be a FDD frame structure and the second frame structure may be a TDD frame structure, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0088] In some aspects, a second switching period of the one or more switching periods may correspond to one or more guard symbols prior to the uplink transmission period on the first CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. The second switching period may further correspond to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. Moreover, the first frame structure may be a TDD frame structure and the second frame structure may be a TDD frame structure, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. The UL Tx switching configuration may be configured via radio resource control (RRC) signaling, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0089] At 1106, the apparatus may signal the UL Tx switching configuration for CA of the first CC and the second CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0090] At 1108, the apparatus may receive at least one UL signal based on the UL Tx switching configuration, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. In some aspects, the at least one UL signal may be received via at least one of the first CC and the second CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. Also, the at least one UL signal may be switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0091] FIG. 12 is a flowchart 1200 of a method of wireless communication. The method may be performed by a UE or a component of a UE (e.g., the UE 104, 350, 1002; an apparatus; a processing system, which may include the memory 360 and which may be the entire UE or a component of the UE, such as the TX processor 368, the

controller/processor 359, transmitter 354TX, antenna(s) 352, and/or the like). Optional aspects are illustrated with a dashed line. The methods described herein can provide a number of benefits, such as improving communication signaling, resource utilization, and/or power savings.

[0092] At 1202, the apparatus may receive a transmission schedule for at least one UL signal from a base station, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0093] At 1204, the apparatus may receive an UL transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0094] In some aspects, a second switching period of the one or more switching periods may correspond to one or more UL symbols at an end of an uplink transmission period on the second CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. Also, the first frame structure may be a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure may be a TDD frame structure or a FDD frame structure, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. In some instances, a second switching period of the one or more switching periods may correspond to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. Further, the uplink transmission period on the first CC may correspond to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0095] In some instances, a second switching period of the one or more switching periods may correspond to one or more UL symbols at a beginning of a subsequent uplink transmission period on the first CC, where the subsequent uplink transmission may occur after the uplink transmission period, as described in connection with the

examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. The second switching period may occur during two adjacent UL slots on the second CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. In addition, the first frame structure may be a FDD frame structure and the second frame structure may be a TDD frame structure, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0096] In some aspects, a second switching period of the one or more switching periods may correspond to one or more guard symbols prior to the uplink transmission period on the first CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. The second switching period may further correspond to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. Moreover, the first frame structure may be a TDD frame structure and the second frame structure may be a TDD frame structure, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. The UL Tx switching configuration may be configured via radio resource control (RRC) signaling, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0097] At 1206, the apparatus may implement the UL Tx switching configuration for CA of the first CC and the second CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0098] At 1208, the apparatus may transmit at least one UL signal based on the UL Tx switching configuration, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. In some aspects, the at least one UL signal may be transmitted via at least one of the first CC and the second CC, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10. Also, the at least one UL signal may be switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods, as described in connection with the examples in FIGs. 4A, 4B, 5, 6A, 6B, 7A, 7B, 8, 9A, 9B, and 10.

[0099] Further disclosure is included in the Appendix.

[00100] 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.

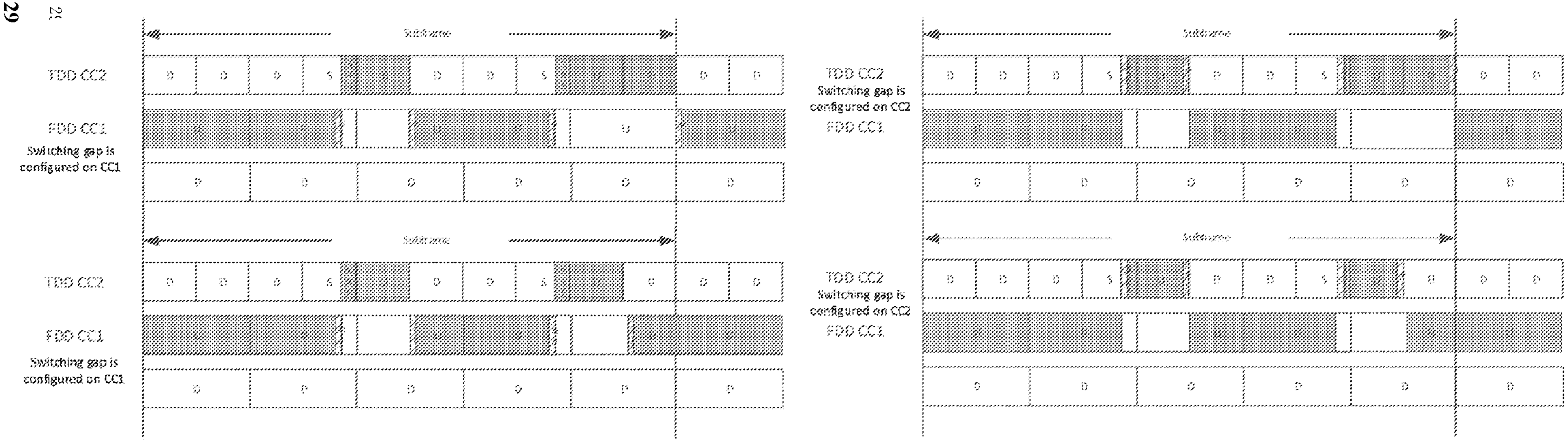
[00101] The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. 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."

Appendix

Tx Switching Period Symbol Location for T+F/T+T UL TDM CA

1Tx-2Tx Switching

- Some aspects of wireless communication include UL 1Tx-2Tx switching where there is at least one NR TDD carrier (high frequency band with large bandwidth) and at least one NR FDD UL carrier (Low frequency band with smaller bandwidth) of a different carrier frequency.
    - When UE is configured with UL 1Tx-2Tx Switching, time-switching of NR TDD UL carrier and NR FDD UL carrier is used.
- The location of the switching period is semi-statically configured by RRC on one specific carrier of the two uplink carriers

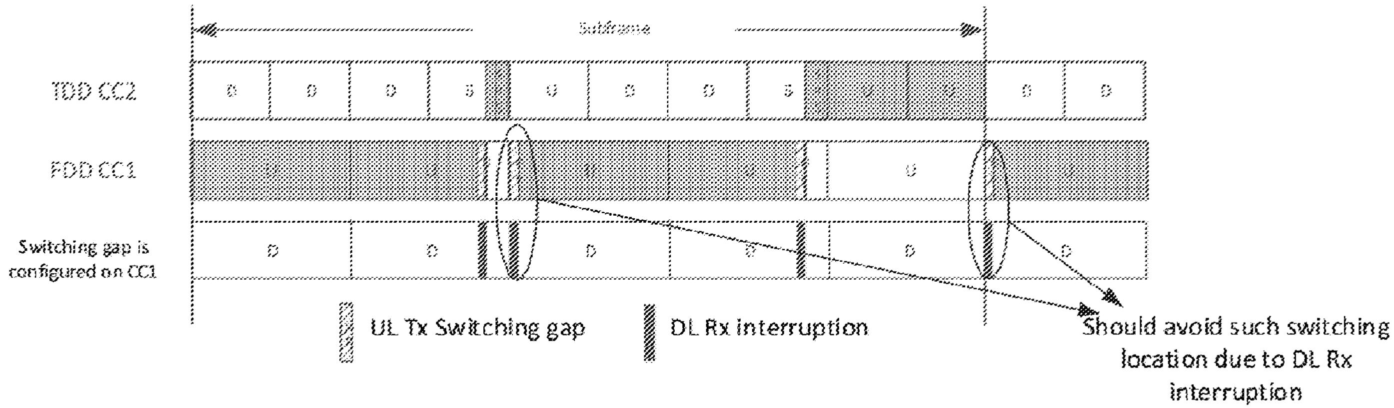


Issue 1

DL Rx interruption due to shared Phase Lock Loop (PLL) for UL and DL

- UL Tx switching need to retune PLL on the frequency of target CC. However, DL Rx interruption will occur as well during the PLL retuning because of shared PLL for UL and DL.
- DL interruption analysis is below for both cases switching period on CC 1 and switching period on CC 2. The DL interruption length depends on the switching length and the time misalignment between the TX switching carrier and the SCS of victim DL carrier.

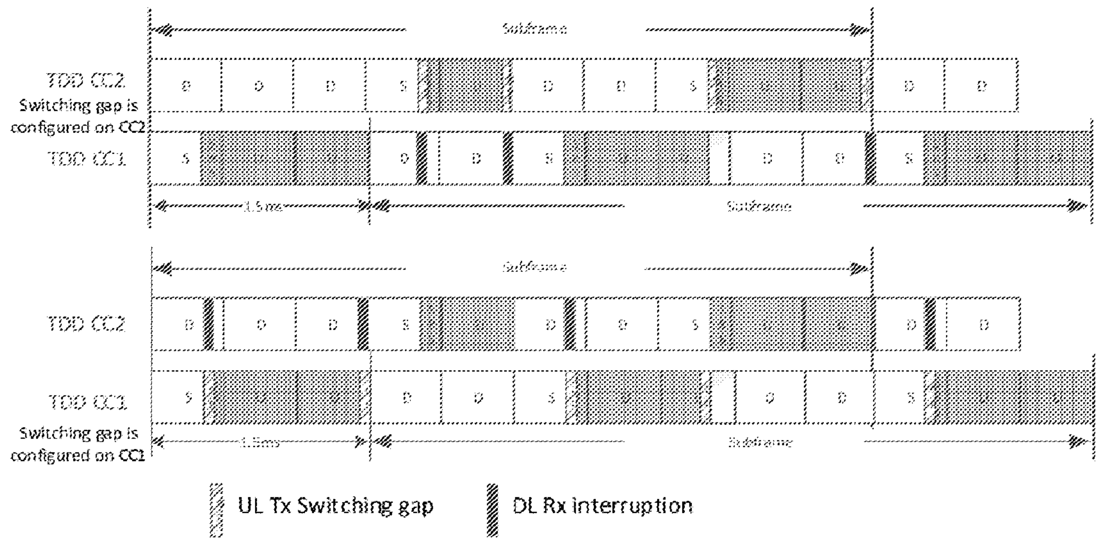
The DL Rx interruption at the beginning of a DL slot should be avoid since CORESET/PDCCH Rx broken will lead to significant DL performance. Current spec cannot avoid such DL Rx interruption due to UL Tx switching.



Issue 2

Async T+T CA

- 1.5ms offset for two aggregated TDD CCs to stagger the UL slots across two carriers.
- According to the spec, once the switching period is configured on one CC, it means the switching period will overlap with the UL symbols in the UL phase of this CC.
- Unnecessary waste of UL symbols being used as switching period for T+T CA since available DL symbols btw each UL phase can be used as switching period.



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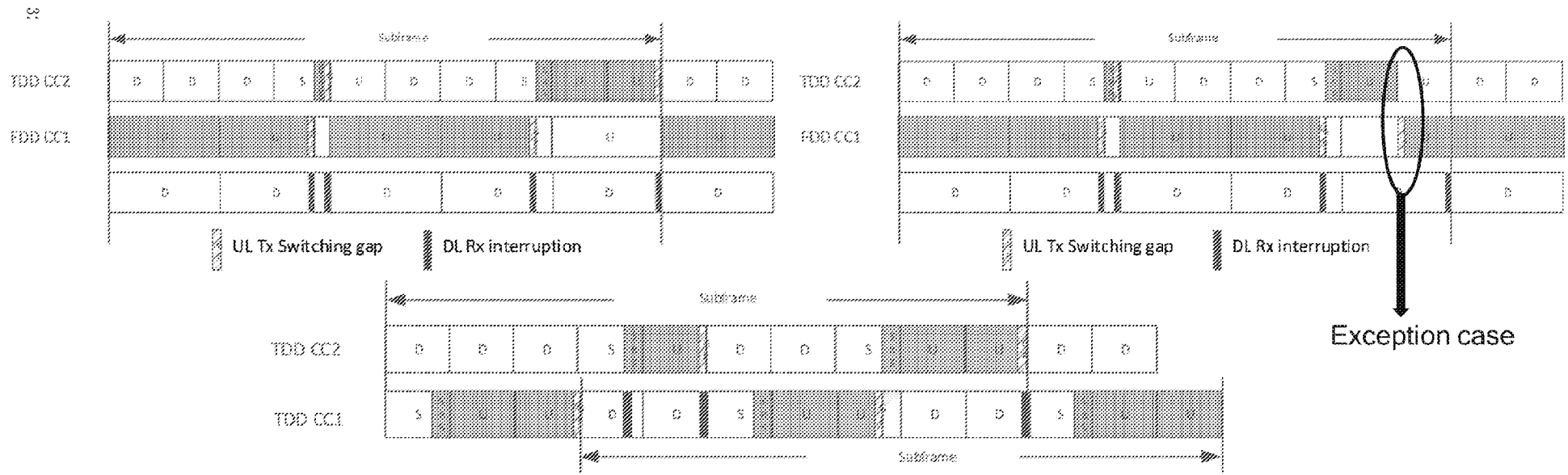
Proposal 1 (To solve Issue 1 and 2)

New switching period location of UL Tx Switching for both T+F/T+T CA

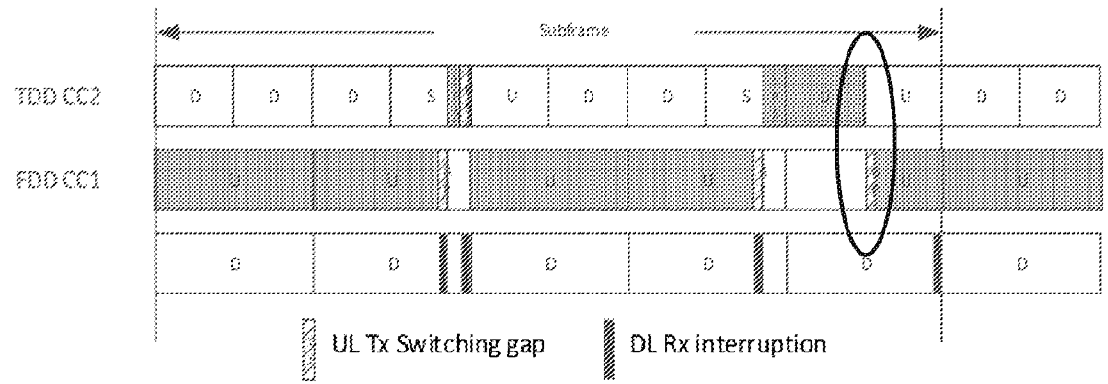
- A new switching period location configuration is used by default if the location of switching period is not semi-statically configured by RRC.
- If the switching period is present, the switching period is placed at the last UL symbols in preceding UL transmission and immediately precedes the UL transmission on anther CC.



Proposal 1 (To solve Issue 1 and 2)

Exception for switching period location of UL Tx Switching for T+F CA

- Given the bandwidth of FDD carrier is smaller than that of TDD carrier, if the switching period btw two consecutive UL slots on the carrier with larger SCS is present, the switching period is placed at the first UL symbols in the subsequent UL transmission on anther CC with smaller SCS.



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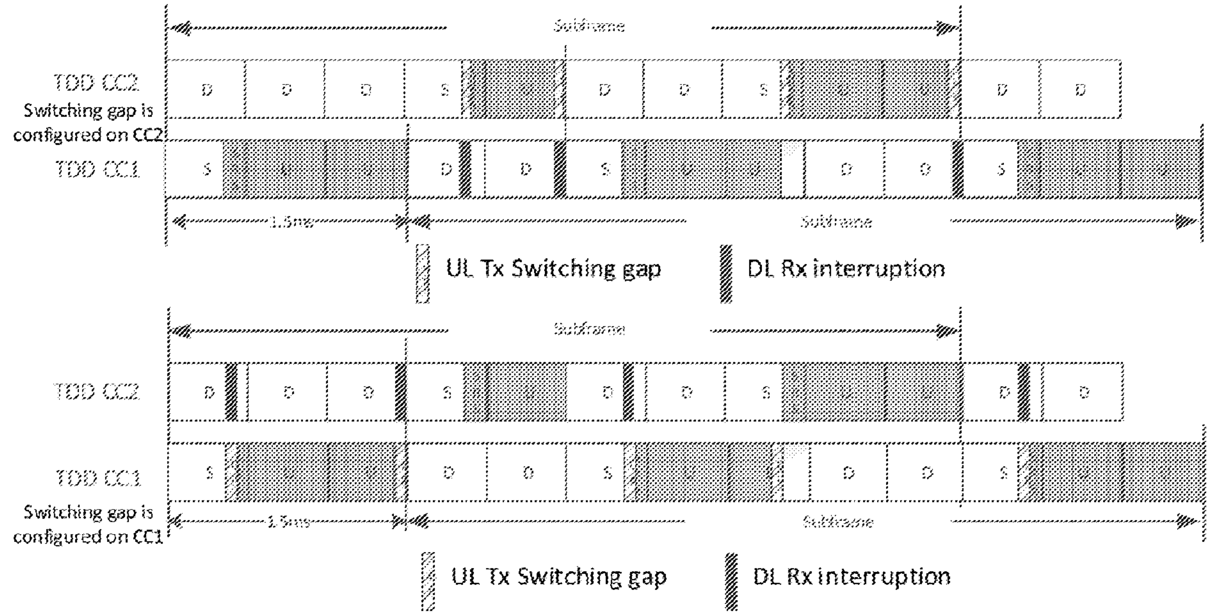
Proposal 2 (To solve issue 2)

New switching period location of UL Tx Switching for async T+T CA

- For async T+T CA with UL Tx switching, the location of the switching period is semi-statically configured by RRC on one specific carrier of the two uplink carriers. If the switching period is present, the switching period is placed at the last DL symbols and/or guard symbols in special slot immediately precedes the UL transmission phase and the last UL symbols in this UL transmission phase on the specific CC by RRC configuration.



CLAIMS

WHAT IS CLAIMED IS:

1. A method of wireless communication of a base station, comprising:

configuring an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

signaling the UL Tx switching configuration for CA of the first CC and the second CC; and

receiving at least one UL signal based on the UL Tx switching configuration.

2. The method of claim 1, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at an end of an uplink transmission period on the second CC.

3. The method of claim 2, wherein the first frame structure is a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure is a TDD frame structure or a FDD frame structure.

4. The method of claim 1, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC.

5. The method of claim 1, wherein the uplink transmission period on the first CC corresponds to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots.

6. The method of claim 1, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at a beginning of a subsequent uplink transmission period on the first CC, the subsequent uplink transmission occurring after the uplink transmission period.

7. The method of claim 6, wherein the second switching period occurs during two adjacent UL slots on the second CC.

8. The method of claim 6, wherein the first frame structure is a FDD frame structure and the second frame structure is a TDD frame structure.

9. The method of claim 1, wherein a second switching period of the one or more switching periods corresponds to one or more guard symbols prior to the uplink transmission period on the first CC.

10. The method of claim 9, wherein the second switching period further corresponds to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC.

11. The method of claim 9, wherein the first frame structure is a TDD frame structure and the second frame structure is a TDD frame structure.

12. The method of claim 9, wherein the UL Tx switching configuration is configured via radio resource control (RRC) signaling.

13. The method of claim 1, further comprising:

scheduling the at least one UL signal for a transmission by a user equipment (UE).

14. The method of claim 1, wherein the at least one UL signal is received via at least one of the first CC and the second CC.

15. The method of claim 1, wherein the at least one UL signal is switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods.

16. An apparatus for wireless communication of a base station, comprising:

a memory; and

at least one processor coupled to the memory and configured to:

configure an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

signal the UL Tx switching configuration for CA of the first CC and the second CC; and

receive at least one UL signal based on the UL Tx switching configuration.

17. The apparatus of claim 16, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at an end of an uplink transmission period on the second CC.

18. The apparatus of claim 17, wherein the first frame structure is a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure is a TDD frame structure or a FDD frame structure.

19. The apparatus of claim 16, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC.

20. The apparatus of claim 16, wherein the uplink transmission period on the first CC corresponds to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots.

21. The apparatus of claim 16, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at a beginning of a subsequent uplink transmission period on the first CC, the subsequent uplink transmission occurring after the uplink transmission period.

22. The apparatus of claim 21, wherein the second switching period occurs during two adjacent UL slots on the second CC.

23. The apparatus of claim 21, wherein the first frame structure is a FDD frame structure and the second frame structure is a TDD frame structure.

24. The apparatus of claim 16, wherein a second switching period of the one or more switching periods corresponds to one or more guard symbols prior to the uplink transmission period on the first CC.

25. The apparatus of claim 24, wherein the second switching period further corresponds to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC.

26. The apparatus of claim 24, wherein the first frame structure is a TDD frame structure and the second frame structure is a TDD frame structure.

27. The apparatus of claim 24, wherein the UL Tx switching configuration is configured via radio resource control (RRC) signaling.

28. The apparatus of claim 16, wherein the at least one processor is further configured to:

schedule the at least one UL signal for a transmission by a user equipment (UE).

29. The apparatus of claim 16, wherein the at least one UL signal is received via at least one of the first CC and the second CC.

30. The apparatus of claim 16, wherein the at least one UL signal is switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods.

31. An apparatus for wireless communication of a base station, comprising:

means for configuring an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first

switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

means for signaling the UL Tx switching configuration for CA of the first CC and the second CC; and

means for receiving at least one UL signal based on the UL Tx switching configuration.

32. The apparatus of claim 31, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at an end of an uplink transmission period on the second CC.

33. The apparatus of claim 32, wherein the first frame structure is a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure is a TDD frame structure or a FDD frame structure.

34. The apparatus of claim 31, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC.

35. The apparatus of claim 31, wherein the uplink transmission period on the first CC corresponds to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots.

36. The apparatus of claim 31, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at a beginning of a subsequent uplink transmission period on the first CC, the subsequent uplink transmission occurring after the uplink transmission period.

37. The apparatus of claim 36, wherein the second switching period occurs during two adjacent UL slots on the second CC.

38. The apparatus of claim 36, wherein the first frame structure is a FDD frame structure and the second frame structure is a TDD frame structure.

39. The apparatus of claim 31, wherein a second switching period of the one or more switching periods corresponds to one or more guard symbols prior to the uplink transmission period on the first CC.

40. The apparatus of claim 39, wherein the second switching period further corresponds to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC.

41. The apparatus of claim 39, wherein the first frame structure is a TDD frame structure and the second frame structure is a TDD frame structure.

42. The apparatus of claim 39, wherein the UL Tx switching configuration is configured via radio resource control (RRC) signaling.

43. The apparatus of claim 31, further comprising:

means for scheduling the at least one UL signal for a transmission by a user equipment (UE).

44. The apparatus of claim 31, wherein the at least one UL signal is received via at least one of the first CC and the second CC.

45. The apparatus of claim 31, wherein the at least one UL signal is switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods.

46. A computer-readable medium storing computer executable code for wireless communication of a base station, the code when executed by a processor instructs the processor to:

configure an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first

switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

signal the UL Tx switching configuration for CA of the first CC and the second CC; and

receive at least one UL signal based on the UL Tx switching configuration.

47. A method of wireless communication of a user equipment (UE), comprising:

receiving an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

implementing the UL Tx switching configuration for CA of the first CC and the second CC; and

transmitting at least one UL signal based on the UL Tx switching configuration.

48. The method of claim 47, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at an end of an uplink transmission period on the second CC.

49. The method of claim 48, wherein the first frame structure is a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure is a TDD frame structure or a FDD frame structure.

50. The method of claim 47, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC.

51. The method of claim 47, wherein the uplink transmission period on the first CC corresponds to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots.

52. The method of claim 47, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at a beginning of a subsequent uplink transmission period on the first CC, the subsequent uplink transmission occurring after the uplink transmission period.

53. The method of claim 52, wherein the second switching period occurs during two adjacent UL slots on the second CC.

54. The method of claim 52, wherein the first frame structure is a FDD frame structure and the second frame structure is a TDD frame structure.

55. The method of claim 47, wherein a second switching period of the one or more switching periods corresponds to one or more guard symbols prior to the uplink transmission period on the first CC.

56. The method of claim 55, wherein the second switching period further corresponds to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC.

57. The method of claim 55, wherein the first frame structure is a TDD frame structure and the second frame structure is a TDD frame structure.

58. The method of claim 55, wherein the UL Tx switching configuration is configured via radio resource control (RRC) signaling.

59. The method of claim 47, further comprising:

receiving a transmission schedule for the at least one UL signal from a base station.

60. The method of claim 47, wherein the at least one UL signal is transmitted via at least one of the first CC and the second CC.

61. The method of claim 47, wherein the at least one UL signal is switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods.

62. An apparatus for wireless communication of a user equipment (UE), comprising:

a memory; and

at least one processor coupled to the memory and configured to:

receive an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

implement the UL Tx switching configuration for CA of the first CC and the second CC; and

transmit at least one UL signal based on the UL Tx switching configuration.

63. The apparatus of claim 62, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at an end of an uplink transmission period on the second CC.

64. The apparatus of claim 63, wherein the first frame structure is a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure is a TDD frame structure or a FDD frame structure.

65. The apparatus of claim 62, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC.

66. The apparatus of claim 62, wherein the uplink transmission period on the first CC corresponds to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots.

67. The apparatus of claim 62, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at a beginning of a subsequent uplink transmission period on the first CC, the subsequent uplink transmission occurring after the uplink transmission period.

68. The apparatus of claim 67, wherein the second switching period occurs during two adjacent UL slots on the second CC.

69. The apparatus of claim 67, wherein the first frame structure is a FDD frame structure and the second frame structure is a TDD frame structure.

70. The apparatus of claim 62, wherein a second switching period of the one or more switching periods corresponds to one or more guard symbols prior to the uplink transmission period on the first CC.

71. The apparatus of claim 70, wherein the second switching period further corresponds to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC.

72. The apparatus of claim 70, wherein the first frame structure is a TDD frame structure and the second frame structure is a TDD frame structure.

73. The apparatus of claim 70, wherein the UL Tx switching configuration is configured via radio resource control (RRC) signaling.

74. The apparatus of claim 62, wherein the at least one processor is further configured to:

receive a transmission schedule for the at least one UL signal from a base station.

75. The apparatus of claim 62, wherein the at least one UL signal is transmitted via at least one of the first CC and the second CC.

76. The apparatus of claim 62, wherein the at least one UL signal is switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods.

77. An apparatus for wireless communication of a user equipment (UE), comprising:

means for receiving an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

means for implementing the UL Tx switching configuration for CA of the first CC and the second CC; and

means for transmitting at least one UL signal based on the UL Tx switching configuration.

78. The apparatus of claim 77, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at an end of an uplink transmission period on the second CC.

79. The apparatus of claim 78, wherein the first frame structure is a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure is a TDD frame structure or a FDD frame structure.

80. The apparatus of claim 77, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC.

81. The apparatus of claim 77, wherein the uplink transmission period on the first CC corresponds to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots.

82. The apparatus of claim 77, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at a beginning of a subsequent uplink transmission period on the first CC, the subsequent uplink transmission occurring after the uplink transmission period.

83. The apparatus of claim 82, wherein the second switching period occurs during two adjacent UL slots on the second CC.

84. The apparatus of claim 82, wherein the first frame structure is a FDD frame structure and the second frame structure is a TDD frame structure.

85. The apparatus of claim 77, wherein a second switching period of the one or more switching periods corresponds to one or more guard symbols prior to the uplink transmission period on the first CC.

86. The apparatus of claim 85, wherein the second switching period further corresponds to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC.

87. The apparatus of claim 85, wherein the first frame structure is a TDD frame structure and the second frame structure is a TDD frame structure.

88. The apparatus of claim 85, wherein the UL Tx switching configuration is configured via radio resource control (RRC) signaling.

89. The apparatus of claim 77, further comprising:

means for receiving a transmission schedule for the at least one UL signal from a base station.

90. The apparatus of claim 77, wherein the at least one UL signal is transmitted via at least one of the first CC and the second CC.

91. The apparatus of claim 77, wherein the at least one UL signal is switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods.

92. A computer-readable medium storing computer executable code for wireless communication of a user equipment (UE), the code when executed by a processor instructs the processor to:

receive an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

implement the UL Tx switching configuration for CA of the first CC and the second CC; and

transmit at least one UL signal based on the UL Tx switching configuration.

AMENDED CLAIMS
received by the International Bureau on 01.11.2021

WHAT IS CLAIMED IS:

1. A method of wireless communication at a base station, comprising:

configuring an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

signaling the UL Tx switching configuration for CA of the first CC and the second CC; and

receiving at least one UL signal based on the UL Tx switching configuration.

2. The method of claim 1, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at an end of an uplink transmission period on the second CC.

3. An apparatus for wireless communication, comprising:

a memory; and

at least one processor coupled to the memory and configured to:

configure an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

signal the UL Tx switching configuration for CA of the first CC and the second CC; and

receive at least one UL signal based on the UL Tx switching configuration.

4. The apparatus of claim 3, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at an end of an uplink transmission period on the second CC.

5. The apparatus of claim 4, wherein the first frame structure is a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure is a TDD frame structure or a FDD frame structure.

6. The apparatus of claim 3, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC.

7. The apparatus of claim 3, wherein the uplink transmission period on the first CC corresponds to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots.

8. The apparatus of claim 3, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at a beginning of a subsequent uplink transmission period on the first CC, the subsequent uplink transmission occurring after the uplink transmission period.

9. The apparatus of claim 8, wherein the second switching period occurs during two adjacent UL slots on the second CC.

10. The apparatus of claim 8, wherein the first frame structure is a FDD frame structure and the second frame structure is a TDD frame structure.

11. The apparatus of claim 3, wherein a second switching period of the one or more switching periods corresponds to one or more guard symbols prior to the uplink transmission period on the first CC.

12. The apparatus of claim 11, wherein the second switching period further corresponds to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC.

13. The apparatus of claim 11, wherein the first frame structure is a TDD frame structure and the second frame structure is a TDD frame structure.

14. The apparatus of claim 11, wherein the UL Tx switching configuration is configured via radio resource control (RRC) signaling.

15. The apparatus of claim 3, wherein the at least one processor is further configured to:

schedule the at least one UL signal for a transmission by a user equipment (UE).

16. The apparatus of claim 3, wherein the at least one UL signal is received via at least one of the first CC and the second CC.

17. The apparatus of claim 3, wherein the at least one UL signal is switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods.

18. A method of wireless communication at a user equipment (UE), comprising:

receiving an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

implementing the UL Tx switching configuration for CA of the first CC and the second CC; and

transmitting at least one UL signal based on the UL Tx switching configuration.

19. The method of claim 18, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at an end of an uplink transmission period on the second CC.

20. An apparatus for wireless communication, comprising:

a memory; and

at least one processor coupled to the memory and configured to:

receive an uplink (UL) transmit (Tx) switching configuration for carrier aggregation (CA) of a first component carrier (CC) and a second CC, the first CC including a first frame structure and the second CC including a second frame structure, the UL Tx switching configuration including one or more switching periods, a first switching period of the one or more switching periods corresponding to one or more UL symbols at an end of an uplink transmission period on the first CC;

implement the UL Tx switching configuration for CA of the first CC and the second CC; and

transmit at least one UL signal based on the UL Tx switching configuration.

21. The apparatus of claim 20, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at an end of an uplink transmission period on the second CC.

22. The apparatus of claim 21, wherein the first frame structure is a frequency division duplex (FDD) frame structure or a time division duplex (TDD) frame structure and the second frame structure is a TDD frame structure or a FDD frame structure.

23. The apparatus of claim 20, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols after a sounding reference symbol (SRS) transmission and within an uplink transmission period on the second CC.

24. The apparatus of claim 20, wherein 1 irst CC corresponds to at least one of one or more UL symbols in a special slot or one or more consecutive UL slots.

25. The apparatus of claim 20, wherein a second switching period of the one or more switching periods corresponds to one or more UL symbols at a beginning of a subsequent uplink transmission period on the first CC, the subsequent uplink transmission occurring after the uplink transmission period.

26. The apparatus of claim 25, wherein the second switching period occurs during two adjacent UL slots on the second CC.

27. The apparatus of claim 25, wherein the first frame structure is a FDD frame structure and the second frame structure is a TDD frame structure.

28. The apparatus of claim 20, wherein a second switching period of the one or more switching periods corresponds to one or more guard symbols prior to the uplink transmission period on the first CC.

29. The apparatus of claim 28, wherein the second switching period further corresponds to one or more downlink (DL) symbols prior to the one or more guard symbols on the first CC.

30. The apparatus of claim 28, wherein the first frame structure is a TDD frame structure and the second frame structure is a TDD frame structure.

31. The apparatus of claim 28, wherein the UL Tx switching configuration is configured via radio resource control (RRC) signaling.

32. The apparatus of claim 20, wherein the at least one processor is further configured to:

receive a transmission schedule for the at least one UL signal from a base station.

33. The apparatus of claim 20, wherein the at least one UL signal is transmitted via at least one of the first CC and the second CC

34. The apparatus of claim 20, wherein the at least one UL signal is switched from the first CC to the second CC, or from the second CC to the first CC, during the one or more switching periods.

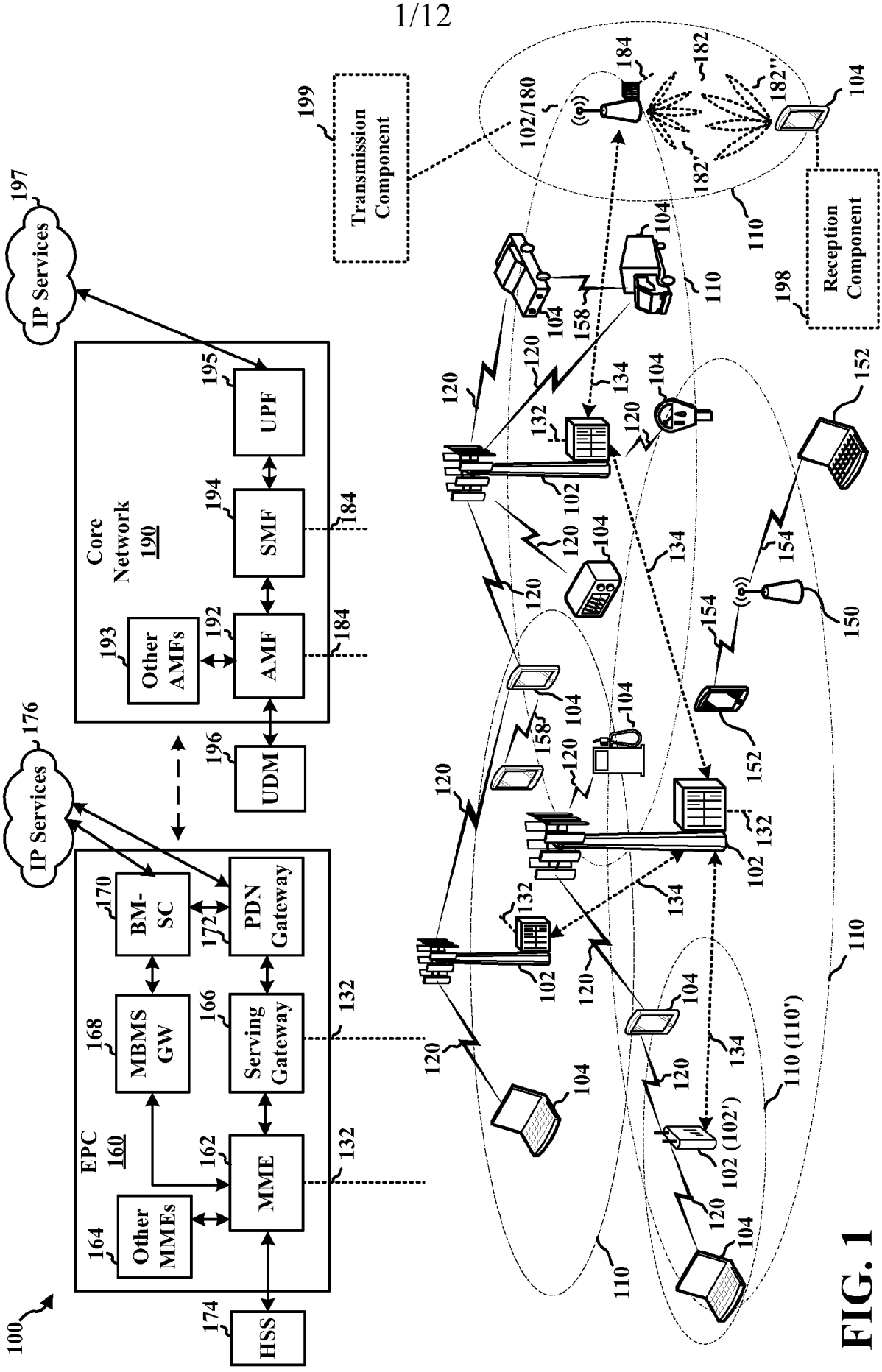

100
IP Services
197
IP Services
176
IP Services
Core Network 190
UPF
195
SMF
194
AMF
192
Other AMFs
193
UDM
196
184
184
EPC 160
BM-SC
170
PDN Gateway
172
MBMS GW
168
Serving Gateway
166
MME
162
Other MMEs
164
HSS
174
132
132
199
Transmission Component
198
Reception Component
102/180
182
182'
182''
184
104
110
120
102
132
134
152
154
150
158
110 (110')
102 (102')

FIG. 1

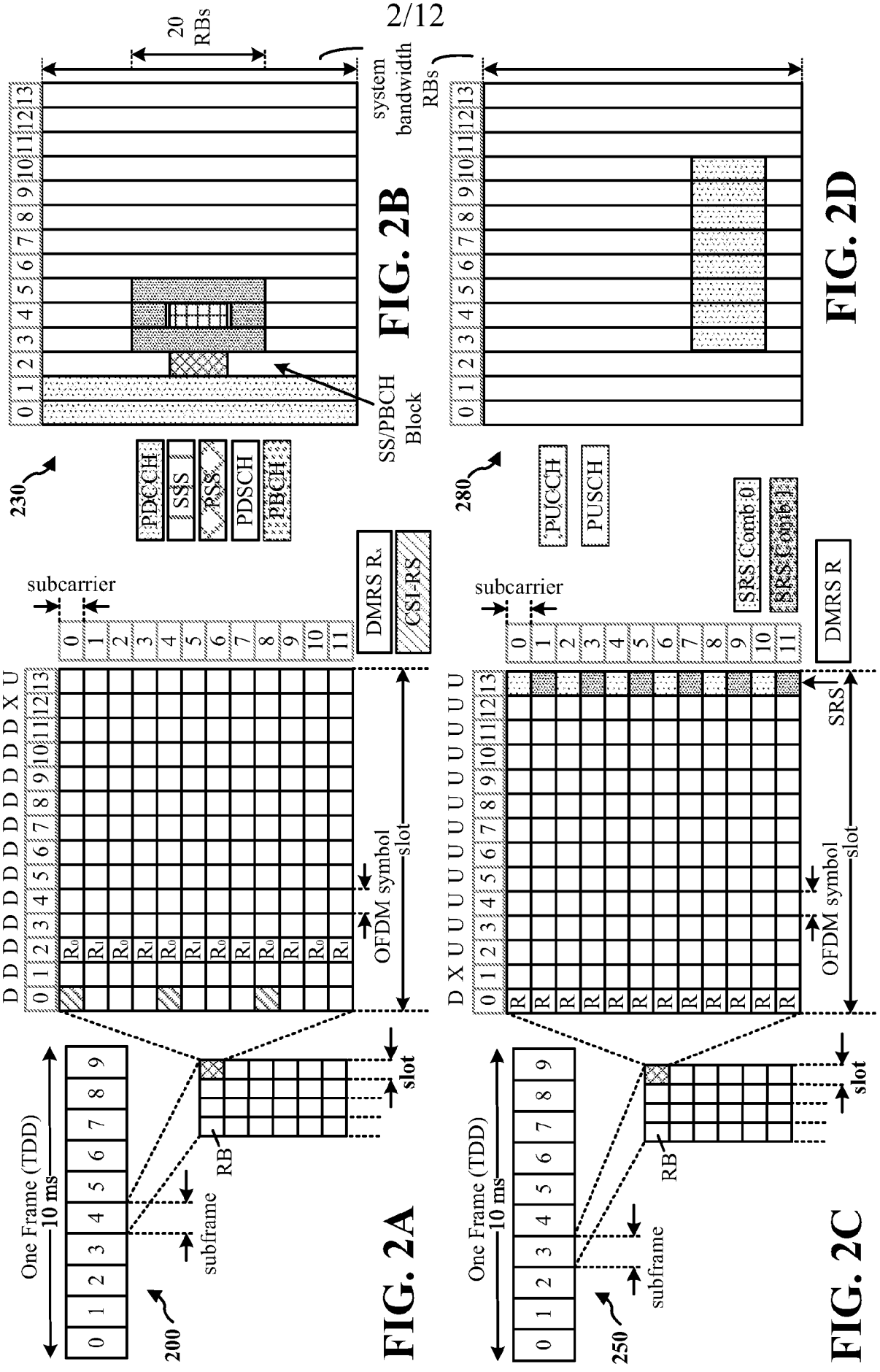


FIG. 2A

FIG. 2B

FIG. 2C

FIG. 2D

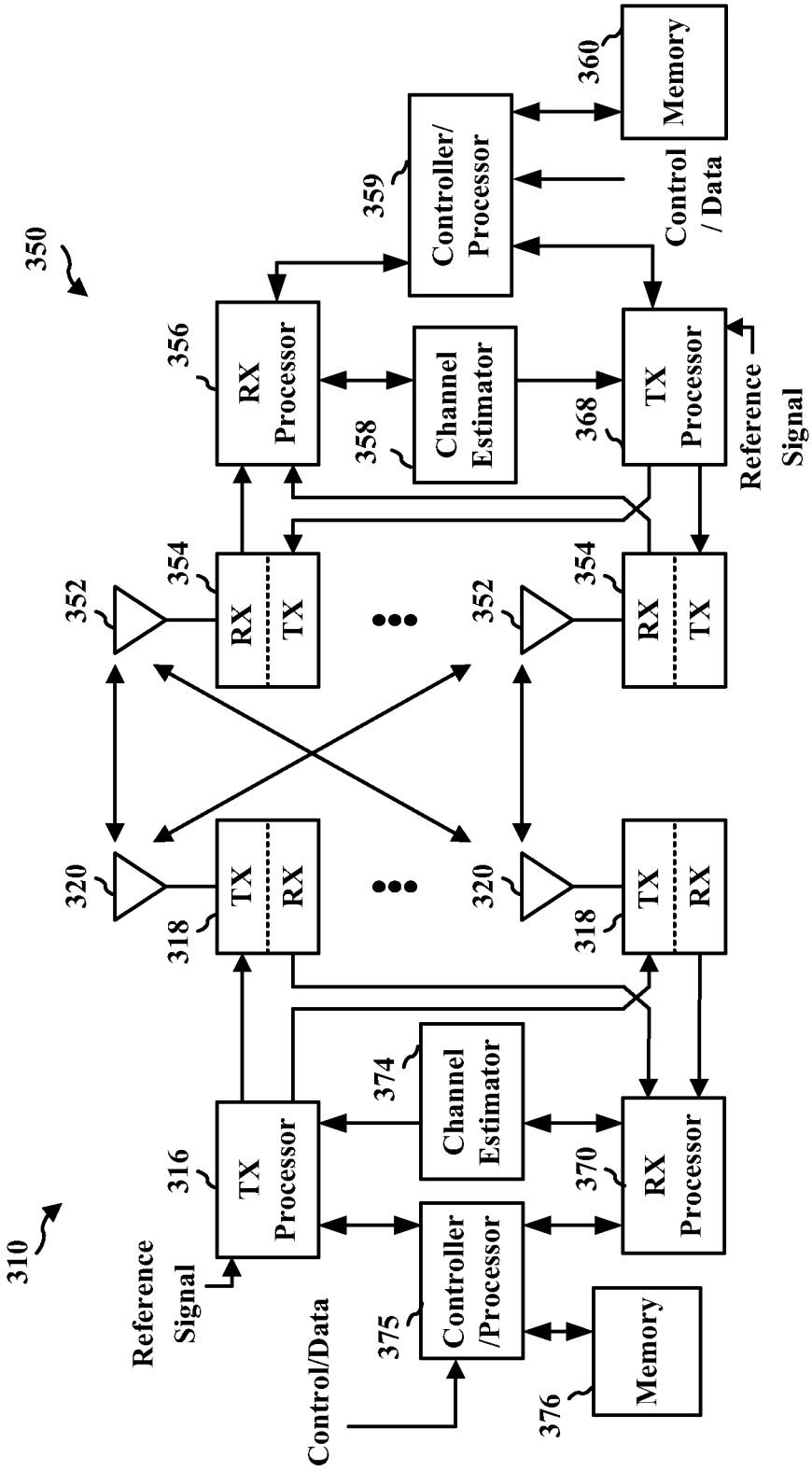

350
310
Reference Signal
Control/Data
316
TX Processor
374
Channel Estimator
375
Controller /Processor
370
RX Processor
376
Memory
320
318
TX
RX
352
354
RX
TX
356
RX Processor
358
Channel Estimator
359
Controller/ Processor
360
Memory
Control / Data
368
TX Processor
Reference Signal

FIG. 3

FIG. 4A

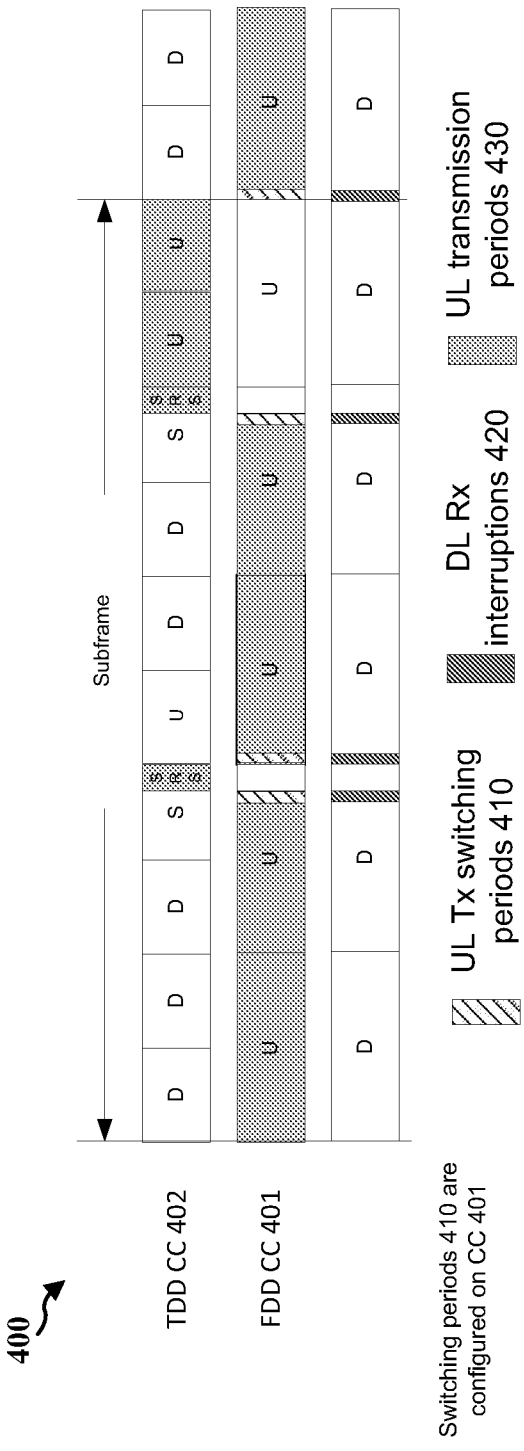
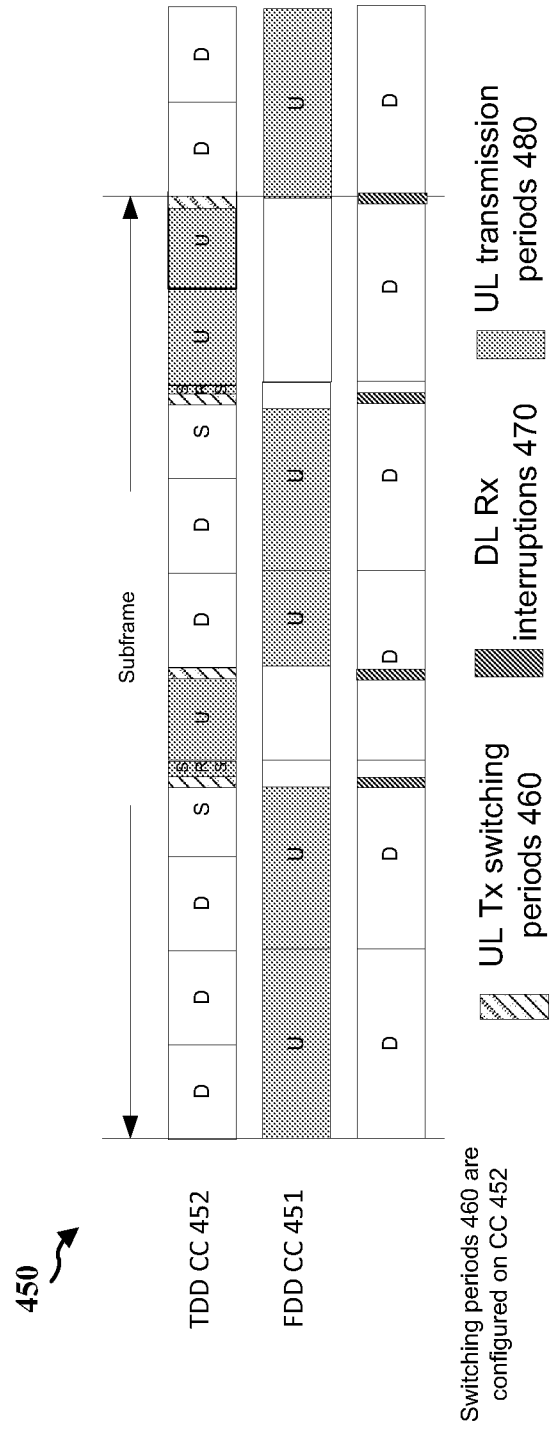

400
TDD CC 402
FDD CC 401
Subframe
D
U
S
UL Tx switching periods 410
DL Rx interruptions 420
UL transmission periods 430
Switching periods 410 are configured on CC 401

FIG. 4B


450
TDD CC 452
FDD CC 451
Subframe
D
U
S
UL Tx switching periods 460
DL Rx interruptions 470
UL transmission periods 480
Switching periods 460 are configured on CC 452

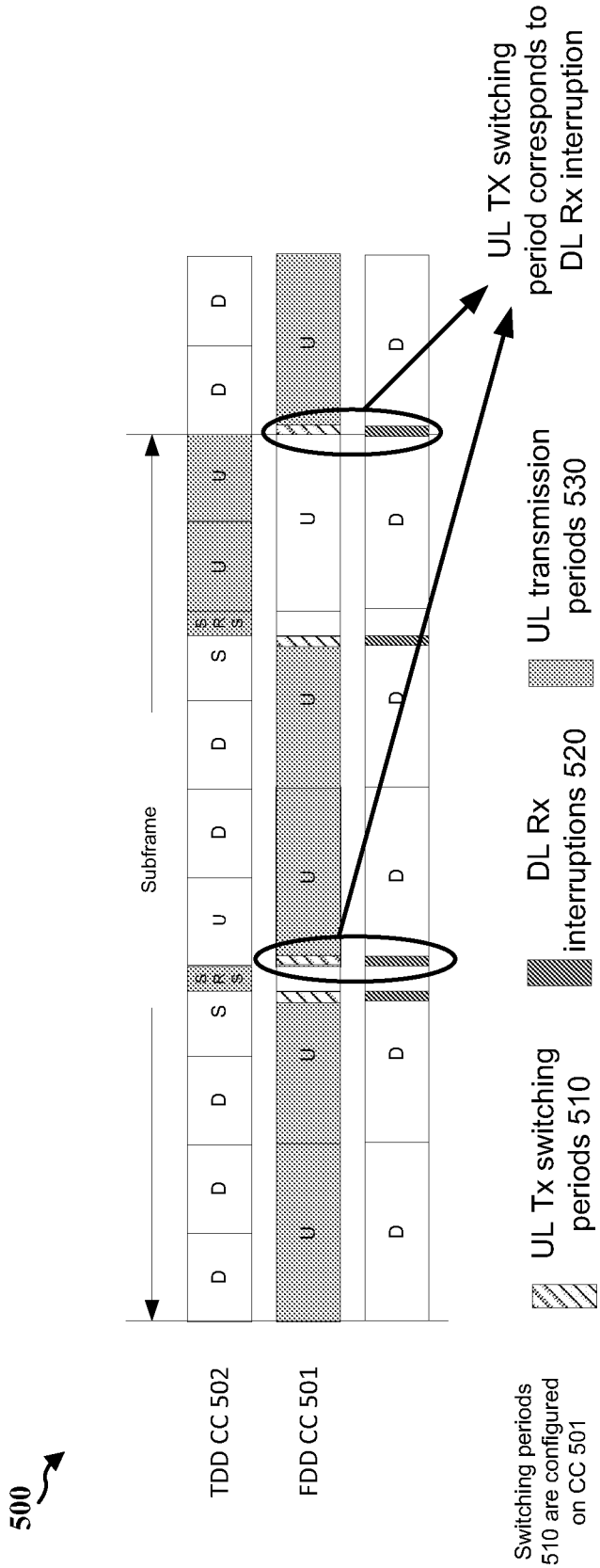

500
TDD CC 502
FDD CC 501
Subframe
D
U
S
UL TX switching period corresponds to DL Rx interruption
UL transmission periods 530
DL Rx interruptions 520
UL Tx switching periods 510
Switching periods 510 are configured on CC 501

FIG. 5

FIG. 6A

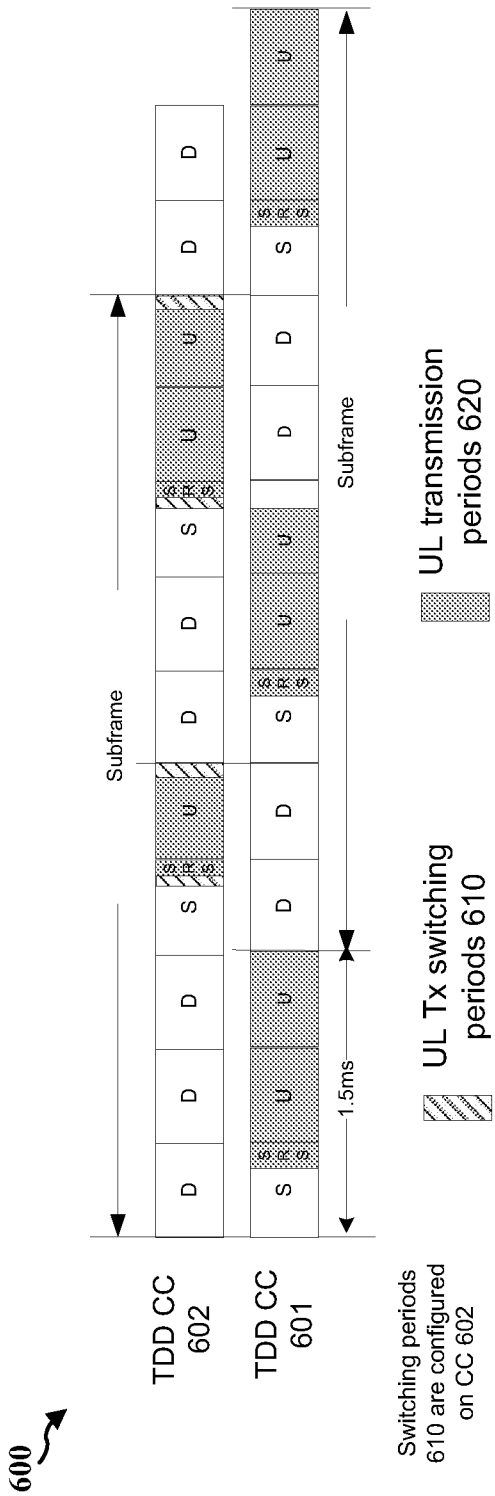

600
TDD CC 602
TDD CC 601
Subframe
Subframe
1.5ms
UL Tx switching periods 610
UL transmission periods 620
Switching periods 610 are configured on CC 602

FIG. 6B

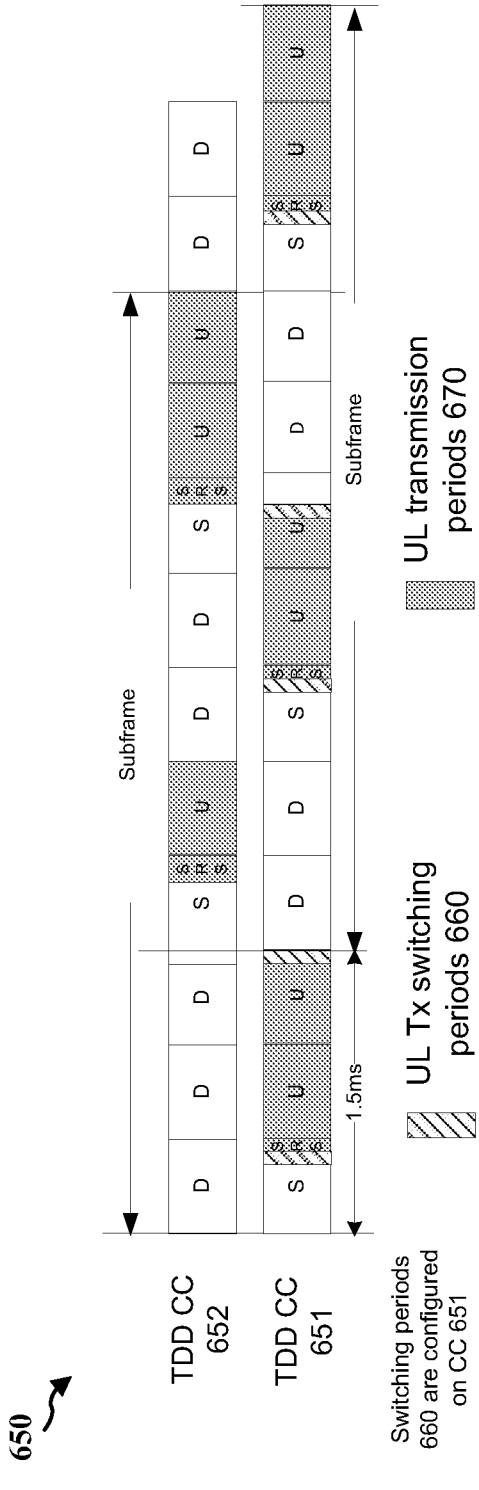

650
TDD CC 652
TDD CC 651
Subframe
Subframe
1.5ms
UL Tx switching periods 660
UL transmission periods 670
Switching periods 660 are configured on CC 651

FIG. 7A

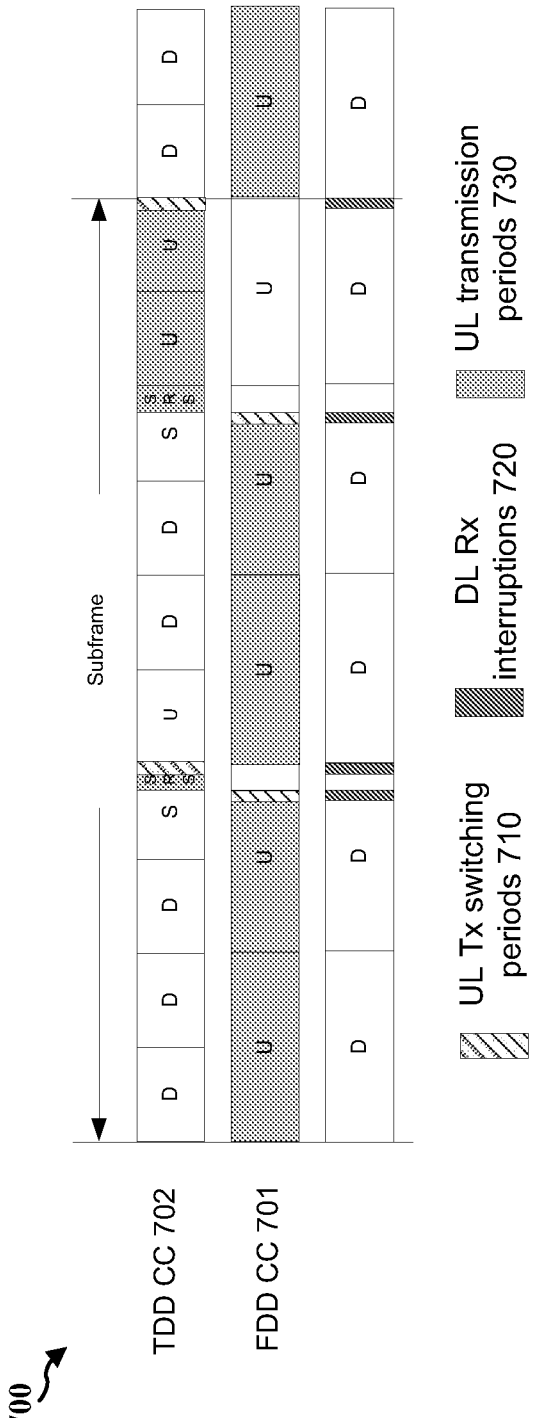
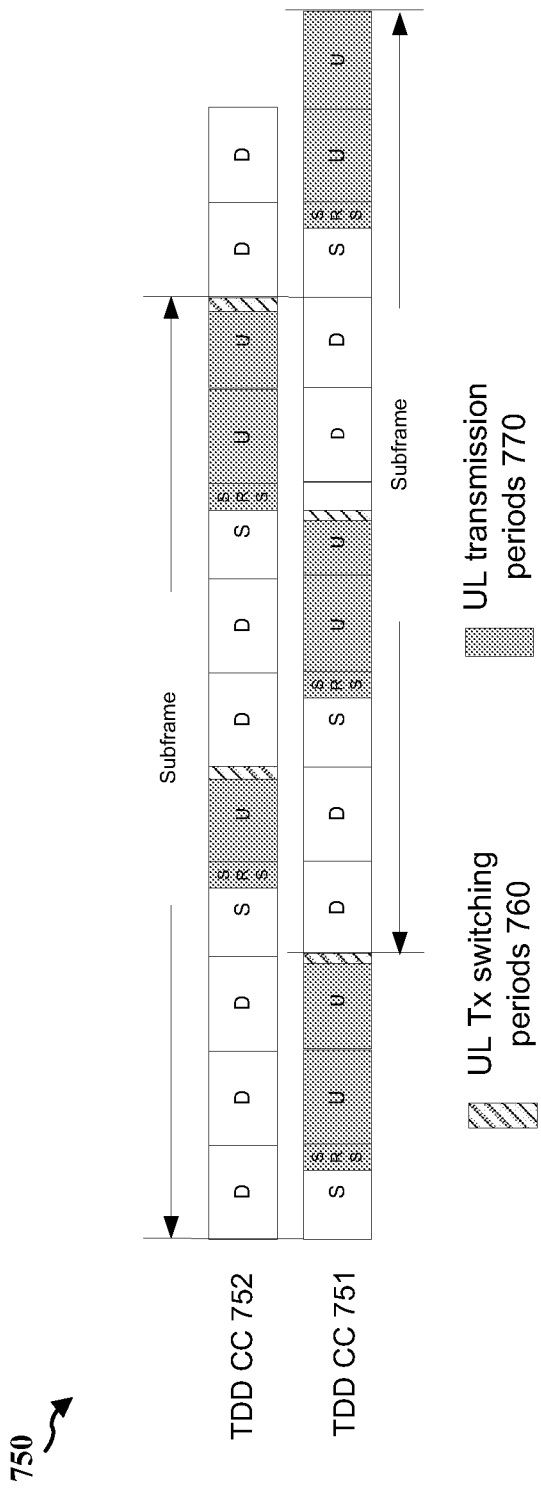

700
TDD CC 702
FDD CC 701
Subframe
UL Tx switching periods 710
DL Rx interruptions 720
UL transmission periods 730

FIG. 7B


750
TDD CC 752
TDD CC 751
Subframe
Subframe
UL Tx switching periods 760
UL transmission periods 770

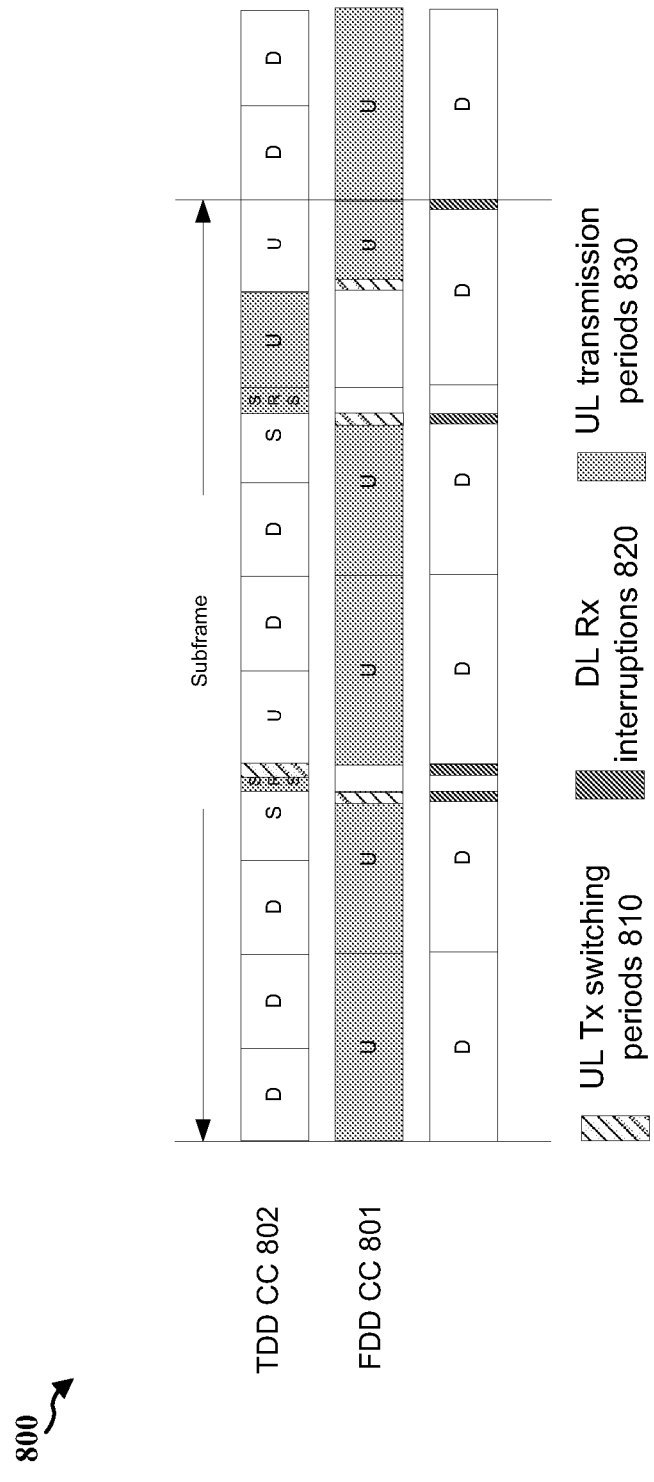

800
TDD CC 802
FDD CC 801
Subframe
D
U
S
UL Tx switching periods 810
DL Rx interruptions 820
UL transmission periods 830

FIG. 8

FIG. 9A

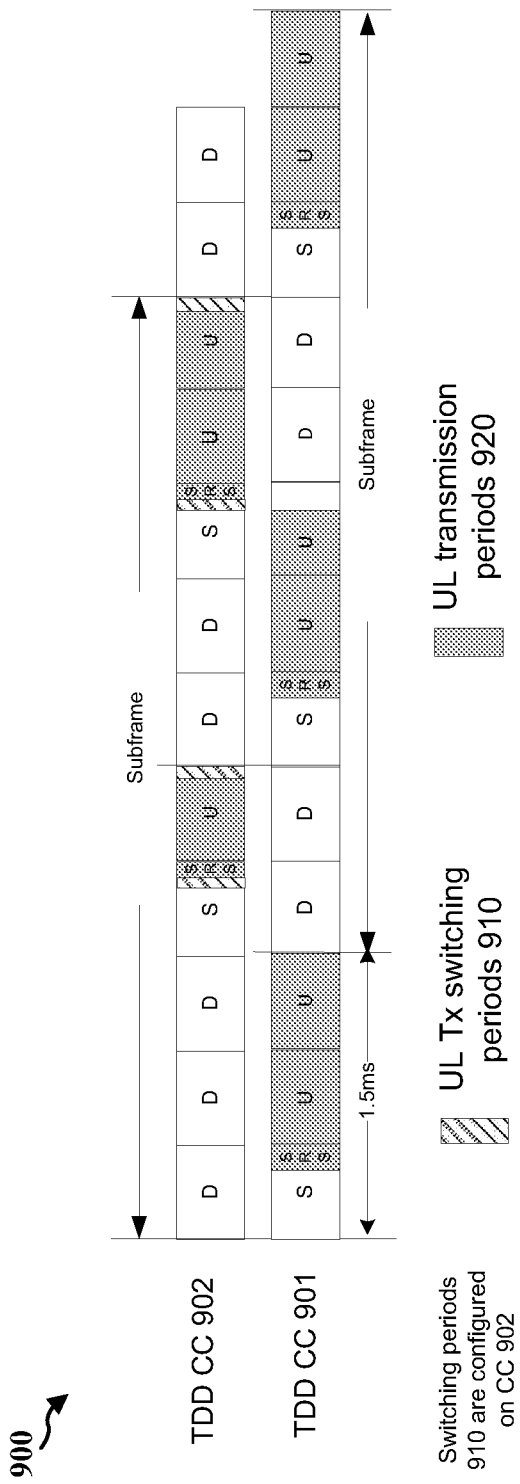
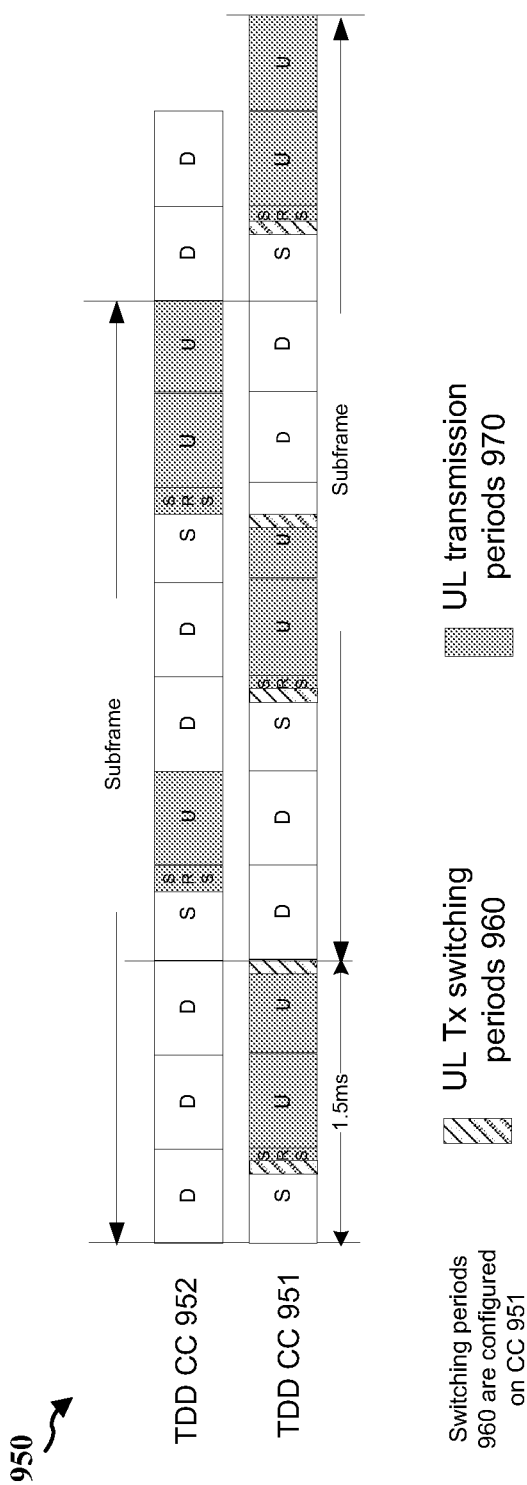

900
TDD CC 902
TDD CC 901
Subframe
Subframe
1.5ms
UL transmission periods 920
UL Tx switching periods 910
Switching periods 910 are configured on CC 902

FIG. 9B


950
TDD CC 952
TDD CC 951
Subframe
Subframe
1.5ms
UL transmission periods 970
UL Tx switching periods 960
Switching periods 960 are configured on CC 951

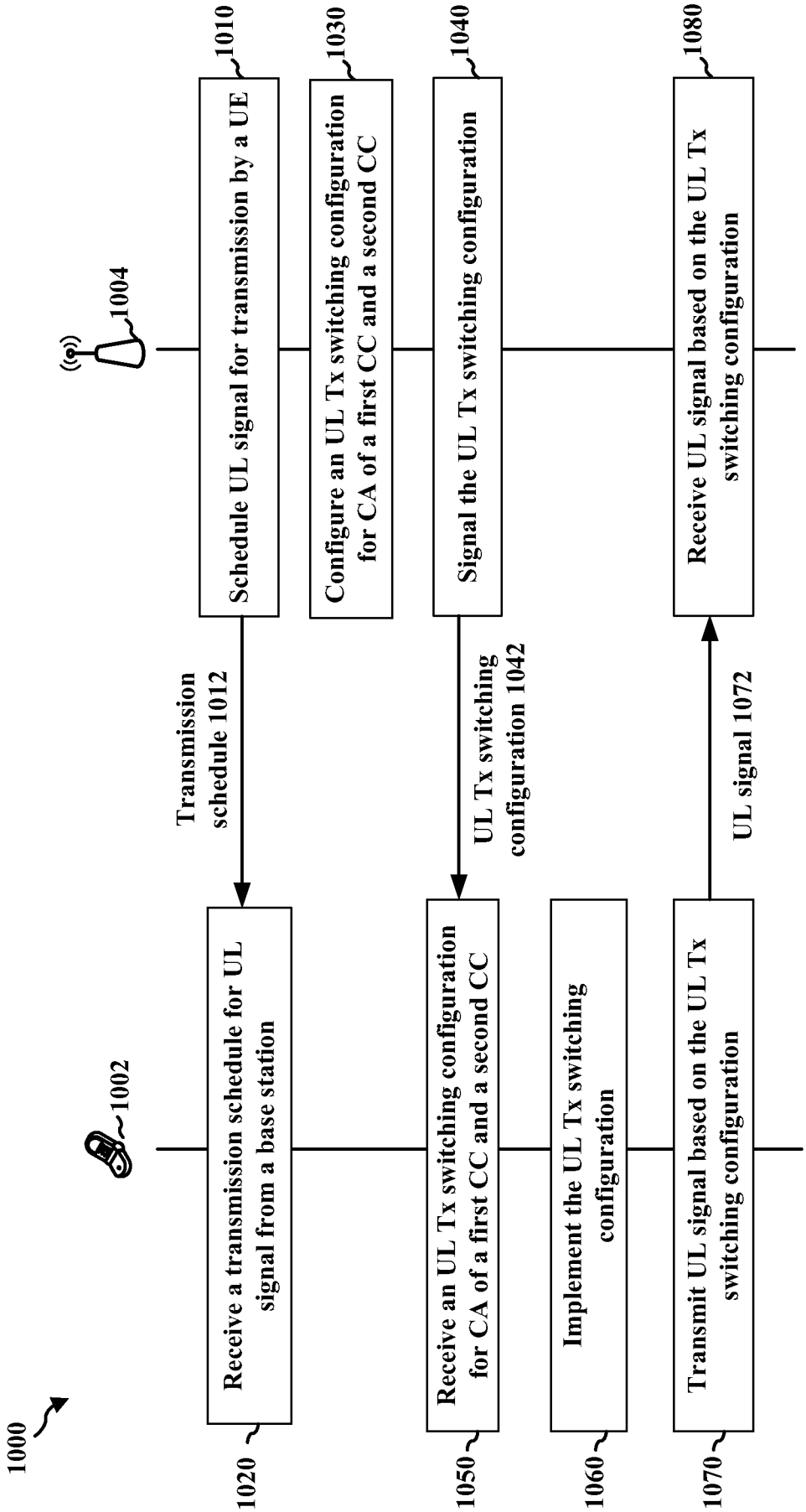

1000
1002
1004
Receive a transmission schedule for UL signal from a base station
1020
Schedule UL signal for transmission by a UE
1010
Transmission schedule 1012
Configure an UL Tx switching configuration for CA of a first CC and a second CC
1030
Receive an UL Tx switching configuration for CA of a first CC and a second CC
1050
Signal the UL Tx switching configuration
1040
UL Tx switching configuration 1042
Implement the UL Tx switching configuration
1060
Transmit UL signal based on the UL Tx switching configuration
1070
Receive UL signal based on the UL Tx switching configuration
1080
UL signal 1072

FIG. 10

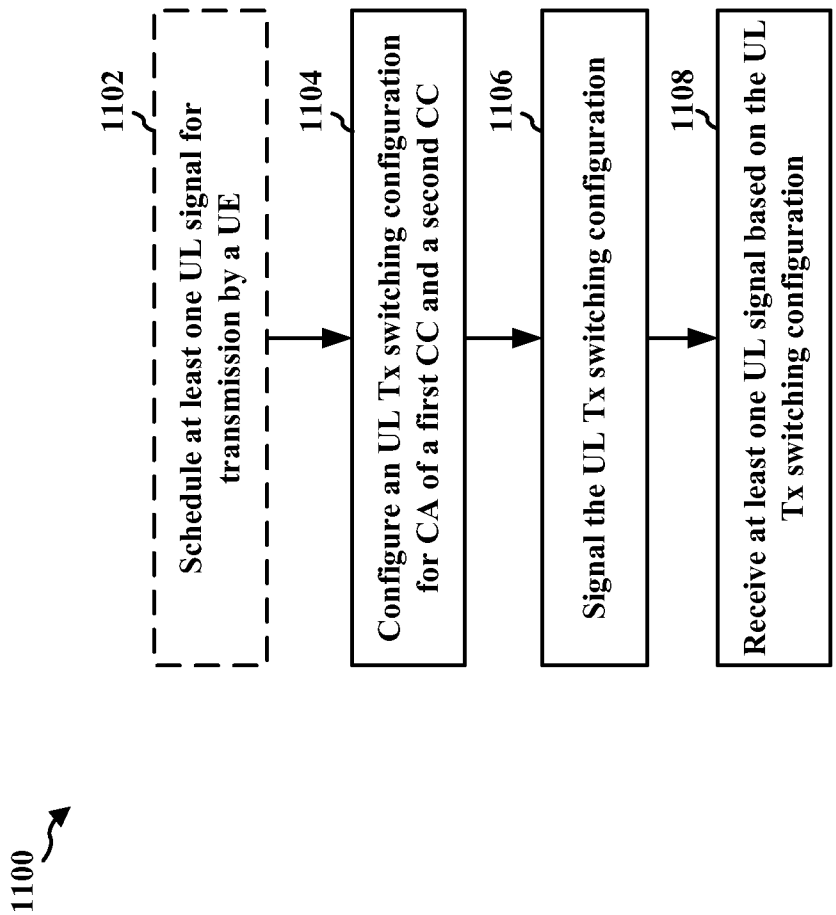

1100
1102
Schedule at least one UL signal for transmission by a UE
1104
Configure an UL Tx switching configuration for CA of a first CC and a second CC
1106
Signal the UL Tx switching configuration
1108
Receive at least one UL signal based on the UL Tx switching configuration

FIG. 11

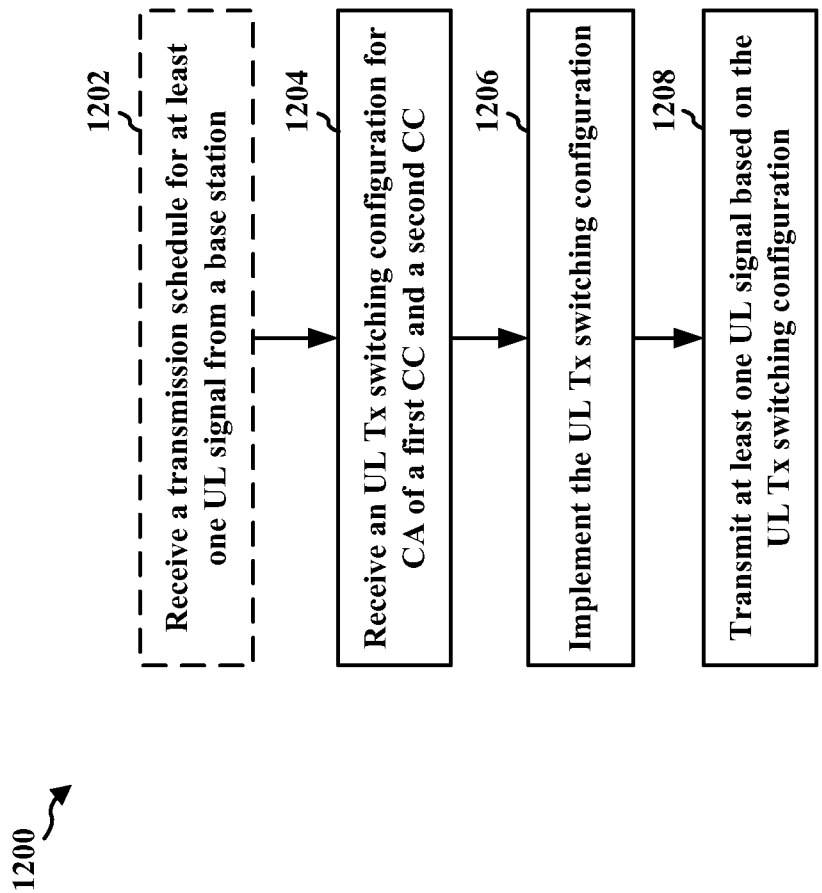

1200
1202
Receive a transmission schedule for at least one UL signal from a base station
1204
Receive an UL Tx switching configuration for CA of a first CC and a second CC
1206
Implement the UL Tx switching configuration
1208
Transmit at least one UL signal based on the UL Tx switching configuration

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/103281

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/02(2009.01)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;EPTXT;USTXT;WOTXT;3GPP:transient, switching, period, aggregation, carrier, configuration, uplink, symbol, end

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017303182 A1 (NTT DOCOMO INC.) 19 October 2017 (2017-10-19) description, paragraphs [0054]-[0064]	1-92
A	CN 109327300 A (SAMSUNG ELECTRONICS CO., LTD.) 12 February 2019 (2019-02-12) the whole document	1-92
A	CN 103797747 A (QUALCOMM INC.) 14 May 2014 (2014-05-14) the whole document	1-92
A	CN 105580463 A (NTT DOCOMO INC.) 11 May 2016 (2016-05-11) the whole document	1-92

☐ 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
30 March 2021	**12 April 2021**

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**	**ZHOU,Dan**
Facsimile No. **(86-10)62019451**	Telephone No. **62412011**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2020/103281

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
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		JP WO2016133123 A1	30 November 2017
CN 109327300 A	12 February 2019	US 10349410 B2	09 July 2019
		KR 20160021288 A	24 February 2016
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		EP 3011689 B1	09 December 2020
		JP 2019037006 A	07 March 2019
		JP 2019216481 A	19 December 2019
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		US 2019335463 A1	31 October 2019
		CN 105340196 B	30 November 2018
		EP 3011689 A1	27 April 2016
		US 2017303283 A1	19 October 2017
		JP 6595076 B2	23 October 2019
		US 2014369242 A1	18 December 2014
		WO 2014204202 A1	24 December 2014
CN 103797747 A	14 May 2014	CN 103797747 B	06 April 2016
		WO 2013016525 A2	31 January 2013
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		ZA 201401393 B	30 August 2017
		EP 2737653 A2	04 June 2014
		US 2013028205 A1	31 January 2013
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		US 10524262 B2	31 December 2019
		MX 341442 B	18 August 2016
		IL 252879 A	31 March 2019
		US 2017013625 A1	12 January 2017
		MX 2014000979 A	27 February 2014
		KR 101604291 B1	17 March 2016
		RU 2014106992 A	10 September 2015
		IL 230432 A	29 June 2017
		CA 2842693 A1	31 January 2013
		JP 6324936 B2	16 May 2018
		KR 20140057281 A	12 May 2014
		RU 2572566 C2	20 January 2016
		ES 2715324 T3	03 June 2019
		JP 2014526196 A	02 October 2014
		HU E041992 T2	28 June 2019
		EP 2737653 B1	12 December 2018
		IL 230432 D0	31 March 2014
		MX 337859 B	18 March 2016
		AU 2012286795 A1	27 February 2014

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2020/103281

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
				IL	252879	D0	31 August 2017
				EP	3496323	A1	12 June 2019
				HK	1197325	A1	09 January 2015
				JP	5815862	B2	17 November 2015
				CA	2842693	C	14 June 2016
CN	105580463	A	11 May 2016	EP	3051895	A4	03 May 2017
				EP	3051895	A1	03 August 2016
				JP	2015070323	A	13 April 2015
				WO	2015045960	A1	02 April 2015
				US	2016227492	A1	04 August 2016
				US	9936465	B2	03 April 2018