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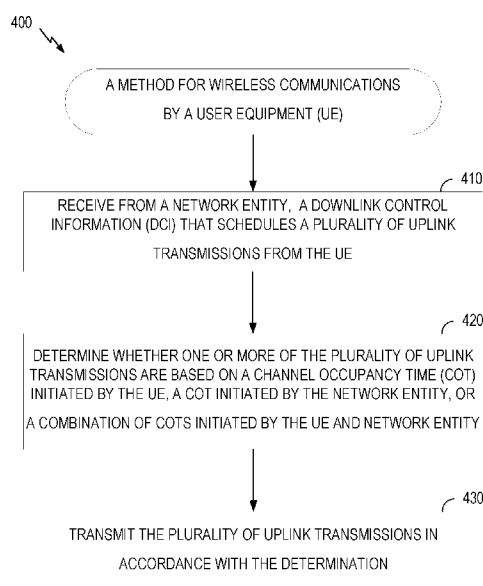


FIG. 4

(57) Abstract: Certain aspects of the present disclosure provide techniques for indicating and determining whether one or more of multiple uplink transmissions scheduled by a common downlink control information (DCI) are based on a channel occupancy time (COT) initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity. The determination may be based on a direct indication in the DCI for one or more of the multiple uplink transmissions. The determination may also be based on determining the type of COT for the remaining uplink transmissions not directly indicated by the DCI. For example, the DCI may indicate a COT type for only a first one of the multiple uplink transmissions and the UE determines a COT type for the remaining uplink transmissions based on various conditions and criteria.

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CHANNEL OCCUPANCY TIME (COT) DETERMINATION FOR SINGLE DCI-BASED MULTIPLE UPLINK TRANSMISSIONS

INTRODUCTION

[0001] Aspects of the present disclosure relate to wireless communications, and more particularly, to techniques for dynamically indicating and determining an applicable channel occupancy time (COT) for uplink transmissions scheduled with a single downlink control information (DCI).

[0002] Wireless communication systems are widely deployed to provide various telecommunication services such as telephony, video, data, messaging, broadcasts, or other similar types of services. These wireless communication systems may employ multiple-access technologies capable of supporting communication with multiple users by sharing available system resources with those users (e.g., bandwidth, transmit power, or other resources). Multiple-access technologies can rely on any of code division, time division, frequency division orthogonal frequency division, single-carrier frequency division, or time division synchronous code division, to name a few. These and other 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.

[0003] Although wireless communication systems have made great technological advancements over many years, challenges still exist. For example, complex and dynamic environments can still attenuate or block signals between wireless transmitters and wireless receivers, undermining various established wireless channel measuring and reporting mechanisms, which are used to manage and optimize the use of finite wireless channel resources. Consequently, there exists a need for further improvements in wireless communications systems to overcome various challenges.

SUMMARY

[0004] One aspect provides a method for wireless communications by a user equipment (UE). The method includes receiving from a network entity, a downlink control information (DCI) that schedules a plurality of uplink transmissions from the UE. The method further includes determining whether one or more of the plurality of uplink transmissions are based on a channel occupancy time (COT) initiated by the UE, a COT

initiated by the network entity, or a combination of COTs initiated by the UE and network entity, and transmitting the plurality of uplink transmissions in accordance with the determination.

[0005] One aspect provides a method for wireless communications by a network entity. The method includes transmitting to a user equipment (UE), a DCI that schedules a plurality of uplink transmissions from the UE. The method further includes determining whether one or more of the plurality of uplink transmissions are based on a COT initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity, and receiving the plurality of uplink transmissions in accordance with the determination.

[0006] One aspect provides a UE for wireless communications. The UE includes a memory and a processor coupled to the memory. The processor and memory are configured to receive from a network entity, a DCI that schedules a plurality of uplink transmissions from the UE; determine whether one or more of the plurality of uplink transmissions are based on a COT initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity; and transmit the plurality of uplink transmissions in accordance with the determination.

[0007] One aspect provides a non-transitory computer readable medium storing instructions that when executed by a UE cause the UE to: receive from a network entity, a DCI that schedules a plurality of uplink transmissions from the UE; determine whether one or more of the plurality of uplink transmissions are based on a COT initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity; and transmit the plurality of uplink transmissions in accordance with the determination.

[0008] Other aspects provide: an apparatus operable, configured, or otherwise adapted to perform the aforementioned methods as well as those described elsewhere herein; a non-transitory, computer-readable media comprising instructions that, when executed by one or more processors of an apparatus, cause the apparatus to perform the aforementioned methods as well as those described elsewhere herein; a computer program product embodied on a computer-readable storage medium comprising code for performing the aforementioned methods as well as those described elsewhere herein; and an apparatus comprising means for performing the aforementioned methods as well as

those described elsewhere herein. By way of example, an apparatus may comprise a processing system, a device with a processing system, or processing systems cooperating over one or more networks.

[0009] The following description and the appended figures set forth certain features for purposes of illustration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The appended figures depict certain features of the various aspects described herein and are not to be considered limiting of the scope of this disclosure.

[0011] **FIG. 1** is a block diagram conceptually illustrating an example wireless communication network.

[0012] **FIG. 2** is a block diagram conceptually illustrating aspects of an example a base station and user equipment.

[0013] **FIGS. 3A-3D** depict various example aspects of data structures for a wireless communication network.

[0014] **FIG. 4** depicts an example flow diagram for operations by a user equipment (UE).

[0015] **FIG. 5** depicts an example flow diagram for operations by a network entity.

[0016] **FIG. 6** depicts an example call flow diagram.

[0017] **FIGS. 7-15** depict various example diagrams for determining one or more channel occupancy times (COTs) for a number of uplink transmissions scheduled by a downlink control information (DCI).

[0018] **FIG. 16** depicts aspects of an example communications device.

[0019] **FIG. 17** depicts aspects of an example communications device.

DETAILED DESCRIPTION

[0020] Aspects of the present disclosure provide apparatuses, methods, processing systems, and computer-readable mediums for indicating or determining channel occupancy time (COT) for multiple uplink transmissions scheduled by a downlink control information (DCI). A COT generally refers to the maximum continuous transmission time a device has on a channel after channel sensing. Uplink transmissions may be sent by a

UE based on a gNB initiated COT or based on a COT initiated by the UE (e.g., after channel sensing by the UE). It may be important for the gNB and UE to be in agreement on which COT is used for every uplink transmission (e.g., the COT may be different from one uplink transmission to another), so the UE knows when to send the uplink transmission and so the gNB knows when to expect the transmission.

[0021] For each uplink transmission, a user equipment (UE) may determine whether a scheduled uplink transmission is based on UE-initiated COT or sharing a network initiated COT (both generally referred to as “COT types”). The present disclosure provides techniques for determining the COT initiator for each of a number of uplink transmissions scheduled by a single DCI. For example, the single DCI may schedule multiple physical uplink shared channel (PUSCH) repetitions, multiple sounding reference signals (SRSS), multiple physical uplink control channel (PUCCH) repetitions, or other types of uplink transmissions.

[0022] Given the UE may operate as an initiating device, such as in semi-static channel access mode, the UE may determine, based on an indication in the DCI, whether one or more of the multiple uplink transmissions are based on a COT initiated by the UE or by the network entity, according to aspects of the present disclosure. In particular, the single DCI may indicate COT types only to the first of the multiple uplink transmissions in one aspect, and the single DCI may indicate COT types for each of the multiple uplink transmissions separately in another aspect. When the DCI indicates the COT type for only the first of the multiple uplink transmissions, the UE and the network entity need to further determine, and agree upon, the COT types for the remaining uplink transmissions of the multiple uplink transmissions scheduled by the DCI.

Introduction to Wireless Communication Networks

[0023] **FIG. 1** depicts an example of a wireless communications system 100, in which aspects described herein may be implemented.

[0024] Generally, wireless communications system 100 includes base stations (BSs) 102, user equipments (UEs) 104, one or more core networks, such as an Evolved Packet Core (EPC) 160 and 5G Core (5GC) network 190, which interoperate to provide wireless communications services.

[0025] Base stations 102 may provide an access point to the EPC 160 and/or 5GC 190 for a user equipment 104, and 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, delivery of warning messages, among other functions. Base stations may include and/or be referred to as a gNB, NodeB, eNB, ng-eNB (e.g., an eNB that has been enhanced to provide connection to both EPC 160 and 5GC 190), an access point, a base transceiver station, a radio base station, a radio transceiver, or a transceiver function, or a transmission reception point in various contexts.

[0026] Base stations 102 wirelessly communicate with UEs 104 via communications links 120. Each of base stations 102 may provide communication coverage for a respective geographic coverage area 110, which may overlap in some cases. For example, small cell 102' (e.g., a low-power base station) may have a coverage area 110' that overlaps the coverage area 110 of one or more macrocells (e.g., high-power base stations).

[0027] The communication links 120 between base stations 102 and UEs 104 may include uplink (UL) (also referred to as reverse link) transmissions from a user equipment 104 to a base station 102 and/or downlink (DL) (also referred to as forward link) transmissions from a base station 102 to a user equipment 104. The communication links 120 may use multiple-input and multiple-output (MIMO) antenna technology, including spatial multiplexing, beamforming, and/or transmit diversity in various aspects.

[0028] 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, 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 other similar devices. Some of UEs 104 may be internet of things (IoT) devices (e.g., parking meter, gas pump, toaster, vehicles, heart monitor, or other IoT devices), always on (AON) devices, or edge processing devices. UEs 104 may also be referred to more generally 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, or a client.

[0029] Communications using higher frequency bands may have higher path loss and a shorter range compared to lower frequency communications. Accordingly, certain base stations (e.g., 180 in **FIG. 1**) may utilize beamforming 182 with a UE 104 to improve path loss and range. For example, 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.

[0030] In some cases, base station 180 may transmit a beamformed signal to UE 104 in one or more transmit directions 182'. UE 104 may receive the beamformed signal from the base station 180 in one or more receive directions 182''. UE 104 may also transmit a beamformed signal to the base station 180 in one or more transmit directions 182''. Base station 180 may also receive the beamformed signal from UE 104 in one or more receive directions 182'. Base station 180 and UE 104 may then perform beam training to determine the best receive and transmit directions for each of base station 180 and UE 104. Notably, the transmit and receive directions for base station 180 may or may not be the same. Similarly, the transmit and receive directions for UE 104 may or may not be the same.

[0031] Wireless communication network 100 includes COT manager 199, which may be configured to determine the COT types for the uplink transmissions scheduled from the UE. For example, the COT manager 199 may perform operations 500 of **FIG. 5**. Wireless network 100 further includes COT manager 198, which may be configured to determine the COT types based on the indications of the DCI or a rule for the scheduled uplink transmissions. For example, the COT manager 198 may perform operations 400 of **FIG. 4**.

[0032] **FIG. 2** depicts aspects of an example base station (BS) 102 and a user equipment (UE) 104.

[0033] Generally, base station 102 includes various processors (e.g., 220, 230, 238, and 240), antennas 234a-t (collectively 234), transceivers 232a-t (collectively 232), which include modulators and demodulators, and other aspects, which enable wireless transmission of data (e.g., data source 212) and wireless reception of data (e.g., data sink

239). For example, base station 102 may send and receive data between itself and user equipment 104.

[0034] Base station 102 includes controller / processor 240, which may be configured to implement various functions related to wireless communications. In the depicted example, controller / processor 240 includes COT manager 241, which may be representative of COT manager 199 of **FIG. 1**. Notably, while depicted as an aspect of controller / processor 240, COT manager 241 may be implemented additionally or alternatively in various other aspects of base station 102 in other implementations.

[0035] Generally, user equipment 104 includes various processors (e.g., 258, 264, 266, and 280), antennas 252a-r (collectively 252), transceivers 254a-r (collectively 254), which include modulators and demodulators, and other aspects, which enable wireless transmission of data (e.g., data source 262) and wireless reception of data (e.g., data sink 260).

[0036] User equipment 104 includes controller / processor 280, which may be configured to implement various functions related to wireless communications. In the depicted example, controller / processor 280 includes COT manager 281, which may be representative of COT manager 198 of **FIG. 1**. Notably, while depicted as an aspect of controller / processor 280, COT manager 281 may be implemented additionally or alternatively in various other aspects of user equipment 104 in other implementations.

[0037] **FIGS. 3A-3D** depict aspects of data structures for a wireless communication network, such as wireless communication network 100 of **FIG. 1**. In particular, **FIG. 3A** is a diagram 300 illustrating an example of a first subframe within a 5G (e.g., 5G NR) frame structure, **FIG. 3B** is a diagram 330 illustrating an example of DL channels within a 5G subframe, **FIG. 3C** is a diagram 350 illustrating an example of a second subframe within a 5G frame structure, and **FIG. 3D** is a diagram 380 illustrating an example of UL channels within a 5G subframe.

[0038] Further discussions regarding **FIG. 1**, **FIG. 2**, and **FIGS. 3A-3D** are provided later in this disclosure.

Introduction to mmWave Wireless Communications

[0039] In wireless communications, an electromagnetic spectrum is often subdivided into various classes, bands, channels, or other features. The subdivision is often provided

based on wavelength and frequency, where frequency may also be referred to as a carrier, a subcarrier, a frequency channel, a tone, or a subband.

[0040] 5G networks may utilize several frequency ranges, which in some cases are defined by a standard, such as the 3GPP standards. For example, 3GPP technical standard TS 38.101 currently defines Frequency Range 1 (FR1) as including 600 MHz – 6 GHz, though specific uplink and downlink allocations may fall outside of this general range. Thus, FR1 is often referred to (interchangeably) as a “Sub-6 GHz” band.

[0041] Similarly, TS 38.101 currently defines Frequency Range 2 (FR2) as including 26 – 41 GHz, though again specific uplink and downlink allocations may fall outside of this general range. FR2, is sometimes referred to (interchangeably) as a “millimeter wave” (“mmW” or “mmWave”) band, despite being different from the extremely high frequency (EHF) band (30 GHz – 300 GHz) that is identified by the International Telecommunications Union (ITU) as a “millimeter wave” band because wavelengths at these frequencies are between 1 millimeter and 10 millimeters.

[0042] Communications using mmWave / near mmWave radio frequency band (e.g., 3 GHz – 300 GHz) may have higher path loss and a shorter range compared to lower frequency communications. As described above with respect to **FIG. 1**, a base station (e.g., 180) configured to communicate using mmWave / near mmWave radio frequency bands may utilize beamforming (e.g., 182) with a UE (e.g., 104) to improve path loss and range.

[0043] Further, as described herein, to access shared spectrum channels, COT or COT duration for uplink transmissions need be defined. For example, DCI format 2_0 may be used to notify a group of UEs of the slot format, available resource block (RB) sets, and the COT duration. In some cases, a DCI (e.g., format 0_0 or 1_0) may include fields indicating combinations of channel access type and cyclic prefix (CP) extension, such as shown in Table 7.3.1.1-4 or Table 7.3.1.1.1.4A of TS 38.212. As such, the COT duration is often configured by the network entity by a higher layer parameter (e.g., *ul-AccessConfigListDCI-1-1*) for a type of channel access procedure.

[0044] In semi-static channel access mode, a UE may operate as an initiating device and initiate its own COT. The UE may thus need to determine whether a scheduled uplink transmission is based on a COT initiated by the network (i.e., sharing a gNB-initiated COT) or based on a COT initiated by the UE. At a high level, the determination may be

based on the content in the scheduling DCI or based on rules applied for a configured uplink transmission. Details of such determination, however, have yet been resolved for situations where corresponding fields for the indication may be absent in the DCI, as well as how to handle situations when the network entity schedules an uplink transmission in the next fixed frame period (FFP) of the network entity. The present disclosure provides various specific signaling solutions or techniques to resolve these situations.

Aspects Related to Channel Occupancy Time (COT) Determination for Multiple Uplink Transmissions Scheduled by a Single Downlink Control Information (DCI)

[0045] The present disclosure provides techniques for indicating and determining whether one or more of multiple uplink transmissions scheduled by a common downlink control information (DCI) are based on a channel occupancy time (COT) initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity (generally referred to as “COT type(s)”). The determination may be based on a direct indication in the DCI for one or more of the multiple uplink transmissions. The determination may also be based on determining the type of COT for the remaining uplink transmissions not directly indicated by the DCI. For example, the DCI may indicate a COT type for only a first one of the multiple uplink transmissions and the UE determines a COT type for the remaining uplink transmissions based on various conditions and criteria. The DCI may also indicate a corresponding COT type for each of the multiple uplink transmissions. The UE may determine whether, or how, to apply the indicated COT types.

[0046] Aspects of the present disclosure may help a UE determine, for one of multiple uplink transmissions scheduled by a common DCI, whether a scheduled UL transmission is to be based on a UE-initiated COT or if the UL transmission is sent sharing a gNB-initiated COT. In some cases, the determination may be based on the content in the scheduling DCI and/or whether a corresponding field or fields are absent in the DCI. If a field is absent, the determination may be based on the rules applied for configured UL transmissions. Aspects of the present disclosure may also allow a UE to determine whether (or how) to handle the case when a gNB schedules an UL transmission in a subsequent fixed frame period (FFP) of the gNB. In some cases, a determination of what COT (UE-initiated COT or shared gNB COT) to use may be based on the rules applied for a configured UL transmission.

[0047] **FIG. 4** is a flow diagram illustrating example operations 400 for wireless communication. The operations 400 may be performed, for example, by a UE (e.g., such as the UE 104 in the wireless communication network 100 of **FIG. 1**). The operations 400 may be implemented as software components that are executed and run on one or more processors (e.g., the controller/processor 280 of **FIG. 2**). Further, transmission and reception of signals by the UE in operations 400 may be enabled, for example, by one or more antennas (e.g., the antennas 252 of **FIG. 2**). In certain aspects, the transmission and/or reception of signals by the UE may be implemented via a bus interface of one or more processors (e.g., the controller/processor 280) obtaining and/or outputting signals.

[0048] The operations 400 begin, at 410, by receiving from a network entity, a DCI that schedules multiple uplink transmissions from the UE. For example, the UE receives a DCI from the network entity using antenna(s) and transmitter/transceiver components of the UE 104 shown in **FIG. 1** or **FIG. 2** and/or of the apparatus shown in **FIG. 13**.

[0049] At 420, the UE determines whether one or more of the multiple uplink transmissions are based on a channel occupancy time (COT) initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity. For example, the UE may perform the determination using the COT manager 281 of the controller and processor 280, and/or the coupled transmit processor 264 or the receive processor 258 shown in **FIG. 2** and/or of the apparatus shown in **FIG. 13**.

[0050] At 430, the UE transmits the multiple uplink transmissions in accordance with the determination. For example, the UE transmits the multiple uplink transmissions to the network entity using antenna(s) and transmitter/transceiver components of the UE 104 shown in **FIG. 1** or **FIG. 2** and/or of the apparatus shown in **FIG. 16**.

[0051] **FIG. 5** depicts a flow diagram illustrating example operations 500 for wireless communication. The operations 500 may be performed, for example, by a network entity (e.g., such as the BS 102 in the wireless communication network 100 of **FIG. 1**). The operations 500 performed by the network entity may be complimentary to the operations 400 performed by the UE. The operations 500 may be implemented as software components that are executed and run on one or more processors (e.g., the controller/processor 240 of **FIG. 2**). Further, transmission and reception of signals by the network entity in operations 500 may be enabled, for example, by one or more antennas (e.g., the antennas 234 of **FIG. 2**). In certain aspects, the transmission and/or reception of

signals by the network entity may be implemented via a bus interface of one or more processors (e.g., the controller/processor 240) obtaining and/or outputting signals.

[0052] The operations 500 begin, at 510, by transmitting to a UE, a DCI that schedules a multiple uplink transmissions from the UE. At 520, the network entity determines whether one or more of the multiple uplink transmissions are based on a COT initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity. At 530, the network entity receives the multiple uplink transmissions in accordance with the determination.

[0053] Operations 400 and 500 of **FIGs. 4 and 5** may be understood with reference to the call flow diagram 600 of **FIG. 6**. In other words, the UE 602 shown in **FIG. 6** may perform operations 400 of **FIG. 4**, while the gNB 604 shown in **FIG. 6** may perform operations 500 of **FIG. 5**.

[0054] As shown, at 606, the gNB may transmit a single DCI to the UE. The DCI schedules multiple uplink transmissions (i.e., two or more uplink transmissions) from the UE to the gNB.

[0055] At 608, the UE determines whether one or more of the multiple uplink transmissions are based on a COT initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity. For example, the DCI may include an indication of whether only a first uplink transmission of the multiple uplink transmissions, is based on a COT initiated by the UE or a COT initiated by the network entity. The UE may determine whether remaining uplink transmissions are based on a same type of COT as indicated for the first uplink transmission. The DCI may alternatively include indication for each one of the multiple uplink transmissions in the UE.

[0056] The gNB may perform a similar determination (not shown) in order to properly expect the uplink transmission from the UE based on the determined COT. For example, for each uplink transmission, because the UE 602 has alternative options in terms of using a COT initiated by the UE 602 or using a COT shared from the network entity 604, the indication in the DCI known by both the UE 602 and the network entity 604 enable the determination on both.

[0057] At 610, the UE 602 transmits the uplink transmission in accordance with the determination.

[0058] In some cases, the content in the scheduling DCI, indicating which type of COT, is applied only to the first scheduled UL transmission. In this case, the UE may not be allowed to initiate a COT based on the UL transmissions other than the first scheduled UL transmission. The UE may determine whether to initiate a UE COT or share a gNB-initiated COT for the multiple UL transmissions (e.g., multiple PUSCHs with different TBs, PUSCH repetitions, multiple SRSs, PUCCH repetitions etc.) based on the indication for the first scheduled UL transmission. The UL transmissions other than the first UL transmission may assume the same COT as the first scheduled UL transmission, when applicable (e.g., if there is sufficient time in the determined COT type for the remaining transmissions).

[0059] As illustrated in **FIG. 7**, if the content in a first scheduling DCI 702 indicated the UE is to initiate a COT, and the first scheduled UL transmission is aligned with the UE FFP boundary, the UE may initiate a UE COT and transmit the first scheduled UL transmission in UE COT. In this case, given sufficient duration, the UE may also transmit the other UL transmissions in the UE-initiated COT.

[0060] On the other hand, if the content in a second scheduling DCI 704 indicates the UE is to share a gNB-initiated COT (e.g., the UE has not initiated a COT, the UE may transmit the first scheduled UL transmission in a shared gNB initiated COT. In this case, the UE may also transmit the other UL transmissions in the gNB-initiated COT.

[0061] In other words, if the UE has already initiated the UE FFP, then the UE may assume that the first scheduled UL transmission corresponds to UE-initiated COT. The UE may also assume the same COT as the first scheduled UL transmission for the UL transmissions other than the first scheduled UL transmission.

[0062] Otherwise, if the first scheduled UL transmission is confined within a gNB FFP before the idle period of that gNB FFP, and if the UE has already determined that gNB has initiated that gNB FFP, then the UE may assume that the first scheduled UL transmission corresponds to gNB-initiated COT. The UE assumes the same COT as the first scheduled UL transmission for the other UL transmissions.

[0063] As illustrated in **FIG. 8**, if a DCI 802 schedules a first UL transmission that starts after a UE FFP boundary and ends before the idle period of that UE FFP, the same behavior as defined for configured UL transmissions may be applied (e.g., by replacing the configured UL transmission with the first scheduled UL transmission). As illustrated,

if the other UL transmissions overlap with the UE idle period, those other UL transmissions may be dropped.

[0064] As illustrated in **FIG. 9**, for cross-FFP scheduling, meaning the DCI received in one gNB FFP schedules multiple UL transmissions are in the next gNB FFP, the UE behavior can be defined based on one of various alternatives. According to a first alternative, the UE behavior may be as described above (e.g., the DCI indicated COT is applied to the first scheduled UL transmission). According to a second alternative, the UE may initiate a UE COT, irrespective of the indication in the corresponding field in the DCI, if the first scheduled UL transmission in the next gNB FFP is aligned with UE FFP starting point.

[0065] In some cases, the content in the scheduling DCI (indicating COT type) may be applied to each scheduled UL transmission. In this case, the UE may be allowed to initiate a COT based on any of the scheduled PUSCH (or other UL transmissions) which is aligned with the UE FFP boundary.

[0066] The UE may determine whether each of the scheduled UL transmission is based on UE-initiated COT or sharing gNB COT separately. For example, among M scheduled UL transmissions, N scheduled UL transmissions may be aligned with the UE FFP boundary. For an n -th scheduled UL transmission ($n=0,1,\dots,N-1$), the UE may determine whether that UL transmission is based on UE-initiated COT or sharing gNB COT based on the indication in DCI.

[0067] If the content in the scheduling DCI indicates the UE to initiate a COT, and the n -th scheduled UL transmission ($n=0,1,\dots,N-1$) is aligned with the UE FFP boundary, the UE shall initiate a UE COT and transmit n -th scheduled UL transmission in UE COT. If the content in the scheduling DCI indicates the UE to share a gNB-initiated COT, the UE shall transmit the n -th scheduled UL transmission in gNB initiated COT.

[0068] For the K scheduled UL transmissions between n -th scheduled UL and $(n+1)$ -th scheduled UL, various options may be employed to determine whether to use UE-initiated COT or gNB-initiated COT for k -th scheduled UL transmission ($k=0,1,\dots,K-1$).

[0069] As illustrated in **FIGS. 10** and **11**, according to a first option, based on a predefined rule, if the k -th scheduled UL transmissions starts after a UE FFP boundary and ends before the idle period of that UE FFP, the same behavior as defined in configured

UL is applied for the k-th scheduled UL transmission by replacing the configured UL transmission by the k-th scheduled UL transmission.

[0070] As illustrated in **FIG. 11**, if the UE has already initiated the UE FFP, then the UE may assume that the k-th scheduled UL transmission corresponds to UE-initiated COT. Otherwise, if the k-th scheduled UL is confined within a gNB FFP before the idle period of that gNB FFP, and if the UE has already determined that gNB has initiated that gNB FFP, then UE assumes that the k-th scheduled UL transmission corresponds to gNB-initiated COT.

[0071] As illustrated in **FIG. 12**, according to a second option, the UE may assume the same COT as the latest scheduled UL aligned with the UE FFP boundary to be used for the scheduled UL transmissions not aligned with UE FFP boundary. For the K scheduled UL transmissions between n-th scheduled UL and (n+1) scheduled UL, the UE may assume the same COT as the n-th scheduled UL transmission is applied. In the illustrated example, the first scheduled UL transmission is sent in a gNB-initiated COT, but the second scheduled UL transmission is aligned with the UE FFP boundary. Therefore, this UL transmission, as well as the third and fourth UL transmissions are sent in the UE-initiated COT.

[0072] In some cases, if the (n-1)-th UL transmission is based on a gNB initiated COT, while n-th UL transmission is based on UE initiate COT, and UE is initiated to initiate a UE COT based on n-th transmission, there may be some gaps between (n-1)-th UL transmission and n-th UL transmission for UE to do LBT.

[0073] There are various options, in the event there is no gap between (n-1)th and n-th UL transmission. As illustrated in **FIG. 13**, according to a first option, the UE may drop the (n-1)th UL transmission and do LBT right before the n-th UL transmission to initiate a UE COT. As illustrated in **FIG. 14**, according to a second option, the UE may not imitate its own COT and may transmit the n-th transmission based on gNB initiated COT.

[0074] In some cases, the UE receives, from the network entity, signaling indicating whether remaining uplink transmissions other than the first uplink transmission are based on the same type of COT as indicated for the first uplink transmission. For example, the signaling may be radio resource control (RRC) that configures the UE behavior, such that the UE may behave according to (1) DCI indication applying only to the first one of the

multiple scheduled uplink transmissions; or (2) DCI indication applying to each of the multiple scheduled uplink transmissions.

[0075] For cross-FFP scheduling, when the scheduled multi-PUSCH transmission is in the next gNB FFP, the UE behavior may be based on one of various alternatives. For example, according to a first alternative, the UE may behave as described above with reference to **FIGs. 10-12**. According to a second alternative, as illustrated in **FIG. 15**, the UE may initiate a UE COT, irrespective of the indication in the corresponding field.

Example Wireless Communication Devices

[0076] **FIG. 16** depicts an example communications device 1600 that includes various components operable, configured, or adapted to perform operations for the techniques disclosed herein, such as the operations depicted and described with respect to **FIG. 4**. In some examples, communication device 1600 may be a UE, such as the UE 104 as described, for example with respect to **FIGS. 1, and 2**.

[0077] Communications device 1600 includes a processing system 1602 coupled to a transceiver 1608 (e.g., a transmitter and/or a receiver). Transceiver 1608 is configured to transmit (or send) and receive signals for the communications device 1600 via an antenna 1610, such as the various signals as described herein. Processing system 1602 may be configured to perform processing functions for communications device 1600, including processing signals received and/or to be transmitted by communications device 1600.

[0078] Processing system 1602 includes one or more processors 1620 coupled to a computer-readable medium/memory 1630 via a bus 1606. In certain aspects, computer-readable medium/memory 1630 is configured to store instructions (e.g., computer-executable code) that when executed by the one or more processors 1620, cause the one or more processors 1620 to perform the operations illustrated in **FIG. 4**, or other operations for performing the various techniques discussed herein for indicating and determining the COT types.

[0079] In the depicted example, computer-readable medium/memory 1630 stores code 1631 for receiving, code 1632 for determining, and code 1633 for transmitting.

[0080] In the depicted example, the one or more processors 1620 include circuitry configured to implement the code stored in the computer-readable medium/memory 1630,

including circuitry 1621 for receiving, circuitry 1322 for determining, and circuitry 1623 for transmitting.

[0081] Various components of communications device 1600 may provide means for performing the methods described herein, including with respect to **FIG. 4**.

[0082] In some examples, means for transmitting or sending (or means for outputting for transmission) may include the transceivers 254 and/or antenna(s) 252 of the UE 104 illustrated in **FIG. 2** and/or transceiver 1608 and antenna 1610 of the communication device 1600 in **FIG. 16**.

[0083] In some examples, means for receiving (or means for obtaining) may include the transceivers 254 and/or antenna(s) 252 of the UE 104 illustrated in **FIG. 2** and/or transceiver 1608 and antenna 1610 of the communication device 1600 in **FIG. 16**.

[0084] In some examples, means for determining may include various processing system components, such as: the one or more processors 1620 in **FIG. 16**, or aspects of the UE 104 depicted in **FIG. 2**, including receive processor 258, transmit processor 264, TX MIMO processor 266, and/or controller/processor 280 (including the COT manager 281).

[0085] Notably, **FIG. 16** is an example, and many other examples and configurations of communication device 1600 are possible.

[0086] **FIG. 17** depicts an example communications device 1700 that includes various components operable, configured, or adapted to perform operations for the techniques disclosed herein, such as the operations depicted and described with respect to **FIG. 5**. In some examples, communication device 1700 may be a second network entity, such as another base station 102 as described, for example with respect to **FIGS. 1, and 2**.

[0087] Communications device 1700 includes a processing system 1702 coupled to a transceiver 1708 (e.g., a transmitter and/or a receiver). Transceiver 1708 is configured to transmit (or send) and receive signals for the communications device 1700 via an antenna 1710, such as the various signals as described herein. Processing system 1702 may be configured to perform processing functions for communications device 1700, including processing signals received and/or to be transmitted by communications device 1700.

[0088] Processing system 1702 includes one or more processors 1720 coupled to a computer-readable medium/memory 1730 via a bus 1706. In certain aspects, computer-readable medium/memory 1730 is configured to store instructions (e.g., computer-executable code) that when executed by the one or more processors 1720, cause the one or more processors 1720 to perform the operations illustrated in **FIG. 5**, or other operations for performing the various techniques discussed herein for indicating and determining the COT types.

[0089] In the depicted example, computer-readable medium/memory 1730 stores code 1731 for transmitting, code 1432 for determining, and code 1733 for receiving.

[0090] In the depicted example, the one or more processors 1720 include circuitry configured to implement the code stored in the computer-readable medium/memory 1730, including circuitry 1721 for transmitting, circuitry 1422 for determining, and circuitry 1722 for receiving.

[0091] Various components of communications device 1700 may provide means for performing the methods described herein, including with respect to **FIG. 5**.

[0092] In some examples, means for transmitting or sending (or means for outputting for transmission) may include the transceivers 232 and/or antenna(s) 234 of the base station 102 illustrated in **FIG. 2** and/or transceiver 1708 and antenna 1710 of the communication device 1700 in **FIG. 17**.

[0093] In some examples, means for receiving (or means for obtaining) may include the transceivers 232 and/or antenna(s) 234 of the base station 102 illustrated in **FIG. 2** and/or transceiver 1708 and antenna 1710 of the communication device 1700 in **FIG. 17**.

[0094] In some examples, means for updating may include various processing system components, such as: the one or more processors 1720 in **FIG. 17**, or aspects of the base station 102 depicted in **FIG. 2**, including receive processor 238, transmit processor 220, TX MIMO processor 230, and/or controller/processor 240 (including the COT manager 241).

[0095] Notably, **FIG. 17** is an example, and many other examples and configurations of communication device 1700 are possible.

Example Clauses

[0096] Implementation examples are described in the following numbered clauses:

[0097] Clause 1: A method for wireless communications by a user equipment (UE), comprising: receiving from a network entity, a downlink control information (DCI) that schedules a plurality of uplink transmissions from the UE; determining whether one or more of the plurality of uplink transmissions are based on a channel occupancy time (COT) initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity; and transmitting the plurality of uplink transmissions in accordance with the determination.

[0098] Clause 2: The method of Clause 1, wherein the plurality of uplink transmissions include at least one of: transport blocks (TBs), physical uplink initiated channel (PUSCH) repetitions, sounding reference signals (SRSs), or physical uplink control channel (PUCCH) repetitions.

[0099] Clause 3: The method of Clause 1, wherein: the DCI includes an indication of whether a first uplink transmission, of the plurality of uplink transmissions, is based on a COT initiated by the UE or a COT initiated by the network entity; and the determining comprises determining whether remaining uplink transmissions are based on a same type of COT as indicated for the first uplink transmission.

[0100] Clause 4: The method of Clause 3, wherein the DCI includes the indication for only the first uplink transmission of the plurality of uplink transmissions.

[0101] Clause 5: The method of Clause 4, further comprising transmitting the remaining uplink transmissions based on the same type of COT as indicated for the first uplink transmission.

[0102] Clause 6: The method of Clause 4, wherein the determining comprises determining the uplink transmissions are based on the COT initiated by the UE when: the first one of the plurality of uplink transmissions is aligned with a boundary of a fixed frame period (FFP) of the UE, and the DCI indicates a requirement for the COT initiated by the UE.

[0103] Clause 7: The method of Clause 4, wherein the determining comprises determining the uplink transmissions are based on the COT initiated by the network entity when the DCI indicates a requirement for the UE to use the COT initiated by the network entity for the first one of the plurality of uplink transmissions.

[0104] Clause 8: The method of Clause 3, further comprising determining whether the first uplink transmission, of the plurality of uplink transmissions, is based on a COT

initiated by the UE or a COT initiated by the network entity according to a predefined rule when the first uplink transmission of the plurality of uplink transmissions starts after a UE fixed frame period (FFP) boundary and ends before a next idle period of the UE FFP.

[0105] Clause 9: The method of Clause 8, further comprising using the COT initiated by the network entity in the first uplink transmission of the plurality of uplink transmissions when: the first uplink transmission of the plurality of uplink transmissions is within a fixed frame period (FFP) of the network entity before an idle period, the UE determines that the network entity has initiated the COT, and the UE has not initiated the FFP of the UE.

[0106] Clause 10: The method of Clause 8, further comprising: using the COT to be initiated by the UE when the following conditions are met: the UE has initiated the FFP of the UE, and at least one of the plurality of uplink transmissions is before a next idle period of the UE FFP; and removing other conflicting portions of the plurality of uplink transmissions colliding with the next idle period.

[0107] Clause 11: The method of Clause 3, further comprising determining the uplink transmissions are based on a COT initiated by the UE disregarding scheduling by the received DCI.

[0108] Clause 12: The method of Clause 3, wherein the DCI includes the indication for each one of the plurality of uplink transmissions in the UE, wherein the determining comprises determining according to one or more predefined rules associated with the DCI.

[0109] Clause 13: The method of Clause 12, wherein determining according to the one or more predefined rules associated with the DCI comprises determining the uplink transmissions are based on a COT initiated by the UE for each uplink transmission aligned with a boundary of a fixed frame period (FFP) of the UE when the DCI indicates a requirement for the UE to initiate the UE COT.

[0110] Clause 14: The method of Clause 12, wherein determining according to the one or more predefined rules associated with the DCI comprises determining each of the plurality of uplink transmissions to be associated with a COT separately indicated by the DCI scheduling.

[0111] Clause 15: The method of Clause 12, further comprising determining whether one uplink transmission, of the plurality of uplink transmissions, that starts after a UE FFP boundary and before a next idle period of the UE FFP is based on a COT initiated by the UE or a COT initiated by the network entity according to a predefined rule.

[0112] Clause 16: The method of Clause 15, wherein the determining comprises determining the plurality of uplink transmissions are based on a UE initiated COT when the UE has initiated the UE FFP.

[0113] Clause 17: The method of Clause 15, wherein the determining comprises determining one of the plurality of uplink transmissions are based on a COT initiated by the network entity when the one of the plurality of uplink transmissions is within a network FFP before a next idle period of the network FFP and when the UE has determined that the network entity has initiated the network FFP.

[0114] Clause 18: The method of Clause 12, wherein the determining comprises determining the plurality of uplink transmissions are based on a most recently scheduled COT when the plurality of uplink transmissions are not aligned with the UE FFP boundary.

[0115] Clause 19: The method of Clause 12, further comprising removing one or more of the plurality of uplink transmissions at least partially overlapping with an idle period of the UE FFP.

[0116] Clause 20: The method of Clause 12, further comprising initiating a COT for the plurality of uplink transmissions disregarding the COT indicated by the received DCI.

[0117] Clause 21: The method of Clause 3, further comprising receiving, from the network entity, signaling indicating whether remaining uplink transmissions are based on the same type of COT as indicated for the first uplink transmission.

[0118] Clause 22: The method of Clause 1, further comprising performing a listen-before-talk (LBT) when one of the plurality of uplink transmissions is aligned with a fixed frame period (FFP) boundary and a previous uplink transmission transmitted before the one of the plurality of uplink transmissions with a gap.

[0119] Clause 23: The method of Clause 1, further comprising canceling a previous uplink transmission and performing LBT before a next uplink transmission based on a COT initiated by the UE when a timeline comparison between the DCI and the previous

uplink transmission satisfies a cancellation timeline and when the previous uplink transmission and the next uplink transmission are not separated by a gap.

[0120] Clause 24: The method of Clause 23, further comprising transmitting the plurality of uplink transmissions based on COT initiated by the network entity when the timeline comparison between the DCI and the previous uplink transmission does not satisfy a cancellation timeline.

[0121] Clause 25: The method of Clause 1, further comprising transmitting the plurality of uplink transmissions based on the COT initiated by the network entity only.

[0122] Clause 26: A method for wireless communications by a user equipment (UE), comprising: transmitting to a user equipment (UE), a downlink control information (DCI) that schedules a plurality of uplink transmissions from the UE; determining whether one or more of the plurality of uplink transmissions are based on a channel occupancy time (COT) initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity; and receiving the plurality of uplink transmissions in accordance with the determination.

[0123] Clause 27: The method of Clause 26, wherein the plurality of uplink transmissions include at least one of: transport blocks (TBs), physical uplink initiated channel (PUSCH) repetitions, sounding reference signals (SRSs), or physical uplink control channel (PUCCH) repetitions.

[0124] Clause 28: The method of Clause 26, wherein: the DCI includes an indication of whether an first uplink transmission, of the plurality of uplink transmissions, is based on a COT initiated by the UE or a COT initiated by the network entity; and the determining comprises determining whether remaining uplink transmissions are based on a same type of COT as indicated for the first uplink transmission; or the DCI includes the indication for each one of the plurality of uplink transmissions in the UE, and the determining comprises determining according to one or more predefined rules associated with the DCI.

[0125] Clause 29: The method of Clause 28, wherein the DCI includes the indication for only the first uplink transmission of the plurality of uplink transmissions.

[0126] Clause 30: The method of Clause 29, further comprising receiving the remaining uplink transmissions based on the same type of COT as indicated for the first uplink transmission.

[0127] Clause 31: The method of Clause 29, wherein the determining comprises determining the uplink transmissions are based on the COT initiated by the UE when: the first one of the plurality of uplink transmissions is aligned with a boundary of a fixed frame period (FFP) of the UE, and the DCI indicates a requirement for the COT initiated by the UE.

[0128] Clause 32: The method of Clause 29, wherein the determining comprises determining the uplink transmissions are based on the COT initiated by the network entity when the DCI indicates a requirement for the UE to use the COT initiated by the network entity for the first one of the plurality of uplink transmissions.

[0129] Clause 33: The method of Clause 28, further comprising determining whether the first uplink transmission, of the plurality of uplink transmissions, is based on a COT initiated by the UE or a COT initiated by the network entity according to a predefined rule when the first uplink transmission of the plurality of uplink transmissions starts after a UE fixed frame period (FFP) boundary and ends before a next idle period of the UE FFP.

[0130] Clause 34: The method of Clause 33, further comprising using the COT initiated by the network entity in the first uplink transmission of the plurality of uplink transmissions when: the first uplink transmission of the plurality of uplink transmissions is within a fixed frame period (FFP) of the network entity before an idle period, the UE determines that the network entity has initiated the COT, and the UE has not initiated the FFP of the UE.

[0131] Clause 35: The method of Clause 33, further comprising: using the COT to be initiated by the UE when the following conditions are met: the UE has initiated the FFP of the UE, and at least one of the plurality of uplink transmissions is before a next idle period of the UE FFP; and removing other conflicting portions of the plurality of uplink transmissions colliding with the next idle period.

[0132] Clause 36: The method of Clause 28, further comprising determining the uplink transmissions are based on a COT initiated by the UE disregarding scheduling by the received DCI.

[0133] Clause 37: The method of Clause 28, wherein the DCI includes the indication for each one of the plurality of uplink transmissions in the UE, wherein the determining

comprises determining according to one or more predefined rules associated with the DCI.

[0134] Clause 38: The method of Clause 37, wherein determining according to the one or more predefined rules associated with the DCI comprises determining the uplink transmissions are based on a COT initiated by the UE for each uplink transmission aligned with a boundary of a fixed frame period (FFP) of the UE when the DCI indicates a requirement for the UE to initiate the UE COT.

[0135] Clause 39: The method of Clause 37, wherein determining according to the one or more predefined rules associated with the DCI comprises determining each of the plurality of uplink transmissions to be associated with a COT separately indicated by the DCI scheduling.

[0136] Clause 40: The method of Clause 37, further comprising determining whether one uplink transmission, of the plurality of uplink transmissions, that starts after a UE FFP boundary and before a next idle period of the UE FFP is based on a COT initiated by the UE or a COT initiated by the network entity according to a predefined rule.

[0137] Clause 41: The method of Clause 40, wherein the determining comprises determining the plurality of uplink transmissions are based on a UE initiated COT when the UE has initiated the UE FFP.

[0138] Clause 42: The method of Clause 40, wherein the determining comprises determining one of the plurality of uplink transmissions are based on a COT initiated by the network entity when the one of the plurality of uplink transmissions is within a network FFP before a next idle period of the network FFP and when the UE has determined that the network entity has initiated the network FFP.

[0139] Clause 43: The method of Clause 37, wherein the determining comprises determining the plurality of uplink transmissions are based on a most recently scheduled COT when the plurality of uplink transmissions are not aligned with the UE FFP boundary.

[0140] Clause 44: The method of Clause 37, further comprising removing one or more of the plurality of uplink transmissions at least partially overlapping with an idle period of the UE FFP.

[0141] Clause 45: The method of Clause 28, further comprising transmitting to the UE signaling indicating whether remaining uplink transmissions are based on the same type of COT as indicated for the first uplink transmission.

[0142] Clause 46: The method of Clause 26, further comprising canceling a previous uplink transmission and performing LBT before a next uplink transmission based on a COT initiated by the UE when a timeline comparison between the DCI and the previous uplink transmission satisfies a cancellation timeline and when the previous uplink transmission and the next uplink transmission are not separated by a gap.

[0143] Clause 47: The method of Clause 46, further comprising receiving the plurality of uplink transmissions based on COT initiated by the network entity when the timeline comparison between the DCI and the previous uplink transmission does not satisfy a cancellation timeline.

[0144] Clause 48: The method of Clause 26, further comprising receiving the plurality of uplink transmissions based on the COT initiated by the network entity only.

[0145] Clause 49: An apparatus, comprising: a memory comprising executable instructions; one or more processors configured to execute the executable instructions and cause the apparatus to perform a method in accordance with any one of Clauses 1-25.

[0146] Clause 50: An apparatus, comprising means for performing a method in accordance with any one of Clauses 1-25.

[0147] Clause 51: A non-transitory computer-readable medium comprising executable instructions that, when executed by one or more processors of an apparatus, cause the apparatus to perform a method in accordance with any one of Clauses 1-25.

[0148] Clause 52: A computer program product embodied on a computer-readable storage medium comprising code for performing a method in accordance with any one of Clauses 1-25.

[0149] Clause 53: An apparatus, comprising: a memory comprising executable instructions; one or more processors configured to execute the executable instructions and cause the apparatus to perform a method in accordance with any one of Clauses 25-48.

[0150] Clause 54: An apparatus, comprising means for performing a method in accordance with any one of Clauses 25-48.

[0151] Clause 55: A non-transitory computer-readable medium comprising executable instructions that, when executed by one or more processors of an apparatus, cause the apparatus to perform a method in accordance with any one of Clauses 25-48.

[0152] Clause 56: A computer program product embodied on a computer-readable storage medium comprising code for performing a method in accordance with any one of Clauses 25-48.

Additional Wireless Communication Network Considerations

[0153] The techniques and methods described herein may be used for various wireless communications networks (or wireless wide area network (WWAN)) and radio access technologies (RATs). While aspects may be described herein using terminology commonly associated with 3G, 4G, and/or 5G (e.g., 5G new radio (NR)) wireless technologies, aspects of the present disclosure may likewise be applicable to other communication systems and standards not explicitly mentioned herein.

[0154] 5G wireless communication networks may support various advanced wireless communication services, such as enhanced mobile broadband (eMBB), millimeter wave (mmWave), machine type communications (MTC), and/or mission critical targeting ultra-reliable, low-latency communications (URLLC). These services, and others, may include latency and reliability requirements.

[0155] Returning to **FIG. 1**, various aspects of the present disclosure may be performed within the example wireless communication network 100.

[0156] In 3GPP, the term “cell” can refer to a coverage area of a NodeB and/or a narrowband subsystem serving this coverage area, depending on the context in which the term is used. In NR systems, the term “cell” and BS, next generation NodeB (gNB or gNodeB), access point (AP), distributed unit (DU), carrier, or transmission reception point may be used interchangeably. A BS may provide communication coverage for a macro cell, a pico cell, a femto cell, and/or other types of cells.

[0157] A macro cell may generally cover a relatively large geographic area (e.g., several kilometers in radius) and may allow unrestricted access by UEs with service subscription. A pico cell may cover a relatively small geographic area (e.g., a sports stadium) and may allow unrestricted access by UEs with service subscription. A femto cell may cover a relatively small geographic area (e.g., a home) and may allow restricted

access by UEs having an association with the femto cell (e.g., UEs in a Closed Subscriber Group (CSG) and UEs for users in the home). A BS for a macro cell may be referred to as a macro BS. A BS for a pico cell may be referred to as a pico BS. A BS for a femto cell may be referred to as a femto BS, home BS, or a home NodeB.

[0158] 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., an S1 interface). Base stations 102 configured for 5G (e.g., 5G NR or Next Generation RAN (NG-RAN)) may interface with 5GC 190 through second backhaul links 184. Base stations 102 may communicate directly or indirectly (e.g., through the EPC 160 or 5GC 190) with each other over third backhaul links 134 (e.g., X2 interface). Third backhaul links 134 may generally be wired or wireless.

[0159] 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. Small cell 102', employing NR in an unlicensed frequency spectrum, may boost coverage to and/or increase capacity of the access network.

[0160] Some base stations, such as gNB 180 may operate in a traditional sub-6 GHz spectrum, in millimeter wave (mmWave) frequencies, and/or near mmWave frequencies in communication with the UE 104. When the gNB 180 operates in mmWave or near mmWave frequencies, the gNB 180 may be referred to as an mmWave base station.

[0161] The communication links 120 between base stations 102 and, for example, UEs 104, may be through one or more carriers. For example, base stations 102 and UEs 104 may use spectrum up to Y MHz (e.g., 5, 10, 15, 20, 100, 400, and other 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).

[0162] Wireless communications system 100 further includes a Wi-Fi access point (AP) 150 in communication with Wi-Fi stations (STAs) 152 via communication links 154 in, for example, a 2.4 GHz and/or 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.

[0163] Certain UEs 104 may communicate with each other using device-to-device (D2D) communication link 158. The D2D communication link 158 may use the DL/UL WWAN spectrum. The D2D communication link 158 may use one or more sidelink channels, such as a physical sidelink broadcast channel (PSBCH), a physical sidelink discovery channel (PSDCH), a physical sidelink shared channel (PSSCH), and a physical sidelink control channel (PSCCH). D2D communication may be through a variety of wireless D2D communications systems, such as for example, FlashLinQ, WiMedia, Bluetooth, ZigBee, Wi-Fi based on the IEEE 802.11 standard, 4G (e.g., LTE), or 5G (e.g., NR), to name a few options.

[0164] 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. MME 162 may be in communication with a Home Subscriber Server (HSS) 174. MME 162 is the control node that processes the signaling between the UEs 104 and the EPC 160. Generally, MME 162 provides bearer and connection management.

[0165] Generally, user Internet protocol (IP) packets are transferred through Serving Gateway 166, which itself is connected to PDN Gateway 172. PDN Gateway 172 provides UE IP address allocation as well as other functions. PDN Gateway 172 and the BM-SC 170 are connected to the IP Services 176, which may include, for example, the Internet, an intranet, an IP Multimedia Subsystem (IMS), a PS Streaming Service, and/or other IP services.

[0166] BM-SC 170 may provide functions for MBMS user service provisioning and delivery. 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.

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.

[0167] 5GC 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. AMF 192 may be in communication with a Unified Data Management (UDM) 196.

[0168] AMF 192 is generally the control node that processes the signaling between UEs 104 and 5GC 190. Generally, AMF 192 provides QoS flow and session management.

[0169] All user Internet protocol (IP) packets are transferred through UPF 195, which is connected to the IP Services 197, and which provides UE IP address allocation as well as other functions for 5GC 190. IP Services 197 may include, for example, the Internet, an intranet, an IP Multimedia Subsystem (IMS), a PS Streaming Service, and/or other IP services.

[0170] Returning to **FIG. 2**, various example components of BS 102 and UE 104 (e.g., the wireless communication network 100 of **FIG. 1**) are depicted, which may be used to implement aspects of the present disclosure.

[0171] At BS 102, a transmit processor 220 may receive data from a data source 212 and control information from a controller/processor 240. The control information may be for the physical broadcast channel (PBCH), physical control format indicator channel (PCFICH), physical hybrid ARQ indicator channel (PHICH), physical downlink control channel (PDCCH), group common PDCCH (GC PDCCH), and others. The data may be for the physical downlink shared channel (PDSCH), in some examples.

[0172] A medium access control (MAC)-control element (MAC-CE) is a MAC layer communication structure that may be used for control command exchange between wireless nodes. The MAC-CE may be carried in a shared channel such as a physical downlink shared channel (PDSCH), a physical uplink shared channel (PUSCH), or a physical sidelink shared channel (PSSCH).

[0173] Processor 220 may process (e.g., encode and symbol map) the data and control information to obtain data symbols and control symbols, respectively. Transmit processor 220 may also generate reference symbols, such as for the primary synchronization signal

(PSS), secondary synchronization signal (SSS), PBCH demodulation reference signal (DMRS), and channel state information reference signal (CSI-RS).

[0174] Transmit (TX) multiple-input multiple-output (MIMO) processor 230 may perform spatial processing (e.g., precoding) on the data symbols, the control symbols, and/or the reference symbols, if applicable, and may provide output symbol streams to the modulators (MODs) in transceivers 232a-232t. Each modulator in transceivers 232a-232t may process a respective output symbol stream (e.g., for OFDM) to obtain an output sample stream. Each modulator may further process (e.g., convert to analog, amplify, filter, and upconvert) the output sample stream to obtain a downlink signal. Downlink signals from the modulators in transceivers 232a-232t may be transmitted via the antennas 234a-234t, respectively.

[0175] At UE 104, antennas 252a-252r may receive the downlink signals from the BS 102 and may provide received signals to the demodulators (DEMOS) in transceivers 254a-254r, respectively. Each demodulator in transceivers 254a-254r may condition (e.g., filter, amplify, downconvert, and digitize) a respective received signal to obtain input samples. Each demodulator may further process the input samples (e.g., for OFDM) to obtain received symbols.

[0176] MIMO detector 256 may obtain received symbols from all the demodulators in transceivers 254a-254r, perform MIMO detection on the received symbols if applicable, and provide detected symbols. Receive processor 258 may process (e.g., demodulate, deinterleave, and decode) the detected symbols, provide decoded data for the UE 104 to a data sink 260, and provide decoded control information to a controller/processor 280.

[0177] On the uplink, at UE 104, transmit processor 264 may receive and process data (e.g., for the physical uplink shared channel (PUSCH)) from a data source 262 and control information (e.g., for the physical uplink control channel (PUCCH)) from the controller/processor 280. Transmit processor 264 may also generate reference symbols for a reference signal (e.g., for the sounding reference signal (SRS)). The symbols from the transmit processor 264 may be precoded by a TX MIMO processor 266 if applicable, further processed by the modulators in transceivers 254a-254r (e.g., for SC-FDM), and transmitted to BS 102.

[0178] At BS 102, the uplink signals from UE 104 may be received by antennas 234a-t, processed by the demodulators in transceivers 232a-232t, detected by a MIMO detector 236 if applicable, and further processed by a receive processor 238 to obtain decoded data and control information sent by UE 104. Receive processor 238 may provide the decoded data to a data sink 239 and the decoded control information to the controller/processor 240.

[0179] Memories 242 and 282 may store data and program codes for BS 102 and UE 104, respectively.

[0180] Scheduler 244 may schedule UEs for data transmission on the downlink and/or uplink.

[0181] 5G may utilize orthogonal frequency division multiplexing (OFDM) with a cyclic prefix (CP) on the uplink and downlink. 5G may also support half-duplex operation using time division duplexing (TDD). OFDM and single-carrier frequency division multiplexing (SC-FDM) partition the system bandwidth into multiple orthogonal subcarriers, which are also commonly referred to as tones and bins. Each subcarrier may be modulated with data. Modulation symbols may be sent in the frequency domain with OFDM and in the time domain with SC-FDM. The spacing between adjacent subcarriers may be fixed, and the total number of subcarriers may be dependent on the system bandwidth. The minimum resource allocation, called a resource block (RB), may be 12 consecutive subcarriers in some examples. The system bandwidth may also be partitioned into subbands. For example, a subband may cover multiple RBs. NR may support a base subcarrier spacing (SCS) of 15 KHz and other SCS may be defined with respect to the base SCS (e.g., 30 kHz, 60 kHz, 120 kHz, 240 kHz, and others).

[0182] As above, **FIGS. 3A-3D** depict various example aspects of data structures for a wireless communication network, such as wireless communication network 100 of **FIG. 1**.

[0183] In various aspects, the 5G frame structure may be frequency division duplex (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. 5G frame structures may also be time division duplex (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. 3A** and **3C**, the 5G 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 below applies also to a 5G frame structure that is TDD.

[0184] 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. In some examples, each slot may include 7 or 14 symbols, depending on the slot configuration.

[0185] For example, 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).

[0186] 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 $2^\mu \times 15$ kHz, where μ is the numerology 0 to 5. As such, the numerology $\mu = 0$ has a subcarrier spacing of 15 kHz and the numerology $\mu = 5$ has a subcarrier spacing of 480 kHz. The symbol length/duration is inversely related to the subcarrier spacing. **FIGS. 3A-3D** provide an example of slot configuration 0 with 14 symbols per slot and numerology $\mu = 2$ 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 μ s.

[0187] 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.

[0188] As illustrated in **FIG. 3A**, some of the REs carry reference (pilot) signals (RS) for a UE (e.g., UE 104 of **FIGS. 1** and **2**). The RS may include demodulation RS (DM-RS) (indicated as Rx 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).

[0189] **FIG. 3B** 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.

[0190] A primary synchronization signal (PSS) may be within symbol 2 of particular subframes of a frame. The PSS is used by a UE (e.g., 104 of **FIGS. 1** and **2**) to determine subframe/symbol timing and a physical layer identity.

[0191] 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.

[0192] 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.

[0193] As illustrated in **FIG. 3C**, 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.

[0194] **FIG. 3D** illustrates an example of various UL channels within a subframe of a frame. The PUCCH may be located as indicated in one configuration. The PUCCH carries uplink control information (UCI), such as scheduling requests, a channel quality indicator (CQI), a precoding matrix indicator (PMI), a rank indicator (RI), and HARQ ACK/NACK feedback. The PUSCH carries data, and may additionally be used to carry a buffer status report (BSR), a power headroom report (PHR), and/or UCI.

Additional Considerations

[0195] The preceding description provides examples of exchanging transmission-reception-point (TRP) information in communication systems. The preceding description is provided to enable any person skilled in the art to practice the various aspects described herein. The examples discussed herein are not limiting of the scope, applicability, or aspects set forth in the claims. 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. For example, changes may be made in the function and arrangement of elements discussed without departing from the scope of the disclosure. Various examples may omit, substitute, or add various procedures or components as appropriate. For instance, the methods described may be performed in an order different from that described, and various steps may be added, omitted, or combined. Also, features described with respect to some examples may be combined in some other examples. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, the scope of the disclosure is intended to cover such an apparatus or method that is practiced using other structure, functionality,

or structure and functionality in addition to, or other than, the various aspects of the disclosure set forth herein. It should be understood that any aspect of the disclosure disclosed herein may be embodied by one or more elements of a claim.

[0196] The techniques described herein may be used for various wireless communication technologies, such as 5G (e.g., 5G NR), 3GPP Long Term Evolution (LTE), LTE-Advanced (LTE-A), code division multiple access (CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal frequency division multiple access (OFDMA), single-carrier frequency division multiple access (SC-FDMA), time division synchronous code division multiple access (TD-SCDMA), and other networks. The terms “network” and “system” are often used interchangeably. A CDMA network may implement a radio technology such as Universal Terrestrial Radio Access (UTRA), cdma2000, and others. UTRA includes Wideband CDMA (WCDMA) and other variants of CDMA. cdma2000 covers IS-2000, IS-95 and IS-856 standards. A TDMA network may implement a radio technology such as Global System for Mobile Communications (GSM). An OFDMA network may implement a radio technology such as NR (e.g. 5G RA), Evolved UTRA (E-UTRA), Ultra Mobile Broadband (UMB), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDMA, and others. UTRA and E-UTRA are part of Universal Mobile Telecommunication System (UMTS). LTE and LTE-A are releases of UMTS that use E-UTRA. UTRA, E-UTRA, UMTS, LTE, LTE-A and GSM are described in documents from an organization named “3rd Generation Partnership Project” (3GPP). cdma2000 and UMB are described in documents from an organization named “3rd Generation Partnership Project 2” (3GPP2). NR is an emerging wireless communications technology under development.

[0197] The various illustrative logical blocks, modules and circuits described in connection with the present disclosure may be implemented or performed with a general purpose processor, a DSP, an ASIC, a field programmable gate array (FPGA) or other programmable logic device (PLD), discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any commercially available processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of

microprocessors, one or more microprocessors in conjunction with a DSP core, a system on a chip (SoC), or any other such configuration.

[0198] If implemented in hardware, an example hardware configuration may comprise a processing system in a wireless node. The processing system may be implemented with a bus architecture. The bus may include any number of interconnecting buses and bridges depending on the specific application of the processing system and the overall design constraints. The bus may link together various circuits including a processor, machine-readable media, and a bus interface. The bus interface may be used to connect a network adapter, among other things, to the processing system via the bus. The network adapter may be used to implement the signal processing functions of the PHY layer. In the case of a user equipment (see FIG. 1), a user interface (e.g., keypad, display, mouse, joystick, touchscreen, biometric sensor, proximity sensor, light emitting element, and others) may also be connected to the bus. The bus may also link various other circuits such as timing sources, peripherals, voltage regulators, power management circuits, and the like, which are well known in the art, and therefore, will not be described any further. The processor may be implemented with one or more general-purpose and/or special-purpose processors. Examples include microprocessors, microcontrollers, DSP processors, and other circuitry that can execute software. Those skilled in the art will recognize how best to implement the described functionality for the processing system depending on the particular application and the overall design constraints imposed on the overall system.

[0199] If implemented in software, the functions may be stored or transmitted over as one or more instructions or code on a computer readable medium. Software shall be construed broadly to mean instructions, data, or any combination thereof, whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. Computer-readable media include both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. The processor may be responsible for managing the bus and general processing, including the execution of software modules stored on the machine-readable storage media. A computer-readable storage medium may be coupled to a processor such that the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. By way of example, the machine-readable media may include a transmission

line, a carrier wave modulated by data, and/or a computer readable storage medium with instructions stored thereon separate from the wireless node, all of which may be accessed by the processor through the bus interface. Alternatively, or in addition, the machine-readable media, or any portion thereof, may be integrated into the processor, such as the case may be with cache and/or general register files. Examples of machine-readable storage media may include, by way of example, RAM (Random Access Memory), flash memory, ROM (Read Only Memory), PROM (Programmable Read-Only Memory), EPROM (Erasable Programmable Read-Only Memory), EEPROM (Electrically Erasable Programmable Read-Only Memory), registers, magnetic disks, optical disks, hard drives, or any other suitable storage medium, or any combination thereof. The machine-readable media may be embodied in a computer-program product.

[0200] A software module may comprise a single instruction, or many instructions, and may be distributed over several different code segments, among different programs, and across multiple storage media. The computer-readable media may comprise a number of software modules. The software modules include instructions that, when executed by an apparatus such as a processor, cause the processing system to perform various functions. The software modules may include a transmission module and a receiving module. Each software module may reside in a single storage device or be distributed across multiple storage devices. By way of example, a software module may be loaded into RAM from a hard drive when a triggering event occurs. During execution of the software module, the processor may load some of the instructions into cache to increase access speed. One or more cache lines may then be loaded into a general register file for execution by the processor. When referring to the functionality of a software module below, it will be understood that such functionality is implemented by the processor when executing instructions from that software module.

[0201] As used herein, the word “exemplary” means “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.

[0202] As used herein, a phrase referring to “at least one of” a list of items refers to any combination of those items, including single members. As an example, “at least one of: a, b, or c” is intended to cover a, b, c, a-b, a-c, b-c, and a-b-c, as well as any combination with multiples of the same element (e.g., a-a, a-a-a, a-a-b, a-a-c, a-b-b, a-c-c, b-b, b-b-b, b-b-c, c-c, and c-c-c or any other ordering of a, b, and c).

[0203] As used herein, the term “determining” encompasses a wide variety of actions. For example, “determining” may include calculating, computing, processing, deriving, investigating, looking up (e.g., looking up in a table, a database or another data structure), ascertaining and the like. Also, “determining” may include receiving (e.g., receiving information), accessing (e.g., accessing data in a memory) and the like. Also, “determining” may include resolving, selecting, choosing, establishing and the like.

[0204] The methods disclosed herein comprise one or more steps or actions for achieving the methods. The method steps and/or actions may be interchanged with one another without departing from the scope of the claims. In other words, unless a specific order of steps or actions is specified, the order and/or use of specific steps and/or actions may be modified without departing from the scope of the claims. Further, the various operations of methods described above may be performed by any suitable means capable of performing the corresponding functions. The means may include various hardware and/or software component(s) and/or module(s), including, but not limited to a circuit, an application specific integrated circuit (ASIC), or processor. Generally, where there are operations illustrated in figures, those operations may have corresponding counterpart means-plus-function components with similar numbering.

[0205] The following claims are not intended to be limited to the aspects shown herein, but are to be accorded the full scope consistent with the language of the claims. Within a claim, 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.” Unless specifically stated otherwise, the term “some” refers to one or more. No claim element is to be construed under the provisions of 35 U.S.C. §112(f) unless the element is expressly recited using the phrase “means for” or, in the case of a method claim, the element is recited using the phrase “step for.” 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.

WHAT IS CLAIMED IS:

1. A method for wireless communications by a user equipment (UE), comprising:
receiving from a network entity, a downlink control information (DCI) that schedules a plurality of uplink transmissions from the UE;
determining whether one or more of the plurality of uplink transmissions are based on a channel occupancy time (COT) initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity; and
transmitting the plurality of uplink transmissions in accordance with the determination.
2. The method of claim 1, wherein the plurality of uplink transmissions include at least one of: transport blocks (TBs), physical uplink initiated channel (PUSCH) repetitions, sounding reference signals (SRSs), or physical uplink control channel (PUCCH) repetitions.
3. The method of claim 1, wherein:
the DCI includes an indication of whether a first uplink transmission, of the plurality of uplink transmissions, is based on a COT initiated by the UE or a COT initiated by the network entity; and
the determining comprises determining whether remaining uplink transmissions are based on a same type of COT as indicated for the first uplink transmission.
4. The method of claim 3, wherein the DCI includes the indication for only the first uplink transmission of the plurality of uplink transmissions.
5. The method of claim 4, further comprising transmitting the remaining uplink transmissions based on the same type of COT as indicated for the first uplink transmission.

6. The method of claim 4, wherein the determining comprises determining the uplink transmissions are based on the COT initiated by the UE when:
 - the first one of the plurality of uplink transmissions is aligned with a boundary of a fixed frame period (FFP) of the UE, and
 - the DCI indicates a requirement for the COT initiated by the UE.
7. The method of claim 4, wherein the determining comprises determining the uplink transmissions are based on the COT initiated by the network entity when the DCI indicates a requirement for the UE to use the COT initiated by the network entity for the first one of the plurality of uplink transmissions.
8. The method of claim 3, further comprising determining whether the first uplink transmission, of the plurality of uplink transmissions, is based on a COT initiated by the UE or a COT initiated by the network entity according to a predefined rule when the first uplink transmission of the plurality of uplink transmissions starts after a UE fixed frame period (FFP) boundary and ends before a next idle period of the UE FFP.
9. The method of claim 8, further comprising using the COT initiated by the network entity in the first uplink transmission of the plurality of uplink transmissions when:
 - the first uplink transmission of the plurality of uplink transmissions is within a fixed frame period (FFP) of the network entity before an idle period,
 - the UE determines that the network entity has initiated the COT, and
 - the UE has not initiated the FFP of the UE.
10. The method of claim 8, further comprising:
 - using the COT to be initiated by the UE when the following conditions are met:
 - the UE has initiated the FFP of the UE, and
 - at least one of the plurality of uplink transmissions is before a next idle period of the UE FFP; and
 - removing other conflicting portions of the plurality of uplink transmissions colliding with the next idle period.

11. The method of claim 3, further comprising determining the uplink transmissions are based on a COT initiated by the UE disregarding scheduling by the received DCI.
12. The method of claim 3, wherein the DCI includes the indication for each one of the plurality of uplink transmissions in the UE, wherein the determining comprises determining according to one or more predefined rules associated with the DCI.
13. The method of claim 12, wherein determining according to the one or more predefined rules associated with the DCI comprises determining the uplink transmissions are based on a COT initiated by the UE for each uplink transmission aligned with a boundary of a fixed frame period (FFP) of the UE when the DCI indicates a requirement for the UE to initiate the UE COT.
14. The method of claim 12, wherein determining according to the one or more predefined rules associated with the DCI comprises determining each of the plurality of uplink transmissions to be associated with a COT separately indicated by the DCI scheduling.
15. The method of claim 12, further comprising determining whether one uplink transmission, of the plurality of uplink transmissions, that starts after a UE FFP boundary and before a next idle period of the UE FFP is based on a COT initiated by the UE or a COT initiated by the network entity according to a predefined rule.
16. The method of claim 15, wherein the determining comprises determining the plurality of uplink transmissions are based on a UE initiated COT when the UE has initiated the UE FFP.
17. The method of claim 15, wherein the determining comprises determining one of the plurality of uplink transmissions are based on a COT initiated by the network entity when the one of the plurality of uplink transmissions is within a network FFP before a next idle period of the network FFP and when the UE has determined that the network entity has initiated the network FFP.

18. The method of claim 12, wherein the determining comprises determining the plurality of uplink transmissions are based on a most recently scheduled COT when the plurality of uplink transmissions are not aligned with a UE FFP boundary.

19. The method of claim 12, further comprising removing one or more of the plurality of uplink transmissions at least partially overlapping with an idle period of a UE FFP.

20. The method of claim 12, further comprising initiating a COT for the plurality of uplink transmissions disregarding the COT indicated by the received DCI.

21. The method of claim 3, further comprising receiving, from the network entity, signaling indicating whether remaining uplink transmissions are based on the same type of COT as indicated for the first uplink transmission.

22. The method of claim 1, further comprising performing a listen-before-talk (LBT) when one of the plurality of uplink transmissions is aligned with a fixed frame period (FFP) boundary and a previous uplink transmission transmitted before the one of the plurality of uplink transmissions with a gap.

23. The method of claim 1, further comprising canceling a previous uplink transmission and performing LBT before a next uplink transmission based on a COT initiated by the UE when a timeline comparison between the DCI and the previous uplink transmission satisfies a cancellation timeline and when the previous uplink transmission and the next uplink transmission are not separated by a gap.

24. The method of claim 23, further comprising transmitting the plurality of uplink transmissions based on COT initiated by the network entity when the timeline comparison between the DCI and the previous uplink transmission does not satisfy a cancellation timeline.

25. The method of claim 1, further comprising transmitting the plurality of uplink transmissions based on the COT initiated by the network entity only.

26. A method for wireless communications by a network entity, comprising:
transmitting to a user equipment (UE), a downlink control information (DCI) that schedules a plurality of uplink transmissions from the UE;
determining whether one or more of the plurality of uplink transmissions are based on a channel occupancy time (COT) initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity; and
receiving the plurality of uplink transmissions in accordance with the determination.
27. The method of claim 26, wherein the plurality of uplink transmissions include at least one of: transport blocks (TBs), physical uplink initiated channel (PUSCH) repetitions, sounding reference signals (SRSs), or physical uplink control channel (PUCCH) repetitions.
28. The method of claim 26, wherein:
the DCI includes an indication of whether an first uplink transmission, of the plurality of uplink transmissions, is based on a COT initiated by the UE or a COT initiated by the network entity; and the determining comprises determining whether remaining uplink transmissions are based on a same type of COT as indicated for the first uplink transmission; or
the DCI includes the indication for each one of the plurality of uplink transmissions in the UE, and the determining comprises determining according to one or more predefined rules associated with the DCI.
29. A user equipment (UE) for wireless communications, comprising:
a memory; and
a processor coupled to the memory, the processor and memory configured to:
receive from a network entity, a downlink control information (DCI) that schedules a plurality of uplink transmissions from the UE;
determine whether one or more of the plurality of uplink transmissions are based on a channel occupancy time (COT) initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity;
and
transmit the plurality of uplink transmissions in accordance with the determination.

30. A non-transitory computer readable medium storing instructions that when executed by a user equipment (UE) cause the UE to:

- receive from a network entity, a downlink control information (DCI) that schedules a plurality of uplink transmissions from the UE;
- determine whether one or more of the plurality of uplink transmissions are based on a channel occupancy time (COT) initiated by the UE, a COT initiated by the network entity, or a combination of COTs initiated by the UE and network entity; and
- transmit the plurality of uplink transmissions in accordance with the determination.

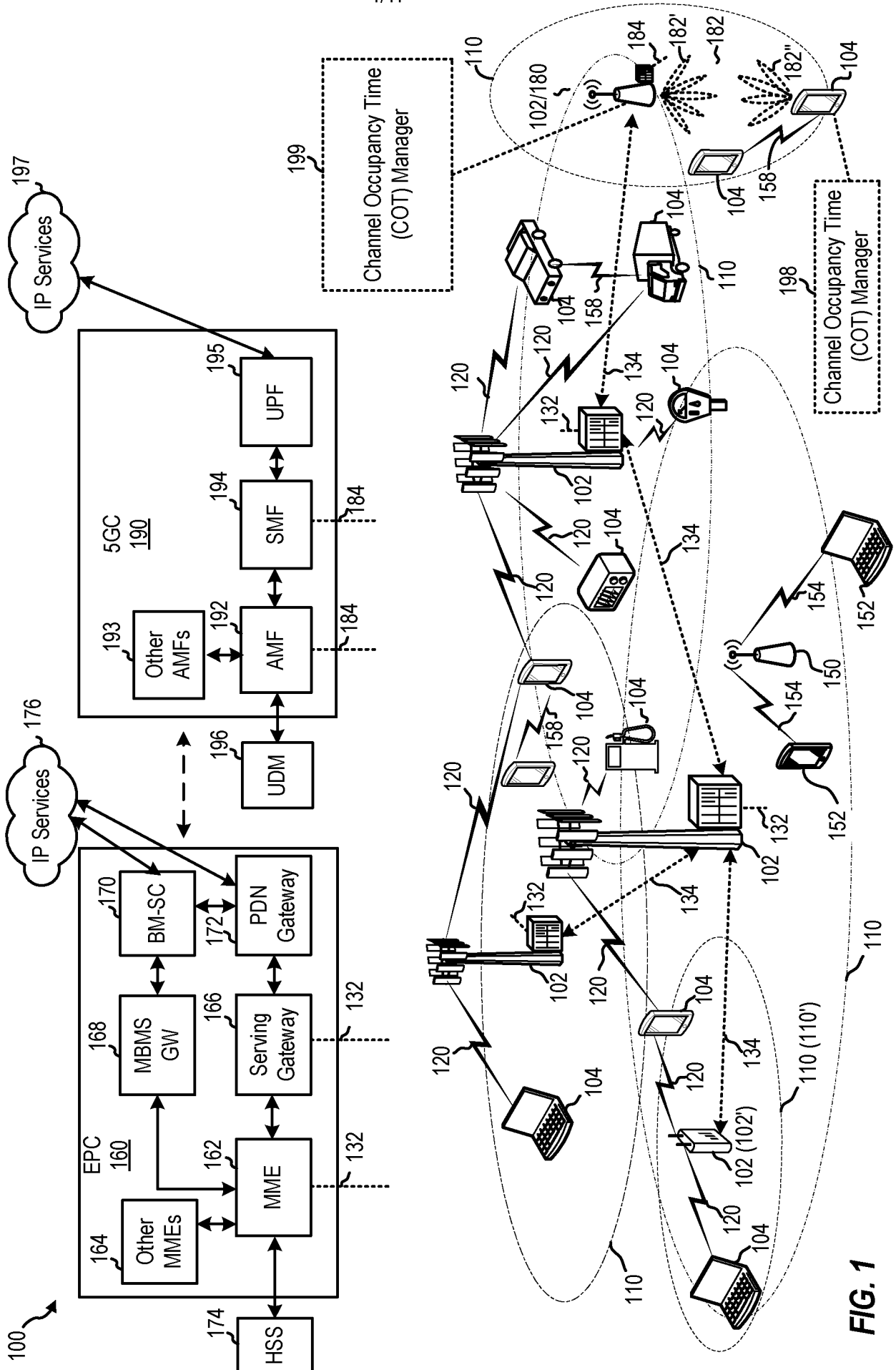


FIG. 1

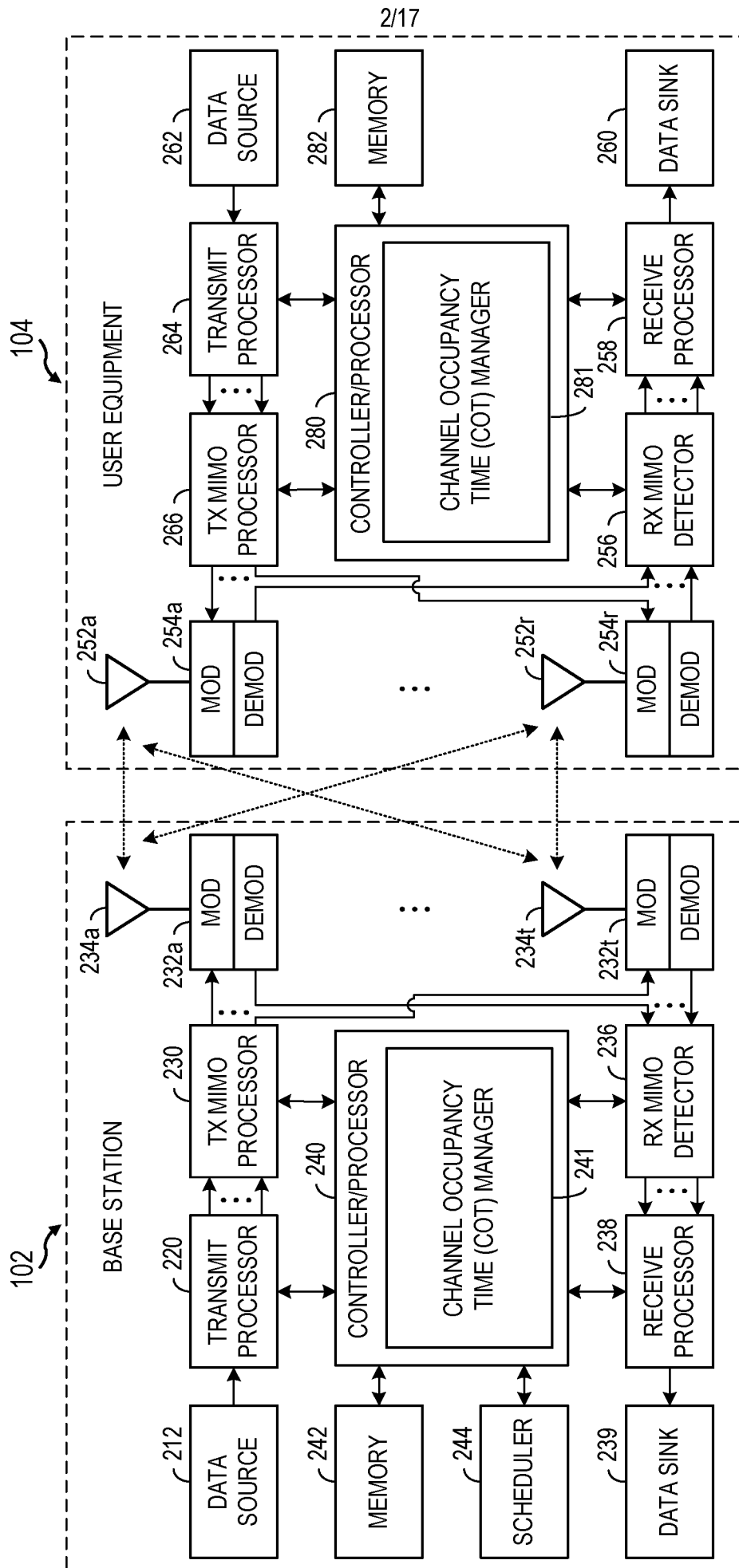
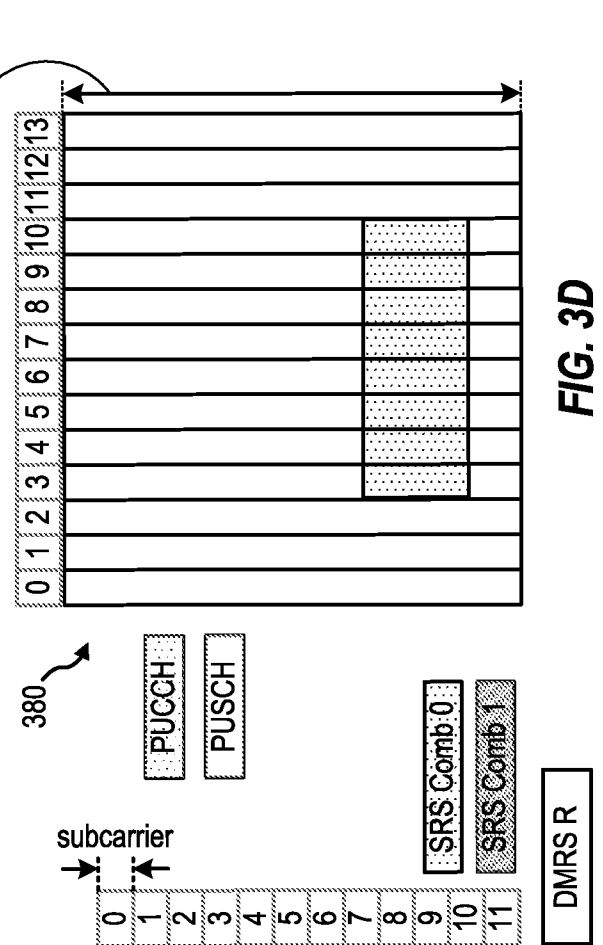
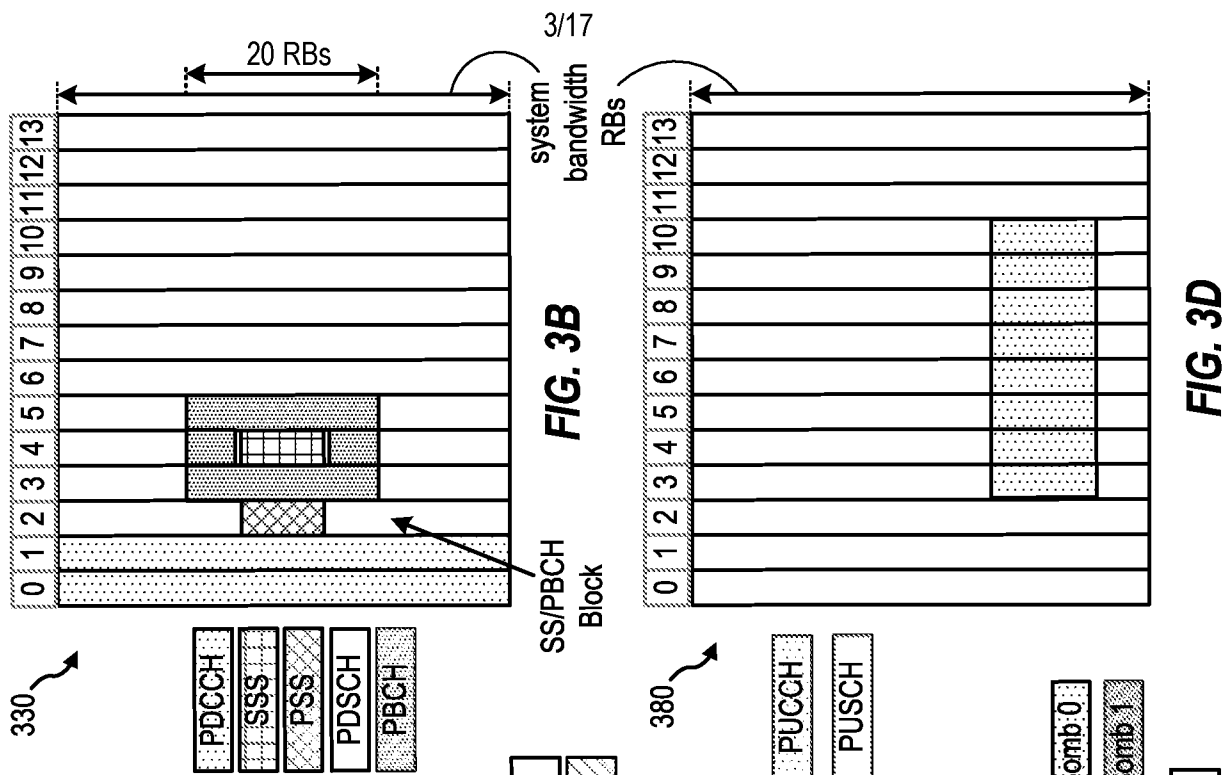
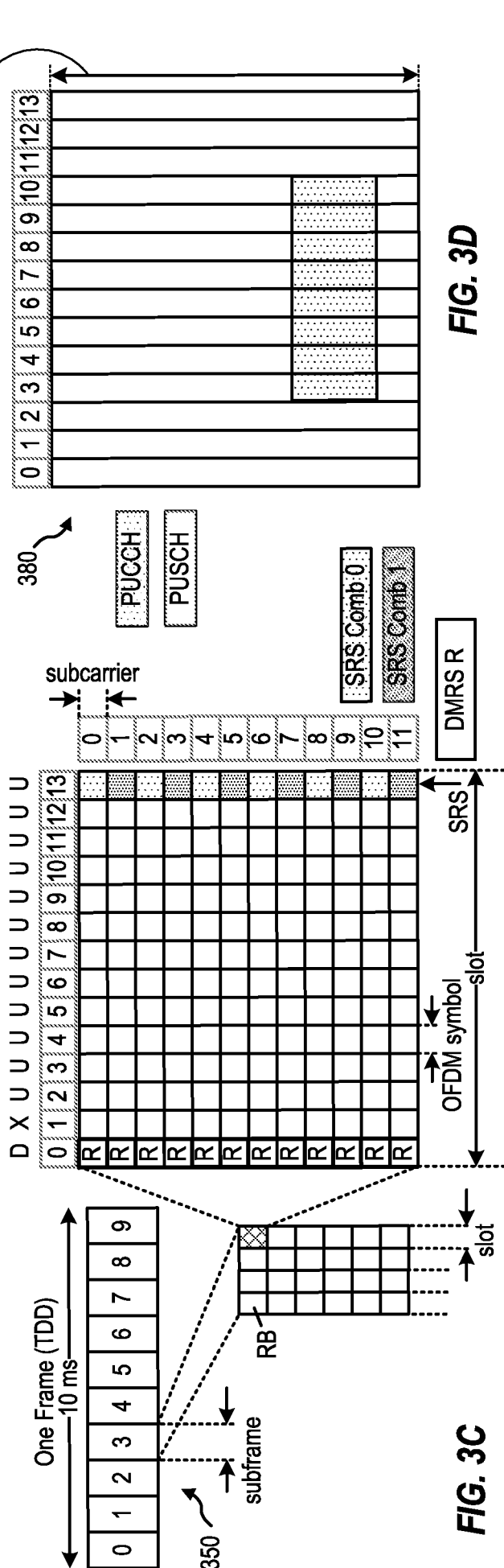
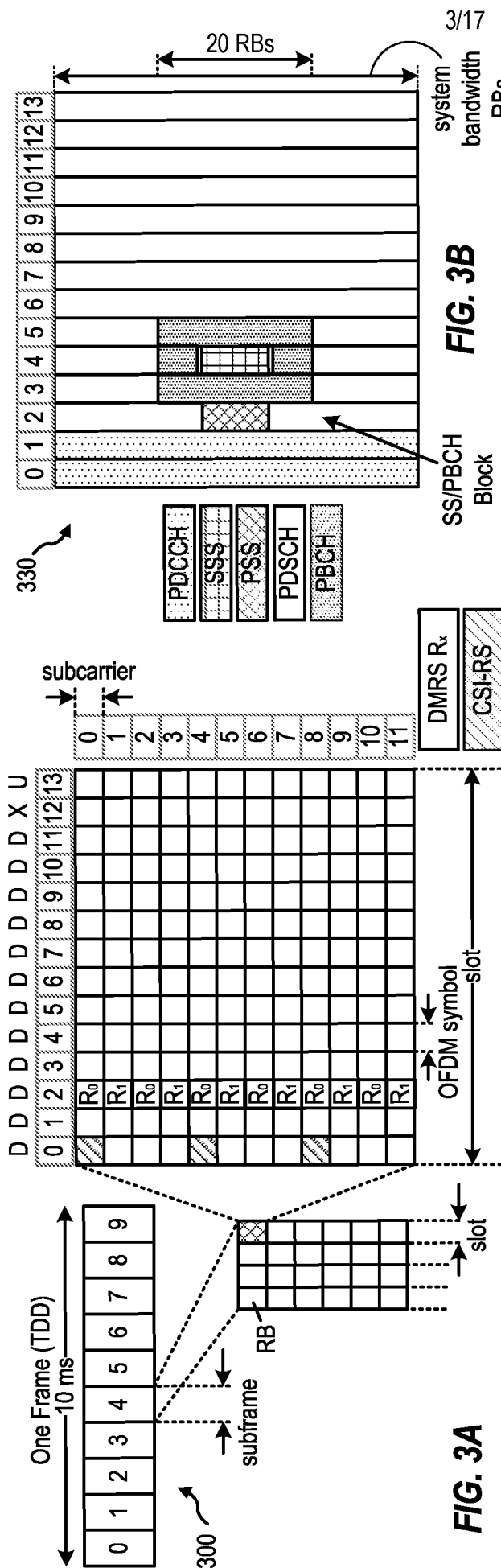
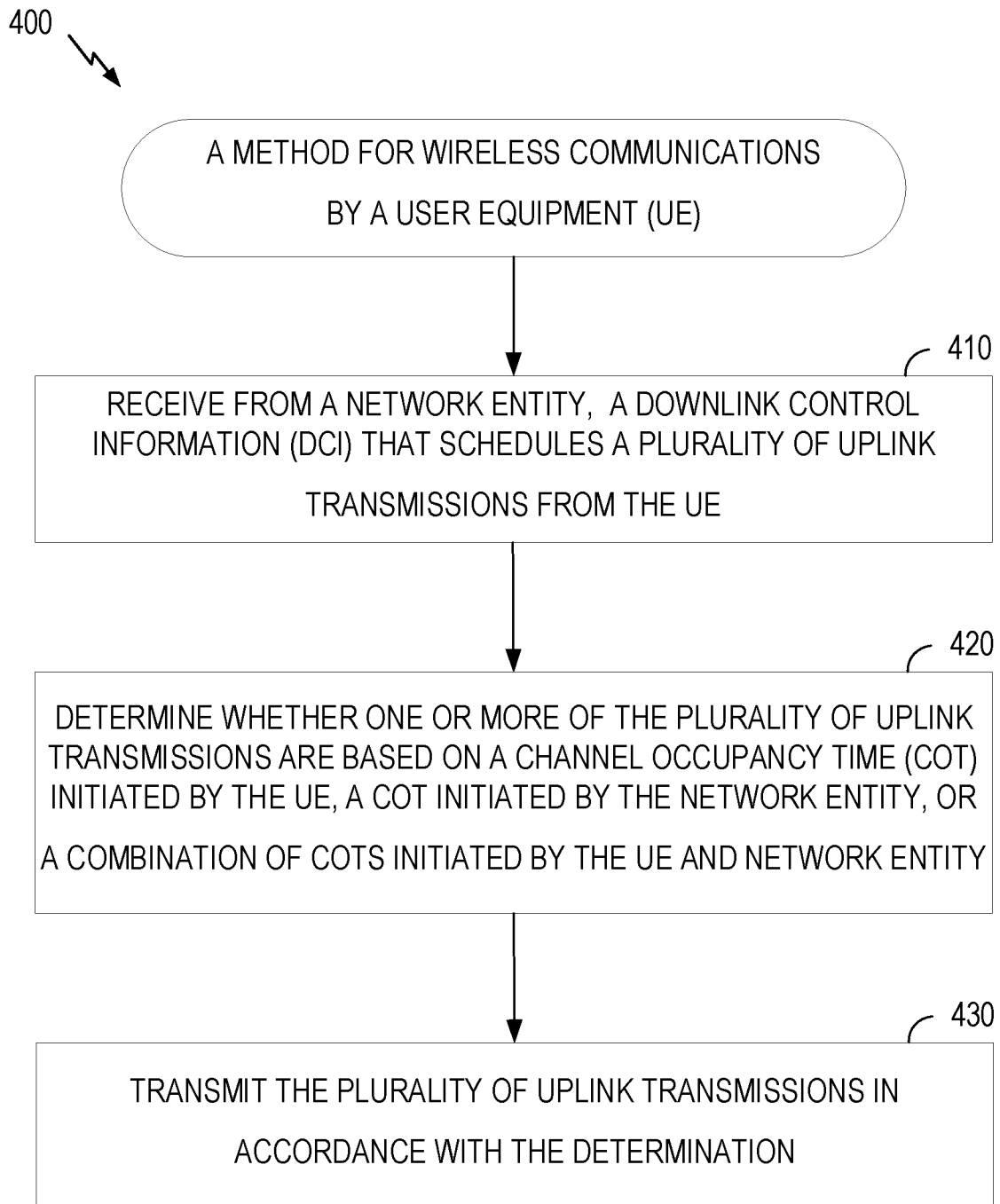


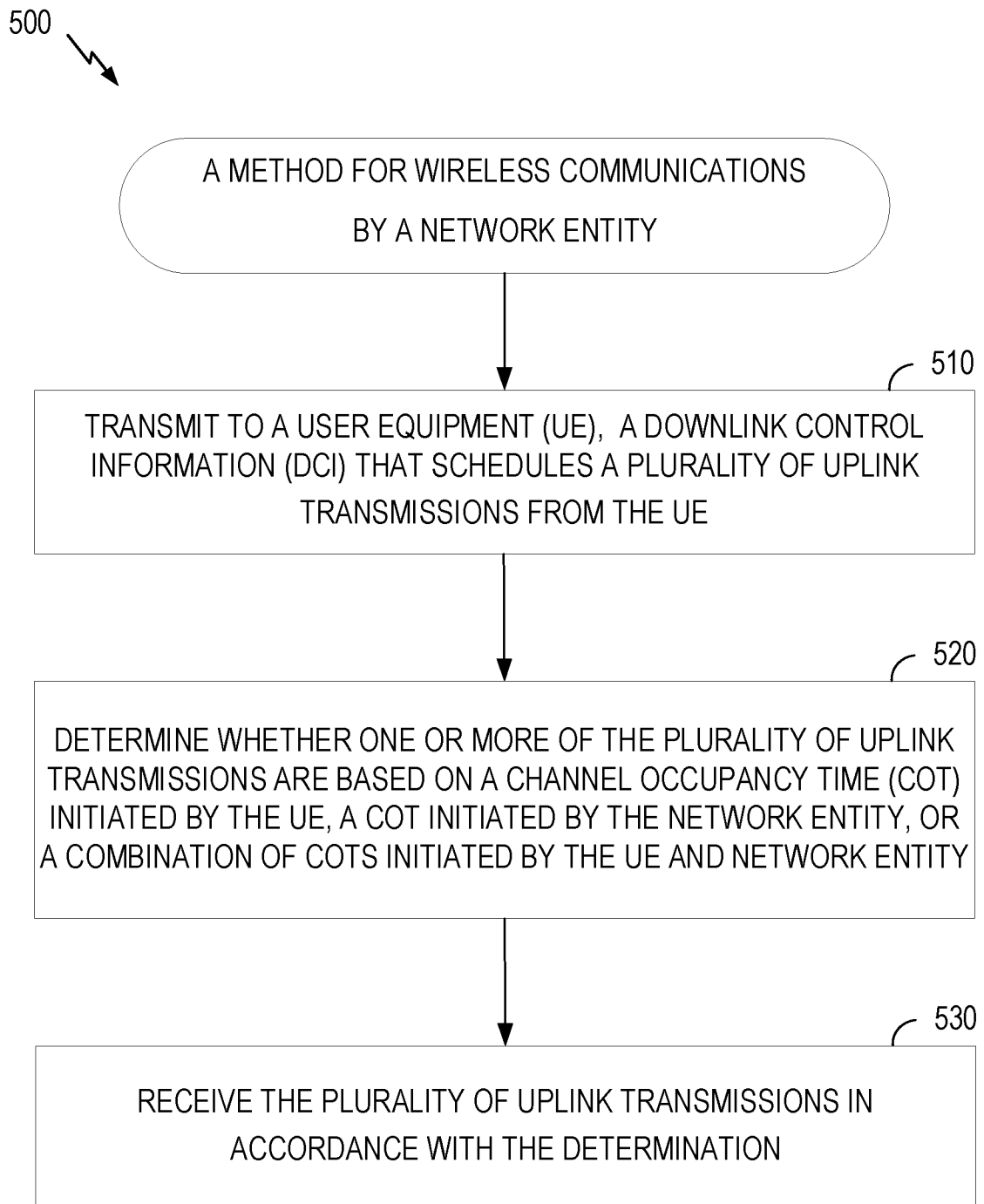
FIG. 2



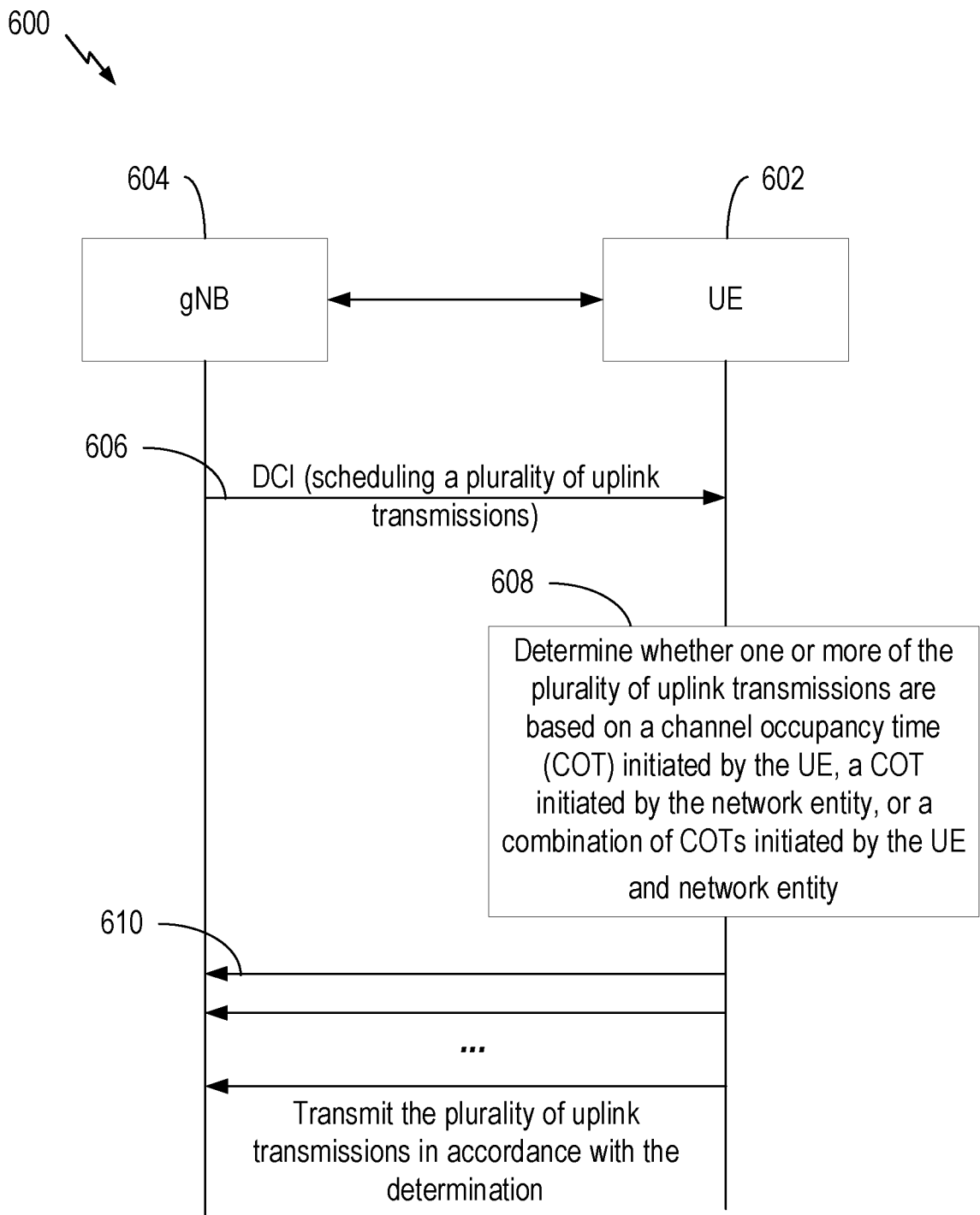
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**FIG. 4**

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**FIG. 5**

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**FIG. 6**

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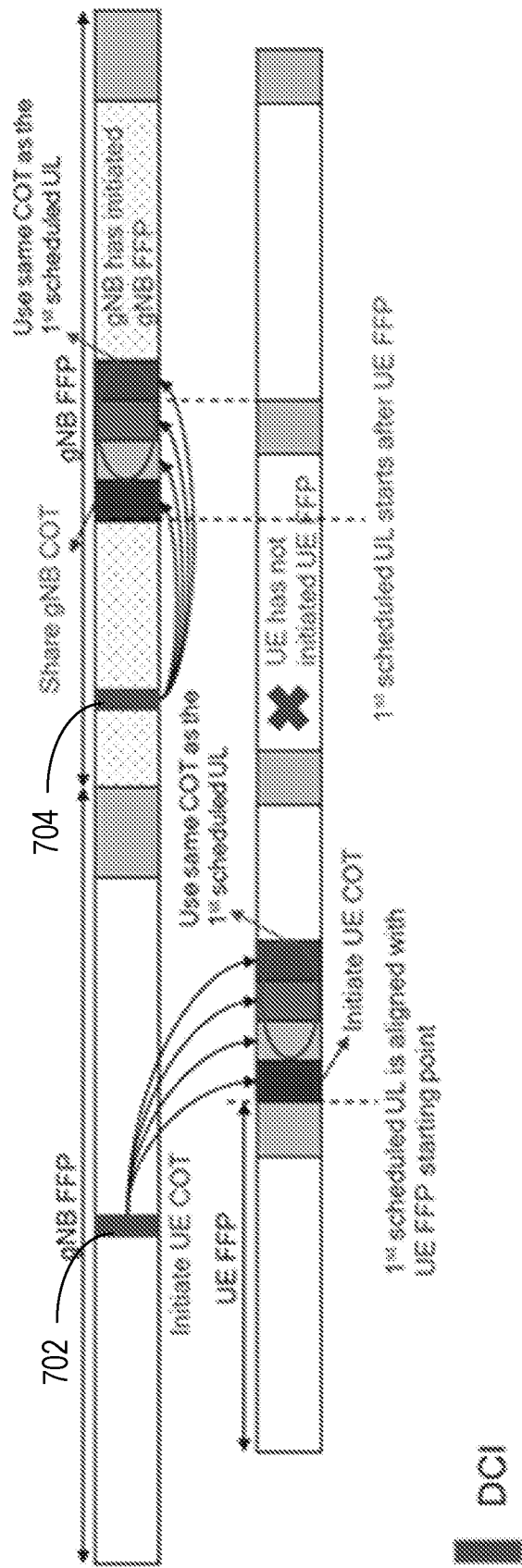


FIG. 7

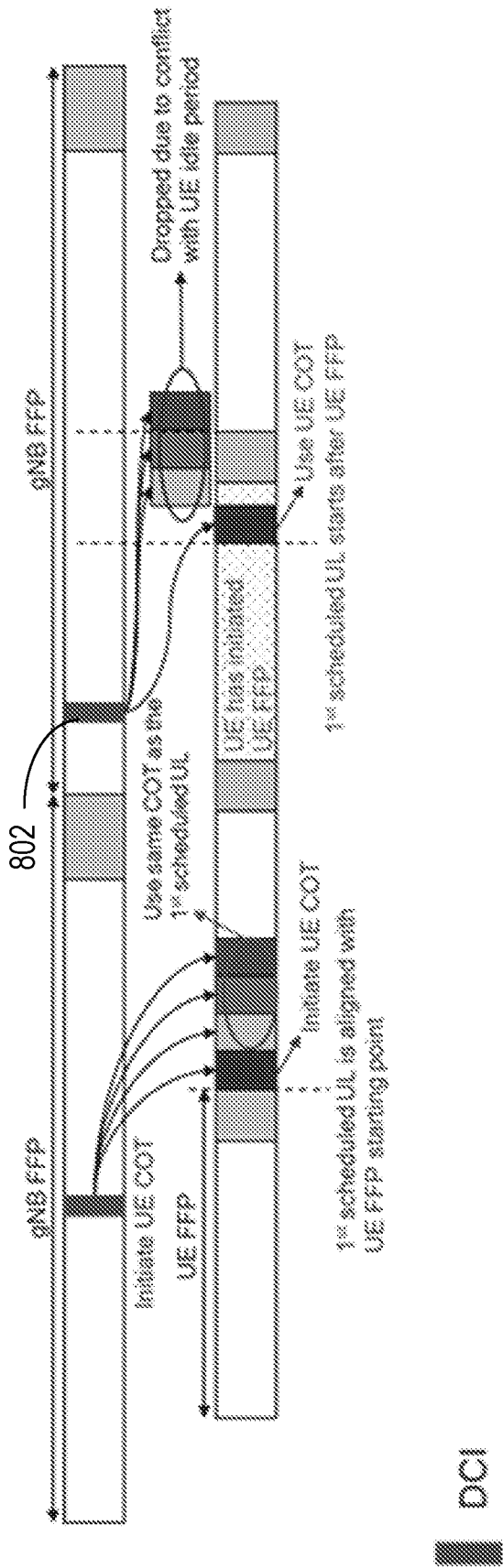


FIG. 8

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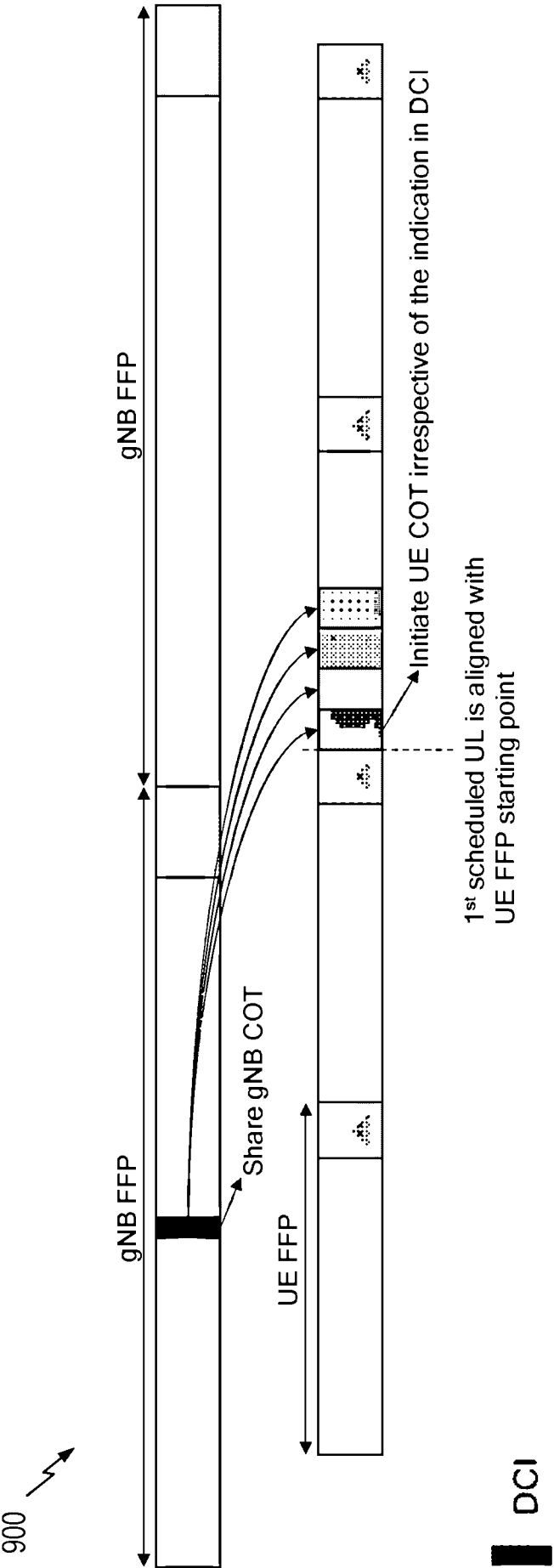


FIG. 9

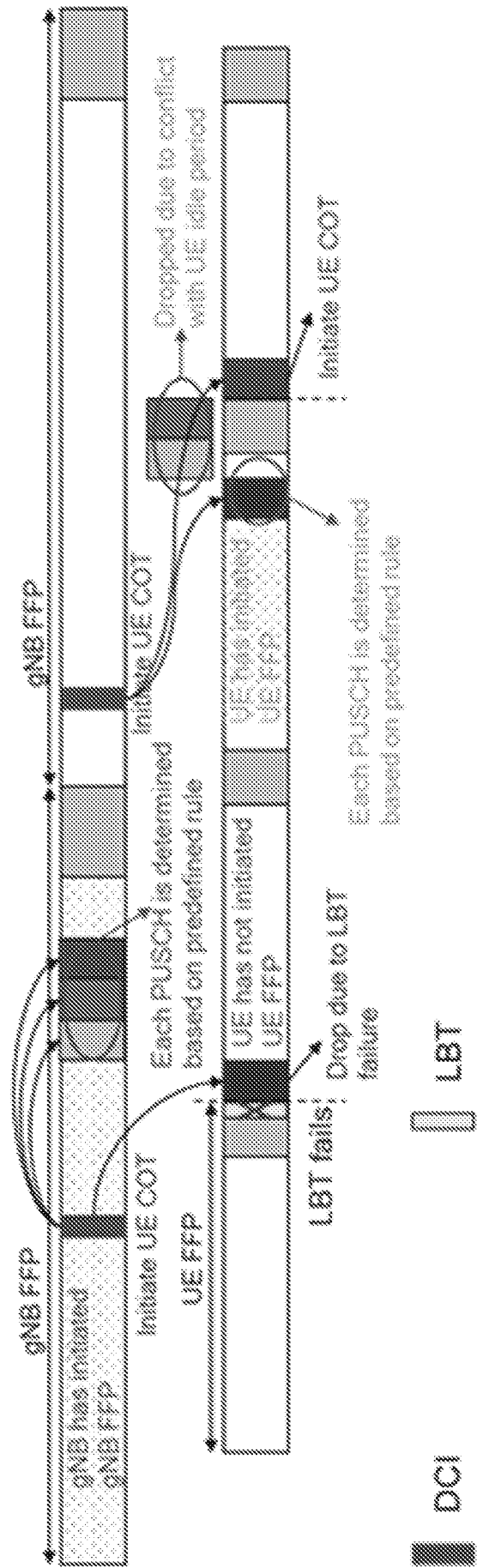


FIG. 10

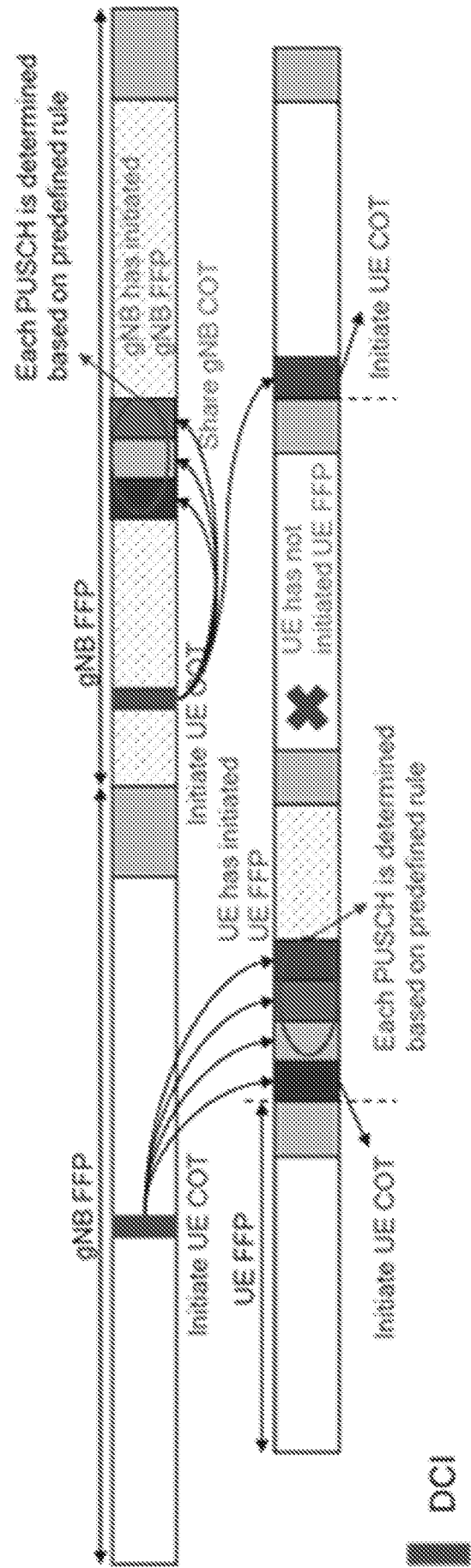


FIG. 11

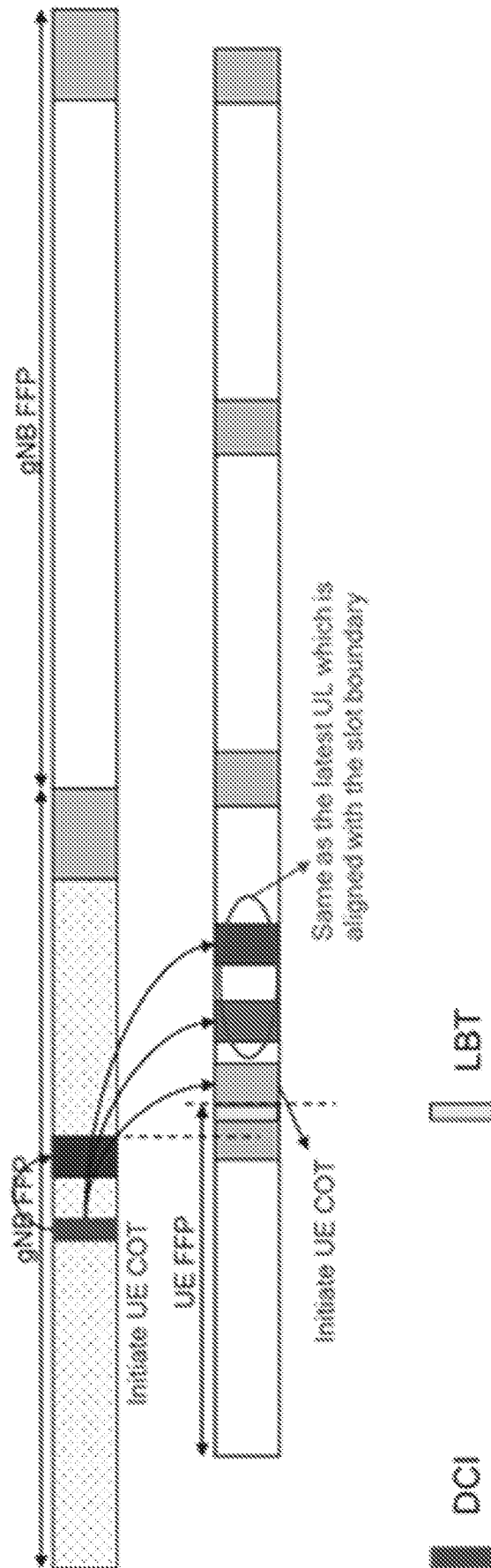


FIG. 12

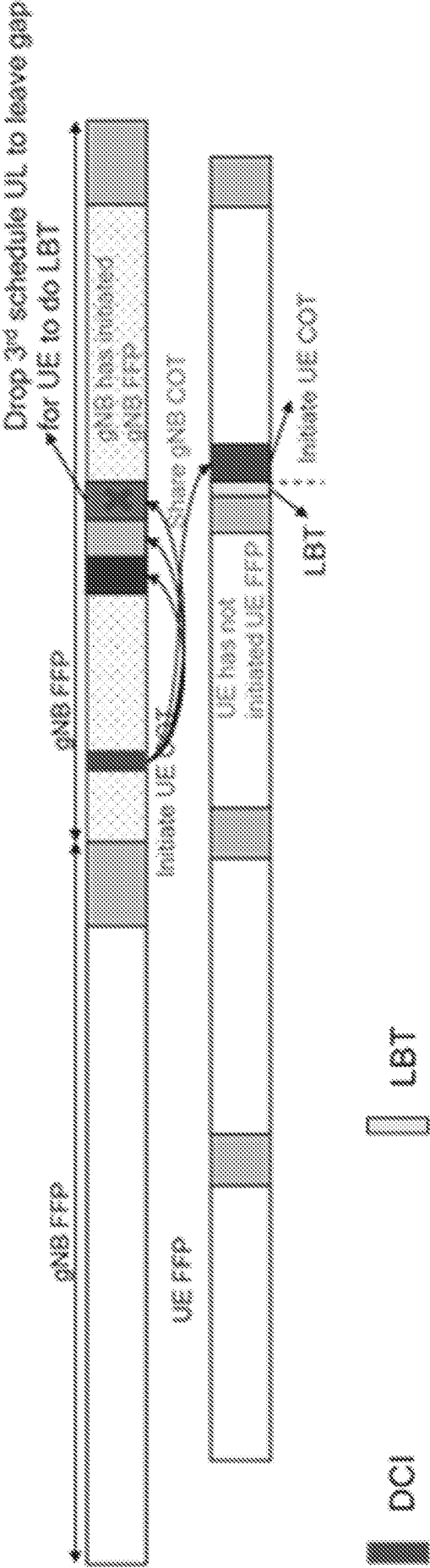


FIG. 13

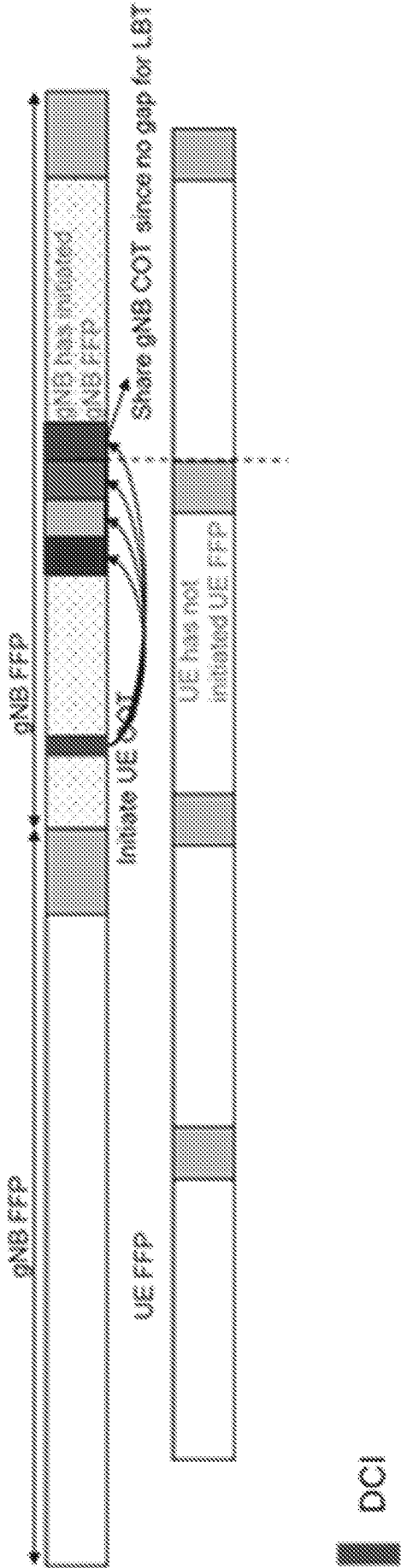


FIG. 14

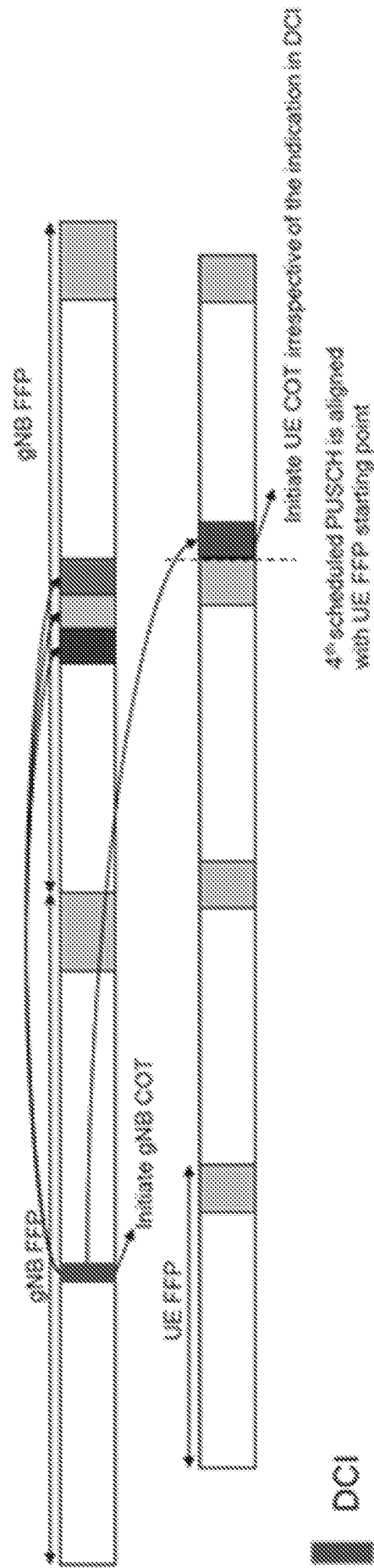
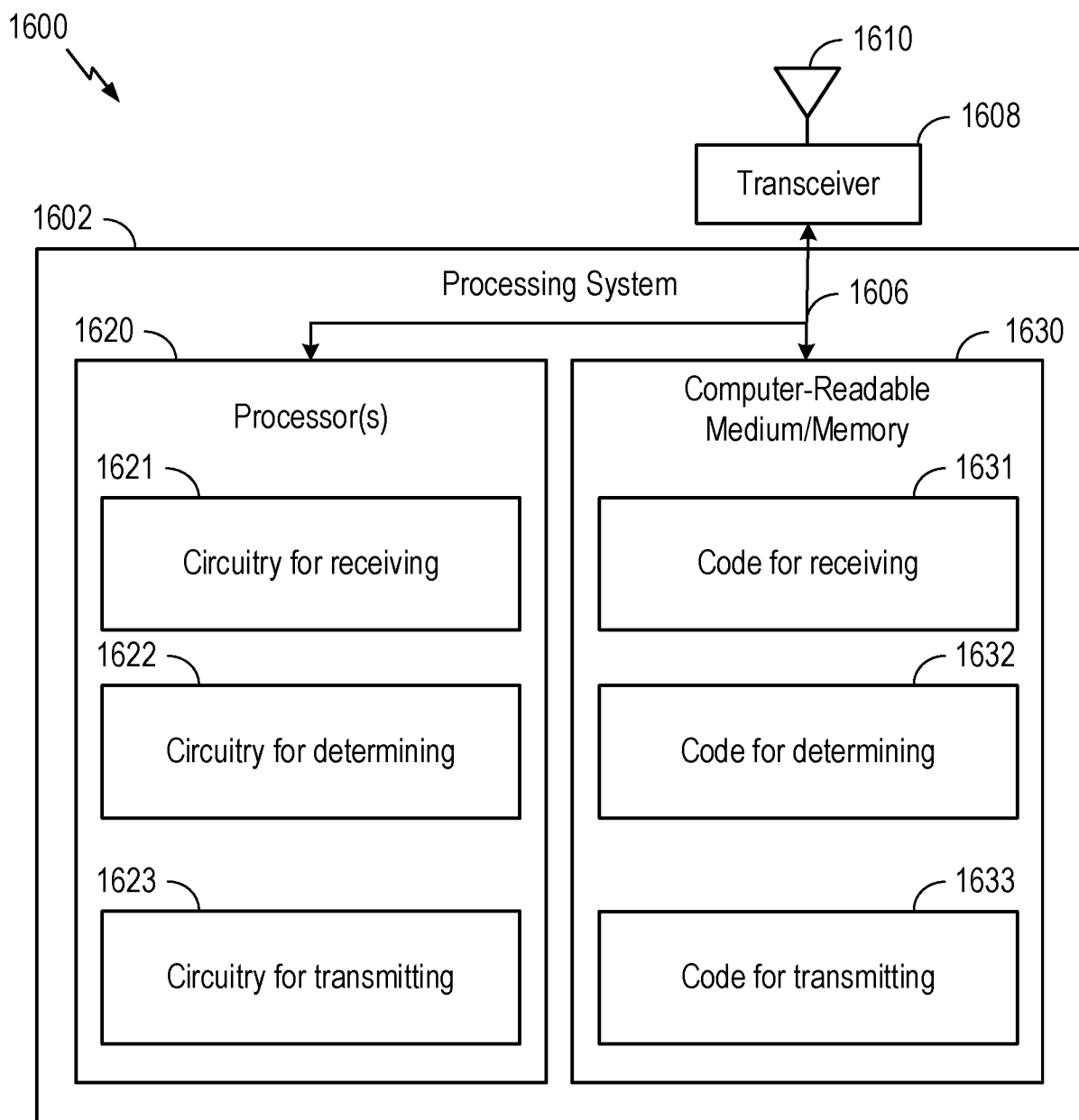
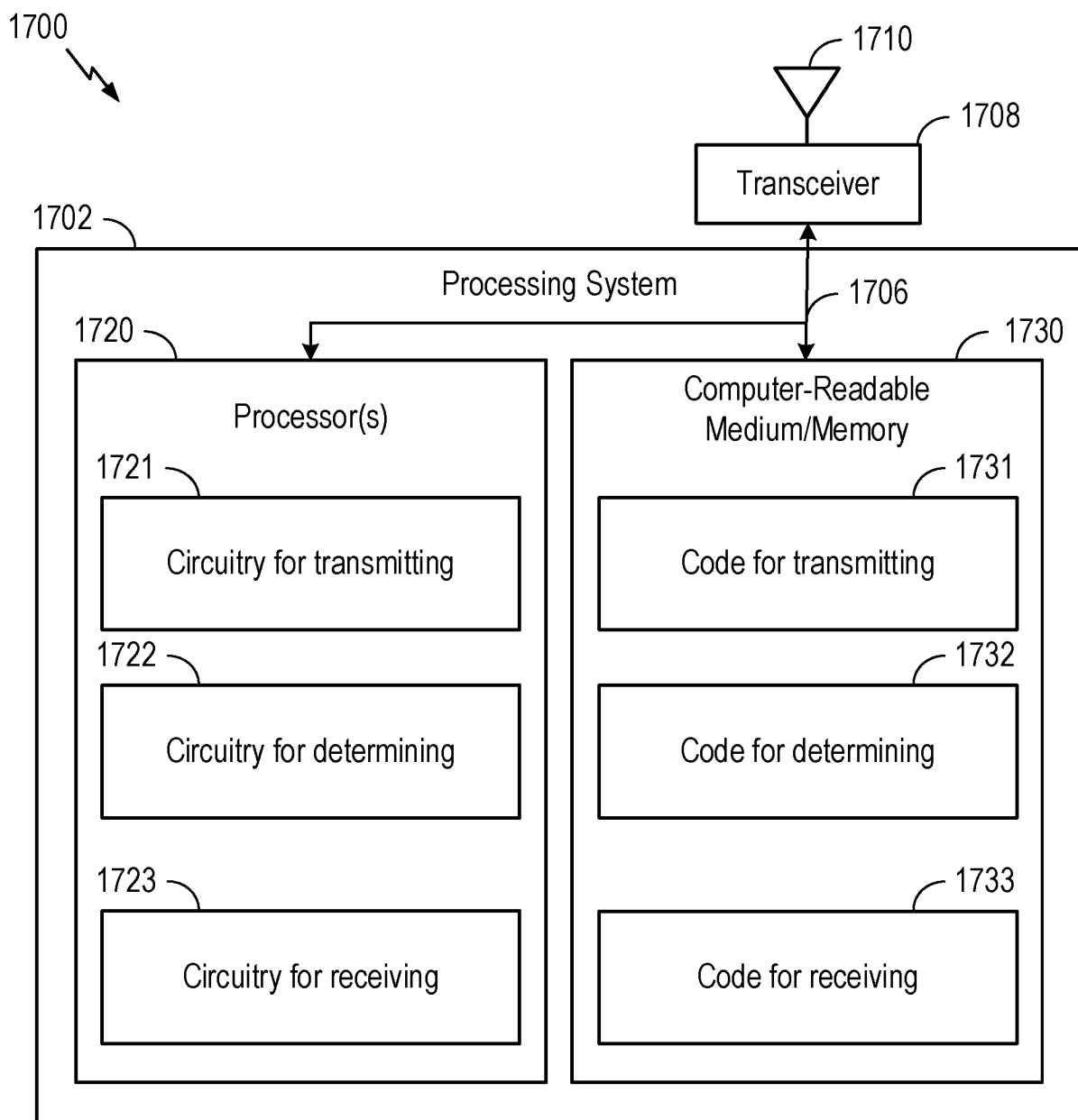


FIG. 15

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**FIG. 16**

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**FIG. 17**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/109931

A. CLASSIFICATION OF SUBJECT MATTER		
H04W 74/08(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)		
WPI,EPODOC,CNKI,CNPAT,3GPP:initiated, COT, type, UE, FFP, gNB, combination, DCI, UL, uplink		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	QUALCOMM INCORPORATED. "Uplink enhancements for URLLC in unlicensed controlled environments" 3GPP TSG-RAN WG1 Meeting #104b-e e-Meeting R1-2103165, 20 April 2021 (2021-04-20), section 2.2	1-30
Y	FUTUREWEI. "UE initiated COT for FFP" 3GPP TSG RAN WG1 Meeting #103-e eMeeting R1-2007551, 13 November 2020 (2020-11-13), section 3.2	1-30
Y	QUALCOMM INCORPORATED. "Uplink enhancements for URLLC in unlicensed controlled environments" 3GPP TSG-RAN WG1 Meeting #105-e e-Meeting R1-2104665, 27 May 2021 (2021-05-27), section 2.1	1-30
A	WO 2021068849 A1 (MEDIATEK INC.) 15 April 2021 (2021-04-15) the whole document	1-30
A	US 2020351941 A1 (APPLE INC.) 05 November 2020 (2020-11-05) the whole document	1-30
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search		Date of mailing of the international search report
19 April 2022		28 April 2022
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		LI,Ping
Facsimile No. (86-10)62019451		Telephone No. 53961602

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/109931

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2021069506 A1 (TELEFONAKTIEBOLAGET LM ERICSSONPUBL) 15 April 2021 (2021-04-15) the whole document	1-30

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2021/109931

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2021068849	A1	15 April 2021	CN	113924817	A	11 January 2022
US	2020351941	A1	05 November 2020	WO	2020223732	A1	05 November 2020
				EP	3964007	A1	09 March 2022
				CN	113906814	A	07 January 2022
WO	2021069506	A1	15 April 2021	None			