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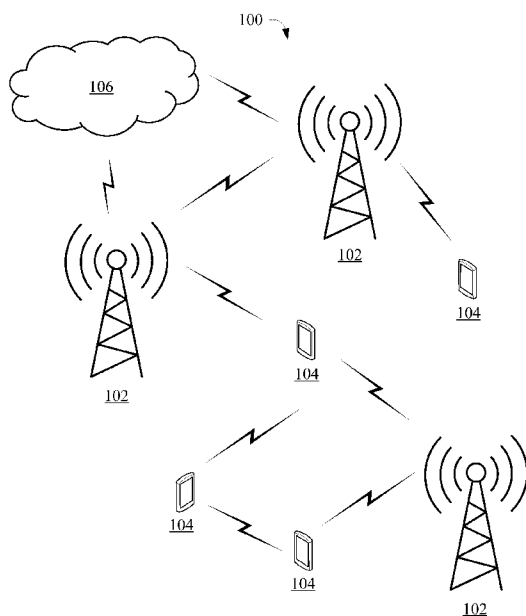


FIG. 1

(57) Abstract: Embodiments of the present disclosure relate to methods and apparatuses for time domain resource indication for multi-cell scheduling with one or more channels per scheduled cell. A UE may: receive signaling for configuring a first set of cells, which is co-schedulable by a single DCI; receive the DCI scheduling a second set of cells in the first set of cells, wherein the DCI indicates TDRA information for the second set of cells; determine time domain resources on the second set of cells based on the TDRA information; and receive downlink channels in the determined time domain resources in response to the DCI scheduling the downlink channels, or transmit uplink channels in the determined time domain resources in response to the DCI scheduling the uplink channels.

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**METHODS AND APPARATUSES FOR TIME DOMAIN RESOURCE
INDICATION FOR MULTI-CELL SCHEDULING WITH ONE OR MORE
CHANNELS PER SCHEDULED CELL**

TECHNICAL FIELD

[0001] Embodiments of the present disclosure generally relate to wireless communication technology, and more particularly to time domain resource indication for multi-cell scheduling with one or more channels per scheduled cell.

BACKGROUND

[0002] A wireless communication system may include one or multiple network communication devices, such as base stations (BS), which may support wireless communication for one or multiple user communication devices, which may be otherwise known as user equipment (UE), or other suitable terminology. The wireless communication system may support wireless communication with one or multiple user communication devices by utilizing resources of the wireless communication system (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like)) or frequency resources (e.g., subcarriers, carriers, or the like). Additionally, the wireless communication system may support wireless communication across various radio access technologies including third generation (3G) radio access technology, fourth generation (4G) radio access technology, fifth generation (5G) (which is also known as new radio (NR)) radio access technology, among other suitable radio access technologies beyond 5G (e.g., sixth generation (6G)).

SUMMARY

[0003] An article “a” before an element is unrestricted and understood to refer to “at least one” of those elements or “one or more” of those elements. The terms “a,” “at least one,” “one or more,” and “at least one of one or more” may be interchangeable. As used herein, including in the claims, “or” as used in a list of items (e.g., a list of

items prefaced by a phrase such as “at least one of” or “one or more of” or “one or both of”) indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase “based on” shall not be construed as a reference to a closed set of conditions. For example, an example step that is described as “based on condition A” may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase “based on” shall be construed in the same manner as the phrase “based at least in part on.” Further, as used herein, including in the claims, a “set” or a “list” may include one or more elements.

[0004] Some embodiments of the present disclosure provide a UE. The UE may include at least one memory; and at least one processor coupled with the at least one memory and configured to cause the UE to: receive signaling for configuring a first set of cells, which is co-schedulable by a single downlink control information (DCI); receive the DCI scheduling a second set of cells in the first set of cells, wherein the DCI indicates time domain resource allocation (TDRA) information for the second set of cells from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells; determine time domain resources on the second set of cells based on the TDRA information; and receive downlink transmission or transmit uplink transmission in the determined time domain resources.

[0005] In some embodiments, the single TDRA list includes at least one entry, and each entry of the at least one entry includes a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.

[0006] In some embodiments, each TDRA list of the set of TDRA lists includes at least one entry, and each entry of the at least one entry includes a set of TDRA indexes corresponding to a cell in the first set of cells.

[0007] In some embodiments, in the case that the DCI indicates the TDRA information for the second set of cells from the single TDRA list, the DCI includes a third indicator indicating a mode of the following scheduling modes of the DCI: a first mode for single-channel scheduling on a single cell; a second mode for multi-channel scheduling on a single cell; a third mode for multi-cell scheduling with a single channel

scheduled per a scheduled cell; and a fourth mode for multi-cell scheduling with one or more channels scheduled per a scheduled cell; and wherein the DCI further includes a fourth indicator indicating an entry in the single TDRA list corresponding to the indicated mode.

[0008] In some embodiments, the single TDRA list corresponds to a TDRA list for single-cell scheduling in response to the third indicator indicating the first mode. In some embodiments, the single TDRA list corresponds to a TDRA list for multi-channel scheduling in response to the third indicator indicating the second mode. In some embodiments, the single TDRA list corresponds to a third TDRA list in response to the third indicator indicating the third mode, the third TDRA list including at least one entry, each of which includes a set of TDRA indexes with each TDRA index corresponding to a cell in the first set of cells. In some embodiments, the single TDRA list corresponds to a fourth TDRA list in response to the third indicator indicating the fourth mode, the fourth TDRA list including at least one entry, each of which includes including a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.

[0009] In some embodiments, each TDRA index of a set of TDRA indexes indicates an entry of a TDRA list for single-cell scheduling or an inapplicable TDRA index. In some embodiments, each TDRA index of the set of TDRA indexes indicates the entry of the TDRA list for single-cell scheduling.

[0010] In some embodiments, the plurality of sets of TDRA indexes is ordered according to cell indexes of cell(s) in the first set of cells.

[0011] In some embodiments, TDRA index(es) in a set of TDRA indexes is ordered according to time.

[0012] In some embodiments, a number of TDRA indexes in a set of TDRA indexes is equal to or smaller than a maximum number of channels schedulable by the DCI on a corresponding cell in the first set of cells.

[0013] In some embodiments, the DCI includes a first indicator indicating a first entry of the at least one entry, the first entry including a first number of sets of TDRA indexes

with each set of TDRA indexes corresponding to a cell in the second set of cells and a second number of sets of TDRA indexes for remaining cell(s) in the first set of cells. A number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA indexes in a corresponding set of TDRA indexes of the first number of sets of TDRA indexes.

[0014] In some embodiments, the second number of sets of TDRA indexes include only inapplicable TDRA indexes. In some embodiments, the DCI further includes a second indicator indicating the second set of cells and determining the time domain resources on the second set of cells includes ignoring the second number of sets of TDRA indexes.

[0015] In some embodiments, a size of the first indicator is dependent on a number of entries in the single TDRA list.

[0016] In some embodiments, each TDRA list of the set of TDRA lists corresponds to a TDRA list for multi-channel scheduling for a corresponding cell in the first set of cells, and each TDRA list for multi-channel scheduling includes at least one entry, with each entry indicating one or more TDRA information sets for multi-channel scheduling on the corresponding cell.

[0017] In some embodiments, the one or more TDRA information sets for multi-channel scheduling on the corresponding cell indicate only applicable TDRA information set or indicate applicable TDRA information set or inapplicable TDRA information set.

[0018] In some embodiments, the one or more TDRA information sets for multi-channel scheduling on the corresponding cell are ordered according to time.

[0019] In some embodiments, a number of TDRA information sets in each entry of the TDRA list for multi-channel scheduling is equal to or smaller than a maximum number of channels schedulable by the DCI on the corresponding cell in the first set of cells.

[0020] In some embodiments, the DCI includes a plurality of first indicators each

corresponding to a cell in the first set of cells and a TDRA list of the set of TDRA lists. A number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA information sets or a number of applicable TDRA indexes in a corresponding TDRA list of the set of TDRA lists.

[0021] In some embodiments, a first indicator corresponding to a cell in the second set of cell indicates at least one applicable TDRA information set or at least one applicable TDRA index and a first indicator corresponding to a cell in remaining cell(s) in the first set of cells indicates an inapplicable value, only inapplicable TDRA information set, empty TDRA information set, only inapplicable TDRA index or empty TDRA index. In some embodiments, the DCI further includes a second indicator indicating the second set of cells and determining the time domain resources on the second set of cells includes ignoring first indicator(s) corresponding to the remaining cell(s) in the first set of cells.

[0022] In some embodiments, a size of each first indicator is dependent on a number of entries in a corresponding TDRA list of the set of TDRA lists.

[0023] In some embodiments, the second set of cells is determined based on the third indicator and the fourth indicator; or wherein the DCI further includes a second indicator indicating the second set of cells.

[0024] Some embodiments of the present disclosure provide a BS. The BS may include at least one memory; and at least one processor coupled with the at least one memory and configured to cause the BS to: transmit, to a UE, signaling for configuring a first set of cells, which is co-schedulable by a single DCI; transmit, to the UE, the DCI scheduling a second set of cells in the first set of cells and assigning time domain resources for the second set of cells by indicating TDRA information from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells; and transmit downlink transmission or receive uplink transmission in the time domain resources.

[0025] In some embodiments, the single TDRA list includes at least one entry, and each entry of the at least one entry includes a plurality of sets of TDRA indexes with

each set of TDRA indexes corresponding to a cell in the first set of cells.

[0026] In some embodiments, each TDRA list of the set of TDRA lists includes at least one entry, and each entry of the at least one entry includes a set of TDRA indexes corresponding to a in the first set of cells.

[0027] In some embodiments, in the case that the DCI indicates the TDRA information for the second set of cells from the single TDRA list, the DCI includes a third indicator indicating a mode of the following scheduling modes of the DCI: a first mode for single-channel scheduling on a single cell; a second mode for multi-channel scheduling on a single cell; a third mode for multi-cell scheduling with a single channel scheduled per a scheduled cell; and a fourth mode for multi-cell scheduling with one or more channels scheduled per a scheduled cell. The DCI further includes a fourth indicator indicating an entry in the single TDRA list corresponding to the indicated mode.

[0028] In some embodiments, the single TDRA list corresponds to a TDRA list for single-cell scheduling in response to the third indicator indicating the first mode. In some embodiments, the single TDRA list corresponds to a TDRA list for multi-channel scheduling in response to the third indicator indicating the second mode. In some embodiments, the single TDRA list corresponds to a third TDRA list in response to the third indicator indicating the third mode, the third TDRA list including at least one entry, each of which includes a set of TDRA indexes with each TDRA index corresponding to a cell in the first set of cells. In some embodiments, the single TDRA list corresponds to a fourth TDRA list in response to the third indicator indicating the fourth mode, the fourth TDRA list including at least one entry, each of which includes including a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.

[0029] In some embodiments, each TDRA index of a set of TDRA indexes indicates an entry of a TDRA list for single-cell scheduling or an inapplicable TDRA index. In some embodiments, each TDRA index of the set of TDRA indexes indicates the entry of the TDRA list for single-cell scheduling.

[0030] In some embodiments, the plurality of sets of TDRA indexes is ordered

according to cell indexes of cell(s) in the first set of cells.

[0031] In some embodiments, TDRA index(es) in a set of TDRA indexes is ordered according to time.

[0032] In some embodiments, a number of TDRA indexes in a set of TDRA indexes is equal to or smaller than a maximum number of channels schedulable by the DCI on a corresponding cell in the first set of cells.

[0033] In some embodiments, the DCI includes a first indicator indicating a first entry of the at least one entry, the first entry including a first number of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the second set of cells and a second number of sets of TDRA indexes for remaining cell(s) in the first set of cells. A number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA indexes in a corresponding set of TDRA indexes of the first number of sets of TDRA indexes.

[0034] In some embodiments, the second number of sets of TDRA indexes include only inapplicable TDRA indexes. In some embodiments, the DCI further includes a second indicator indicating the second set of cells.

[0035] In some embodiments, a size of the first indicator is dependent on a number of entries in the single TDRA list.

[0036] In some embodiments, each TDRA list of the set of TDRA lists corresponds to a TDRA list for multi-channel scheduling for a corresponding cell in the first set of cells, and each TDRA list for multi-channel scheduling includes at least one entry, with each entry indicating one or more TDRA information sets for multi-channel scheduling on the corresponding cell.

[0037] In some embodiments, the one or more TDRA information sets for multi-channel scheduling on the corresponding cell indicate only applicable TDRA information set or indicate applicable TDRA information set or inapplicable TDRA information set.

[0038] In some embodiments, the one or more TDRA information sets for multi-

channel scheduling on the corresponding cell are ordered according to time.

[0039] In some embodiments, a number of TDRA information sets in each entry of the TDRA list for multi-channel scheduling is equal to or smaller than a maximum number of channels schedulable by the DCI on the corresponding cell in the first set of cells.

[0040] In some embodiments, the DCI includes a plurality of first indicators each corresponding to a cell in the first set of cells and a TDRA list of the set of TDRA lists. A number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA information sets or a number of applicable TDRA indexes in a corresponding TDRA list of the set of TDRA lists.

[0041] In some embodiments, a first indicator corresponding to a cell in the second set of cell indicates at least one applicable TDRA information set or at least one applicable TDRA index and a first indicator corresponding to a cell in remaining cell(s) in the first set of cells indicates an inapplicable value, only inapplicable TDRA information set, empty TDRA information set, only inapplicable TDRA index or empty TDRA index. In some embodiments, the DCI further includes a second indicator indicating the second set of cells.

[0042] In some embodiments, a size of each first indicator is dependent on a number of entries in a corresponding TDRA list of the set of TDRA lists.

[0043] In some embodiments, the second set of cells is determined based on the third indicator and the fourth indicator. In some embodiments, the DCI further includes a second indicator indicating the second set of cells.

[0044] Some embodiments of the present disclosure provide a processor. The processor may include at least one controller coupled with at least one memory and configured to cause the processor to: receive signaling for configuring a first set of cells, which is co-schedulable by a single DCI; receive the DCI scheduling a second set of cells in the first set of cells, wherein the DCI indicates TDRA information for the second set of cells from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in

the first set of cells; determine time domain resources on the second set of cells based on the TDRA information; and receive downlink transmission or transmit uplink transmission in the determined time domain resources.

[0045] Some embodiments of the present disclosure provide a processor. The processor may include at least one controller coupled with at least one memory and configured to cause the processor to: transmit, to a UE, signaling for configuring a first set of cells, which is co-schedulable by a single DCI; transmit, to the UE, the DCI scheduling a second set of cells in the first set of cells and assigning time domain resources for the second set of cells by indicating TDRA information from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells; and transmit downlink transmission or receive uplink transmission in the time domain resources.

[0046] Some embodiments of the present disclosure provide a method for wireless communication. The method may include: receiving signaling for configuring a first set of cells, which is co-schedulable by a single DCI; receiving the DCI scheduling a second set of cells in the first set of cells, wherein the DCI indicates TDRA information for the second set of cells from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells; determining time domain resources on the second set of cells based on the TDRA information; and receiving downlink transmission or transmitting uplink transmission in the determined time domain resources.

[0047] Some embodiments of the present disclosure provide a method for wireless communication. The method may include: transmitting, to a UE, signaling for configuring a first set of cells, which is co-schedulable by a single DCI; transmitting, to the UE, the DCI scheduling a second set of cells in the first set of cells and assigning time domain resources for the second set of cells by indicating TDRA information from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells; and transmitting downlink transmission or receiving uplink transmission in the time

domain resources.

[0048] Some embodiments of the present disclosure provide an apparatus. According to some embodiments of the present disclosure, the apparatus may include: at least one non-transitory computer-readable medium having stored thereon computer-executable instructions; at least one receiving circuitry; at least one transmitting circuitry; and at least one processor coupled to the at least one non-transitory computer-readable medium, the at least one receiving circuitry and the at least one transmitting circuitry, wherein the at least one non-transitory computer-readable medium and the computer executable instructions may be configured to, with the at least one processor, cause the apparatus to perform a method according to some embodiments of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0049] In order to describe the manner in which the advantages and features of the disclosure can be obtained, a description of the disclosure is rendered by reference to specific embodiments thereof, which are illustrated in the appended drawings. These drawings depict only exemplary embodiments of the disclosure and are not therefore to be considered limiting of its scope.

[0050] FIG. 1 illustrates a schematic diagram of a wireless communication system in accordance with some embodiments of the present disclosure;

[0051] FIG. 2 illustrates a schematic diagram of a DCI format scheduling a plurality of channels in accordance with some embodiments of the present disclosure;

[0052] FIGs. 3 and 4 illustrate flowcharts of wireless communication methods in accordance with some embodiments of the present disclosure;

[0053] FIG. 5 illustrates an example of a UE in accordance with some embodiments of the present disclosure;

[0054] FIG. 6 illustrates an example of a processor in accordance with some embodiments of the present disclosure; and

[0055] FIG. 7 illustrates an example of a network equipment (NE) in accordance with some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0056] The detailed description of the appended drawings is intended as a description of the preferred embodiments of the present disclosure and is not intended to represent the only form in which the present disclosure may be practiced. It should be understood that the same or equivalent functions may be accomplished by different embodiments that are intended to be encompassed within the spirit and scope of the present disclosure.

[0057] Reference will now be made in detail to some embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. To facilitate understanding, embodiments are provided under a specific network architecture(s) and new service scenarios, such as the 3rd generation partnership project (3GPP) 5G NR or 6G, 3GPP LTE, and so on. It is contemplated that along with the developments of network architectures and new service scenarios, all embodiments in the present disclosure are also applicable to similar technical problems; and moreover, the terminologies recited in the present disclosure may change, which should not affect the principles of the present disclosure.

[0058] With more available scattered spectrum bands or spectrums with wider bandwidth, the need for simultaneous scheduling of multiple cells is expected to increase. The scheduling mechanism, which allows scheduling a single physical uplink shared channel (PUSCH) or physical downlink shared channel (PDSCH) on a single cell per a scheduling DCI, requires much signaling overhead when the number of cells configured for a UE is large.

[0059] To reduce the signaling overhead, it would be beneficial to extend to a more flexible scheduling mechanism. The present disclosure provides a scheduling mechanism that allows one or more cells with one or more PDSCHs or PUSCHs per one scheduled cell using a single DCI. For example, solutions are provided for indicating the time domain resources in the case of multi-cell and multi-channel

scheduling.

[0060] FIG. 1 illustrates a schematic diagram of wireless communication system 100 in accordance with some embodiments of the present disclosure.

[0061] The wireless communication system 100 may include one or more NEs 102 (e.g., one or more BSs), one or more UEs 104, and a core network (CN) 106. The wireless communication system 100 may support various radio access technologies. In some implementations, the wireless communication system 100 may be a 4G network, such as an LTE network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communication system 100 may be a NR network, such as a 5G network, a 5G-Advanced (5G-A) network, or a 5G ultra-wideband (5G-UWB) network. In other implementations, the wireless communication system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), and IEEE 802.20. The wireless communication system 100 may support radio access technologies beyond 5G, for example, 6G. Additionally, the wireless communication system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0062] The one or more NEs 102 may be dispersed throughout a geographic region to form the wireless communication system 100. One or more of the NEs 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a network function, a network entity, a radio access network (RAN), a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. An NE 102 and a UE 104 may communicate via a communication link, which may be a wireless or wired connection. For example, an NE 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

[0063] An NE 102 may provide a geographic coverage area for which the NE 102 may support services for one or more UEs 104 within the geographic coverage area. For example, an NE 102 and a UE 104 may support wireless communication of signals related to services (e.g., voice, video, packet data, messaging, broadcast, etc.) according

to one or multiple radio access technologies. In some implementations, an NE 102 may be moveable, for example, a satellite associated with a non-terrestrial network (NTN). In some implementations, different geographic coverage areas 112 associated with the same or different radio access technologies may overlap, but the different geographic coverage areas may be associated with a different NE 102.

[0064] The one or more UEs 104 may be dispersed throughout a geographic region of the wireless communication system 100. A UE 104 may include or may be referred to as a remote unit, a mobile device, a wireless device, a remote device, a subscriber device, a transmitter device, a receiver device, or some other suitable terminology. In some implementations, the UE 104 may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE 104 may be referred to as an Internet-of-Things (IoT) device, an Internet-of-Everything (IoE) device, or machine-type communication (MTC) device, among other examples.

[0065] A UE 104 may be able to support wireless communication directly with other UEs 104 over a communication link. For example, a UE 104 may support wireless communication directly with another UE 104 over a device-to-device (D2D) communication link. In some implementations, such as vehicle-to-vehicle (V2V) deployments, vehicle-to-everything (V2X) deployments, or cellular-V2X deployments, the communication link 114 may be referred to as a sidelink. For example, a UE 104 may support wireless communication directly with another UE 104 over a PC5 interface.

[0066] An NE 102 may support communication with the CN 106, or with another NE 102, or both. For example, an NE 102 may interface with another NE 102 or the CN 106 through one or more backhaul links (e.g., S1, N2, N3 or another network interface). In some implementations, the NE 102 may communicate with each other directly. In some other implementations, the NE 102 may communicate with each other or indirectly (e.g., via the CN 106). In some implementations, one or more NEs 102 may include subcomponents, such as an access network entity, which may be an example of an access node controller (ANC). An ANC may communicate with the one or more UEs 104 through one or more other access network transmission entities, which may be referred to as radio heads, smart radio heads, or transmission-reception points (TRPs).

[0067] The CN 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The CN 106 may be an evolved packet core (EPC), or a 5G core (5GC), which may include a control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management (AMF)) functions and a user plane entity that routes packets or interconnects to external networks (e.g., a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). In some implementations, the control plane entity may manage non-access stratum (NAS) functions, such as mobility, authentication, and bearer management (e.g., data bearers, signal bearers, etc.) for the one or more UEs 104 served by the one or more NEs 102 associated with the CN 106.

[0068] The CN 106 may communicate with a packet data network over one or more backhaul links (e.g., via an S1, N2, N3, or another network interface). The packet data network may include an application server. In some implementations, one or more UEs 104 may communicate with the application server. A UE 104 may establish a session (e.g., a protocol data unit (PDU) session, or the like) with the CN 106 via an NE 102. The CN 106 may route traffic (e.g., control information, data, and the like) between the UE 104 and the application server using the established session (e.g., the established PDU session). The PDU session may be an example of a logical connection between the UE 104 and the CN 106 (e.g., one or more network functions of the CN 106).

[0069] In the wireless communication system 100, the NEs 102 and the UEs 104 may use resources of the wireless communication system 100 (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers)) to perform various operations (e.g., wireless communication). In some implementations, the NEs 102 and the UEs 104 may support different resource structures. For example, the NEs 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the NEs 102 and the UEs 104 may support a single frame structure. In some other implementations, such as in 5G and among other suitable radio access technologies, the NEs 102 and the UEs 104 may support various frame structures (i.e., multiple frame structures). The NEs 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0070] In some embodiments, the NEs 102 may include one or more relay nodes, integrated access and backhaul (IAB) nodes or wireless access backhaul (WAB) nodes which can provide wireless access services for UEs 104. A relay node (or an IAB node or a WAB node) can directly connect to a BS or hop through one or more relay nodes (or one or more IAB or WAB nodes) before reaching the BS.

[0071] One or more numerologies may be supported in the wireless communication system 100, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g., $\mu=0$) may be associated with a first subcarrier spacing (e.g., 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g., $\mu=0$) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., $\mu=1$) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., $\mu=2$) may be associated with a third subcarrier spacing (e.g., 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g., $\mu=3$) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., $\mu=4$) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix. A sixth numerology (e.g., $\mu=5$) may be associated with a sixth subcarrier spacing (e.g., 480 kHz) and a normal cyclic prefix. A seventh numerology (e.g., $\mu=6$) may be associated with a seventh subcarrier spacing (e.g., 960 kHz) and a normal cyclic prefix. For ambient IoT communication, additional numerologies (e.g., $\mu=-1$ or $\mu=-2$) may be introduced corresponding to 7.5 kHz or 3.75 kHz respectively.

[0072] A time interval of a resource (e.g., a communication resource) may be organized according to frames (also referred to as radio frames). Each frame may have a duration, for example, a 10 millisecond (ms) duration. In some implementations, each frame may include multiple subframes. For example, each frame may include 10 subframes, and each subframe may have a duration, for example, a 1 ms duration. In some implementations, each frame may have the same duration. In some implementations, each subframe of a frame may have the same duration.

[0073] Additionally or alternatively, a time interval of a resource (e.g., a communication resource) may be organized according to slots. For example, a

subframe may include a number (e.g., quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communication system 100. For instance, the first, second, third, fourth, and fifth numerologies (i.e., $\mu=0$, $\mu=1$, $\mu=2$, $\mu=3$, $\mu=4$) associated with respective subcarrier spacings (SCSs) of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g., quantity) of symbols (e.g., orthogonal frequency-division multiplexing (OFDM) symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., $\mu=0$) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0074] In the wireless communication system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communication system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5 (114.25 GHz – 300 GHz). In some implementations, the NEs 102 and the UEs 104 may perform wireless communication over one or more of the operating frequency bands. In some implementations, FR1 may be used by the NEs 102 and the UEs 104, among other equipment or devices for cellular communication traffic (e.g., control information, data). In some implementations, FR2 may be used by the NEs 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

[0075] FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g.,

$\mu=0$), which includes 15 kHz subcarrier spacing; a second numerology (e.g., $\mu=1$), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., $\mu=2$), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g., $\mu=2$), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., $\mu=3$), which includes 120 kHz subcarrier spacing.

[0076] A UE 104 may include computing devices, such as desktop computers, laptop computers, personal digital assistants (PDAs), tablet computers, smart televisions (e.g., televisions connected to the Internet), set-top boxes, game consoles, security systems (including security cameras), vehicle on-board computers, network devices (e.g., routers, switches, and modems), or the like. According to some embodiments of the present disclosure, a UE 104 may include a portable wireless communication device, a smart phone, a cellular telephone, a flip phone, a device having a subscriber identity module, a personal computer, a selective call receiver, or any other device that is capable of sending and receiving communication signals on a wireless network. In some embodiments of the present disclosure, a UE 104 includes wearable devices, such as smart watches, fitness bands, optical head-mounted displays, or the like. Moreover, a UE 104 may be referred to as a subscriber unit, a mobile, a mobile station, a user, a terminal, a mobile terminal, a wireless terminal, a fixed terminal, a subscriber station, a user terminal, or a device, or described using other terminology used in the art. A UE 104 may communicate with an NE 102 (e.g., a BS) via uplink (UL) communication signals. An NE 102 may communicate with a UE 104 via downlink (DL) communication signals.

[0077] In some embodiments of the present disclosure, an NE 102 and a UE 104 may communicate over licensed spectrums, whereas in some other embodiments, an NE 102 and a UE 104 may communicate over unlicensed spectrums. The present disclosure is not intended to be limited to the implementation of any particular wireless communication system architecture or protocol. Persons skilled in the art should understand that as technology develops and advances, the terminologies described in the present disclosure may change, but should not affect or limit the principles and spirit of the present disclosure.

[0078] In a wireless communication system, an NE (e.g., a BS) and a UE may communicate via DL channels and UL channels. For example, a UE may monitor a physical downlink control channel (PDCCH) in one or more search spaces. The PDCCH may carry downlink control information (DCI), which may schedule uplink channels, such as a PUSCH, or downlink channels, such as a PDSCH.

[0079] A communication technology (e.g., NR) may support a wide range of spectrums in different frequency ranges. For example, in the 5G Advanced market, it is expected that the availability of the spectrum will be increased, which is possibly due to re-farming the bands originally used for previous cellular generation networks. For example, for some low frequency bands of frequency range 1 (FR1) (e.g., 410 MHz - 7125 MHz), the available spectrum bands tend to be more fragmented and scattered with a narrower bandwidth. In addition, for bands of frequency range 2 (FR2) (e.g., 24250 MHz - 52600 MHz) and some bands of FR1, the available spectrum may be wider such that an intra-band multi-carrier operation is necessary. To meet different spectrum needs, it is important to ensure that these fragmented or scattered spectrum bands or spectrums with wider bandwidth are utilized in a more spectrum and power efficient and flexible manner, thereby providing higher throughput and decent coverage in the network.

[0080] A communication system (e.g., NR) may be designed to support a maximum of 16 component carriers (CCs) in the case of carrier aggregation (CA) or a maximum of 32 CCs in the case of dual connectivity (DC). In some embodiments of the present disclosure, in the case of CA, one (i.e., a single) DCI can schedule at most one cell (e.g., carrier) by cross-cell (or cross-carrier) scheduling or self-scheduling. In some embodiments, a scheduling mechanism may only allow scheduling a single PUSCH or PDSCH on a single cell per a scheduling DCI. In the context of the present disclosure, this scheduling mechanism is referred to as single-cell scheduling.

[0081] With more available scattered spectrum bands or spectrums with wider bandwidth, the need for simultaneous scheduling of multiple cells is expected to increase. Obviously, the single-cell scheduling mechanism requires much signaling overhead for PDCCHs to schedule DL channels (e.g., PDSCHs) or UL channels (e.g., PUSCHs) when the number of cells configured for a UE is large. To reduce signaling

overhead, it would be beneficial to extend from single-cell scheduling to multi-cell scheduling, that is, using a single DCI format to schedule multiple DL channels (e.g., PDSCHs) or UL channels (e.g., PUSCHs) on multiple cells configured for the UE. This scheduling mechanism can greatly reduce the signaling overhead. However, in some embodiments, there is a limitation on such scheduling mechanism. For example, a maximum of one DL channel (e.g., one PDSCH) or one UL channel (e.g., one PUSCH) is allowed to be scheduled on one cell. For example, each DCI format 0_3 or 1_3 can schedule up to 4 cells, with the restriction of a single PUSCH or PDSCH per scheduled cell.

[0082] In some embodiments, under certain scenarios (e.g., for FR2 with high SCS), a scheduling mechanism that allows multiple DL channels (e.g., PDSCHs) or UL channels (e.g., PUSCHs) scheduling on the same serving cell by a single DCI is introduced. In the context of the present disclosure, this scheduling mechanism is referred to as multi-channel scheduling. For example, up to 8 PUSCHs or PDSCHs on a single serving cell can be scheduled by a single DCI format 0_1 or 1_1. This can save UE power consumption and reduce PDCCH monitoring.

[0083] To fully exploit the gain of power saving and PDCCH overhead reduction, embodiments of the present disclosure propose improved scheduling mechanisms. For example, a single DCI can schedule one or more cells with one or more DL channels (e.g., PDSCHs) or UL channels (e.g., PUSCHs) per scheduled cell. In the context of the present disclosure, this scheduling mechanism is referred to as multi-cell and multi-channel scheduling. This scheduling mechanism is especially useful when a scheduling cell in FR1 with a lower SCS schedules multiple cells in FR2 with a higher SCS.

[0084] FIG. 2 illustrates a schematic diagram of a DCI format scheduling a plurality of channels with one or more channels per scheduled cell in accordance with some embodiments of the present disclosure.

[0085] In some embodiments of the present disclosure, a plurality of CCs (e.g., including but not limited to CCs 251-254 in FIG. 2) may be configured for a UE. It should be understood that the SCSs of the cells configured for a UE may be the same or different. Each of the plurality of CCs may correspond to a respective cell (e.g.,

serving cell) or carrier of the UE. Each cell (serving cell) may be associated with a (serving) cell index.

[0086] In some embodiments of the present disclosure, a BS may transmit a single DCI to schedule a plurality of channels (or transmissions) on a plurality of cells, with each cell carrying one or more channels (or transmissions). For example, as shown in FIG. 2, DCI 211 may schedule channels 221-232 on CCs 251-254. That is, DCI 211 may schedule channel 221 on CC 251, channels 222-224 on CC 252, channels 225-229 on CC 253, and channels 230-232 on CC 254. In some examples, channels 221-232 may be uplink channels or transmissions such as PUSCHs. In some examples, channels 221-232 may be downlink channels or transmissions such as PDSCHs.

[0087] To support multi-cell and multi-channel scheduling, one issue is how to indicate the TDRAs for the scheduled channels under such scenario. In some embodiments, a TDRA list (also referred to as a TDRA table) may be employed for indicating the TDRA information in multi-cell and multi-channel scheduling. On the other hand, before detecting a DCI, a UE needs to know the exact payload size of the DCI. Since the TDRA list may have an impact on the DCI payload size, how to determine the payload size of the DCI should also be resolved. As will be described in the following text, in some examples, the number of bits for a TDRA field (i.e., the size of the TDRA field) in a DCI may be dependent on the number of entries in a corresponding TDRA list. In some examples, in addition to indicating the time domain resources, the TDRA field may also implicitly indicate the co-scheduled cells (e.g., indicating whether a cell is scheduled). In some other examples, the DCI may include an indicator to explicitly indicate the co-scheduled cells. This may have an impact on the TDRA table design as well as the co-scheduled cell indication, thereby impacting the DCI payload size.

[0088] Embodiments of the present disclosure propose solutions for indicating the time domain resources in the case of multi-cell and multi-channel scheduling. More details on the embodiments of the present disclosure will be illustrated in the following text in combination with the appended drawings. It should be noted that the solutions of the present disclosure can be applied to both downlink channels (e.g., PDSCHs) and uplink channels (e.g., PUSCHs) scheduled by a DCI.

[0089] In some embodiments, in the case of single-cell scheduling, a DCI schedules a single channel on a single cell and indicates the time domain resource assigned on the scheduled cell for the scheduled channel. For example, the time domain resource allocation for the single channel (e.g., PUSCH or PDSCH) may be indicated by a TDRA field in the DCI from a TDRA list (or TDRA table). In the context of the present disclosure, this TDRA list is referred to the TDRA list for single-cell scheduling. In some examples, this TDRA list may be separately configured for UL (e.g., PUSCH) or for DL (e.g., PDSCH). In some examples, this TDRA list may be configured per cell. In some examples, this TDRA list may be specifically configured per UL or DL bandwidth part (BWP) for PUSCH or PDSCH. For example, the TDRA list for UL single-cell scheduling (e.g., the TDRA list for PUSCH) for a cell may be configured by RRC signaling (e.g., *PUSCH-TimeDomainResourceAllocationList* as specified in 3GPP specifications) and applicable for DCI format 0_1 for the cell. For example, the TDRA list for DL single-cell scheduling (e.g., the TDRA list for PDSCH) for a cell may be configured by RRC signaling (e.g., *PDSCH-TimeDomainResourceAllocationList* as specified in 3GPP specifications) and applicable for DCI format 1_1 for the cell.

[0090] For example, a TDRA list may include one or more entries with each entry including a single TDRA information set (e.g., a single configuration of {a start and length indicator value (SLIV), mapping type, scheduling offset K2}) for UL single-cell scheduling, or a single TDRA information set (e.g., a single configuration of {SLIV, mapping type, scheduling offset K0}) for DL single-cell scheduling, wherein K2 may indicate an offset between a slot where a DCI is transmitted and a slot where the scheduled UL channel (e.g., PUSCH) is transmitted, and K0 may indicate an offset between a slot where the DCI format is transmitted and a slot where the scheduled DL channel (e.g., PDSCH) is transmitted. In some embodiments, the SLIV may be replaced with a start indicator (e.g., “S”) and a length indicator (e.g., “L”). In some embodiments, each entry in the TDRA list for single-cell scheduling may include an applicable TDRA information set which points to an applicable resource for a scheduled channel.

[0091] Table 1 below shows an exemplary TDRA list for single-cell scheduling. It should be understood that Table 1 is only for illustrative purposes, and should not be construed as limiting the embodiments of the present disclosure.

Table 1: TDRA list for DL single-cell scheduling

Row index	<i>dmrs-TypeA-Position</i>	PDSCH mapping type	K_0	S	L
1	2	Type A	0	2	12
	3	Type A	0	3	11
2	2	Type A	0	2	10
	3	Type A	0	3	9
3	2	Type A	0	2	9
	3	Type A	0	3	8
4	2	Type A	0	2	7
	3	Type A	0	3	6
5	2	Type A	0	2	5
	3	Type A	0	3	4
6	2	Type B	0	9	4
	3	Type B	0	10	4
7	2	Type B	0	4	4
	3	Type B	0	6	4
8	2,3	Type B	0	5	7
9	2,3	Type B	0	5	2
10	2,3	Type B	0	9	2
11	2,3	Type B	0	12	2
12	2,3	Type A	0	1	13
13	2,3	Type A	0	1	6
14	2,3	Type A	0	2	4
15	2,3	Type B	0	4	7
16	2,3	Type B	0	8	4

[0092] The first column of Table 1 includes the index of each entry of Table 1 (denoted as "Row index" in the table and can also be referred to as "TDRA index") and the remaining columns of Table 1 include the TDRA information for a channel. Each entry of Table 1 corresponds to one configuration of {SLIV, mapping type, K_0 }, which can be referred to as one TDRA information set. However, a TDRA information set may be organized in other forms as long as it can indicate the time domain resource for a channel. The specific definitions of the TDRA information in Table 1 can be found in 3GPP specifications.

[0093] In some embodiments, in the case of multi-channel scheduling, a DCI schedules one or multiple channels on the same cell and indicates the time domain resources assigned for the scheduled channels on the cell. For example, the time domain resource allocation for the one or multiple channels may be indicated by a TDRA field in the DCI from a TDRA list (or TDRA table). In the context of the present disclosure, this TDRA list is referred to the TDRA list for multi-channel scheduling. In some examples, this TDRA list may be separately configured for UL (e.g., PUSCH) or for DL (e.g., PDSCH). In some examples, this TDRA list may be configured per cell. In some examples, this TDRA list may be specifically configured per UL or DL BWP for PUSCH or PDSCH. For example, the TDRA list for PUSCH

may be configured by RRC signaling (e.g., *pusch-TimeDomainAllocationListForMultiPUSCH* as specified in 3GPP specifications). For example, the TDRA list for PDSCH may be configured by RRC signaling (e.g., *pdsch-TimeDomainAllocationListForMultiPDSCH* as specified in 3GPP specifications).

[0094] For example, a TDRA list for multi-channel scheduling may include one or more entries with each entry including one or more TDRA information sets (e.g., one or more configurations of {SLIV, mapping type, K₂}) for UL multi-channel scheduling or one or more TDRA information sets (e.g., one or more configurations of {SLIV, mapping type, K₀}) for DL multi-channel scheduling. In some embodiments, the SLIV may be replaced with a start indicator (e.g., “S”) and a length indicator (e.g., “L”). In some embodiments, each entry in the TDRA list for multi-channel scheduling may include only applicable TDRA information sets, each of which points to an applicable resource for a scheduled channel.

[0095] In some embodiments of the present disclosure, a BS may configure a set of cells (denoted as cell set #1) which can be used for multi-cell scheduling for a UE. For example, the BS may transmit a DCI to the UE, and the DCI may schedule one or more downlink channels (e.g., PDSCHs) or one or more uplink channels (e.g., PUSCHs) on one or more cells of cell set #1. Various methods may be employed for indicating the co-scheduled cells, the channels scheduled on each scheduled cell, and the time domain resources for the scheduled channels.

[0096] In some embodiments of the present disclosure, in the case of multi-cell and multi-channel scheduling, the co-scheduled cells among cell set #1 and the one or more channels (e.g., PDSCHs or PUSCHs) scheduled on each scheduled cell as well as the corresponding time domain resources for all the scheduled channels on all the co-scheduled cells are indicated by a TDRA field (e.g., a single TDRA field) in the scheduling DCI. The TDRA field (denoted as TDRA field #A) may point to an entry from a TDRA list (denoted as TDRA list #A) for cell set #1 for multi-cell and multi-channel scheduling.

[0097] In some embodiments, TDRA list #A may be configured by RRC signaling, preconfigured or predefined, and may be associated with the DCI. TDRA list #A may

include at least one entry, each of which may include a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in cell set #1. For example, referring to FIG. 2, each entry of TDRA list #A may include fourth sets of TDRA indexes respectively corresponding to CCs 251-254.

[0098] The plurality of sets of TDRA indexes in each entry may be ordered according to cell indexes of cells in cell set #1, for example, according to an ascending or descending order of the corresponding cell indexes. Within each set of TDRA indexes, the TDRA index(es) may be ordered according to time (e.g., an ascending or descending order of transmission time). For example, the first TDRA index may correspond to the earliest scheduled PDSCH or PUSCH, the second TDRA index may correspond to the second earliest PDSCH or PUSCH, ..., the last TDRA index may correspond to the last scheduled PDSCH or PUSCH. For example, the first TDRA index may correspond to the last scheduled PDSCH or PUSCH, the second TDRA index may correspond to the second last PDSCH or PUSCH, ..., the last TDRA index may correspond to the earliest scheduled PDSCH or PUSCH.

[0099] Each TDRA index in a set of TDRA indexes may indicate an applicable or inapplicable TDRA index. Each applicable or inapplicable TDRA index may correspond to one channel (e.g., PDSCH or PUSCH); however, an inapplicable TDRA index implicitly indicates that the corresponding channel is not scheduled. The number of TDRA indexes in one set of TDRA indexes may be independent (e.g., different) from that in another set of TDRA indexes. The number of applicable (or inapplicable) TDRA indexes in one set of TDRA indexes may be independent (e.g., different) from that in another set of TDRA indexes. The number of TDRA indexes in a set of TDRA indexes may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the set of TDRA indexes.

[00100] An applicable TDRA index in a set of TDRA indexes may indicate (e.g., point to) an entry of a TDRA list for single-cell scheduling for a cell corresponding to the set of TDRA indexes. Each applicable TDRA index in a set of TDRA indexes may correspond to one TDRA information set (e.g., one configuration of {SLIV, mapping type, K0 or K2}) in the TDRA list for single-cell scheduling for the cell corresponding

to the set of TDRA indexes. Each applicable TDRA index may be an integer value larger than or equal to 0 and may not exceed the largest TDRA index in the TDRA list for single-cell scheduling for the cell. Each inapplicable TDRA index may indicate a minus value (e.g., -1), thereby indicating that the corresponding channel is not scheduled. The number of channels scheduled on a cell may be dependent on the number of applicable TDRA indexes in the corresponding set of TDRA indexes.

[00101] For example, an entry of TDRA list #A may include only applicable TDRA indexes for a cell, only inapplicable TDRA indexes for the cell, or both applicable TDRA indexes and inapplicable TDRA indexes for the cell. A cell with only applicable TDRA indexes, when indicated, may imply that the cell is scheduled with the maximum number of PDSCHs or PUSCHs on the cell. A cell with only inapplicable TDRA indexes, when indicated, may imply that the cell is not scheduled. A cell with both applicable TDRA indexes and inapplicable TDRA indexes, when indicated, may imply that the cell is scheduled and the number of scheduled PDSCHs or PUSCHs on the cell is dependent on (e.g., equal to) the number of applicable TDRA indexes and smaller than the maximum number of schedulable PDSCHs or PUSCHs on the cell.

[00102] Table 2 below shows an exemplary TDRA list for multi-cell and multi-channel scheduling. It should be understood that Table 2 is only for illustrative purposes, and should not be construed as limiting the embodiments of the present disclosure. Assuming that a BS configures cell set #1 including cell #1 to cell #4 for a UE, the BS may further configure the TDRA list shown in Table 2 for cell set #1 via RRC signaling.

Table 2: TDRA list for multi-cell and multi-channel scheduling

Entry index	TDRA index for cell #1	TDRA index for cell #2			TDRA index for cell #3						TDRA index for cell #4			
0	a_0^1	b_0^1	b_0^2	b_0^3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	a_1^1	-1	-1	-1	c_1^1	c_1^2	c_1^3	c_1^4	c_1^5	c_1^6	d_1^1	d_1^2	d_1^3	d_1^4
2	a_2^1	b_2^1	b_2^2	b_2^3	c_2^1	c_2^2	c_2^3	c_2^4	c_2^5	c_2^6	d_2^1	d_2^2	d_2^3	d_2^4
3	a_3^1	b_3^1	b_3^2	-1	c_3^1	c_3^2	c_3^3	c_3^4	-1	-1	d_3^1	d_3^2	d_3^3	d_3^4
4	a_4^1	b_4^1	b_4^2	b_4^3	c_4^1	c_4^2	-1	-1	-1	-1	d_4^1	d_4^2	-1	-1
5	a_5^1	b_5^1	b_5^2	b_5^3	c_5^1	c_5^2	-1	-1	-1	-1	d_5^1	d_5^2	-1	-1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

[00103] In Table 2, the value of "-1" may indicate an inapplicable TDRA index and the remaining parameters (e.g., a_0^1 and b_0^3) may indicate applicable TDRA indexes. The applicable TDRA indexes (e.g., a_0^1 and b_0^3) may be integer values larger than or equal to 0. Each applicable TDRA index may represent the TDRA index for a corresponding cell in a TDRA list configured for the corresponding cell (e.g., the TDRA lists for single-cell scheduling for the corresponding cell). For example, each applicable TDRA index for a cell may correspond to one PDSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K0}) in the TDRA list applicable for DCI format 1_1 for the cell, or one PUSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K2}) in the TDRA list applicable for DCI format 0_1 for the cell. The inapplicable TDRA index value of "-1" indicates that the corresponding PDSCH or PUSCH is not scheduled. Within each entry of the TDRA list, the plurality sets of TDRA indexes for cell #1 to cell #4 are ordered in an ascending order of the serving cell indexes of cell #1 to cell #4, and TDRA indexes in each set of TDRA indexes are ordered in an ascending order of transmission time.

[00104] For example, a_0^1 in the first entry of the TDRA list in Table 2 may represent the TDRA index for cell #1 in a TDRA list specifically configured for cell #1, which corresponds to one channel scheduled on cell #1; a_2^1 in the third entry of the TDRA list in Table 2 may represent the TDRA index for cell #1 in the TDRA list specifically configured for cell #1, which corresponds to one channel scheduled on cell #1; b_0^1 , b_0^2 , and b_0^3 in the first entry of the TDRA list in Table 2 may represent three TDRA indexes for cell #2 in a TDRA list specifically configured for cell #2, which correspond to three channels scheduled on cell #2; c_2^1 , c_2^2 , c_2^3 , c_2^4 , c_2^5 , and c_2^6 in the third entry of the TDRA list in Table 2 represent the TDRA indexes for cell #3 in a TDRA list specifically configured for cell #3, which correspond to six channels scheduled on cell #3; and d_2^1 , d_2^2 , d_2^3 , and d_2^4 in the third entry of the TDRA list in Table 2 represent the TDRA indexes for cell #4 in a TDRA list specifically configured for cell #4, which correspond to four channels scheduled on cell #4.

[00105] In some embodiments, a size of TDRA field #A (e.g., the number of bits of TDRA field #A) in the DCI may be dependent on the number of entries in TDRA list #A. For example, assuming that there are Y entries in TDRA list #A for cell set #1, then the TDRA field may require $\lceil \log_2 Y \rceil$ bits for pointing out one entry from the Y

entries.

[00106] In this way, the time domain resource allocations for all cells of the set of cells are fully reused and signaling overhead can be greatly reduced.

[00107] In some embodiments of the present disclosure, in the case of multi-cell and multi-channel scheduling, the co-scheduled cells among cell set #1 are indicated by a cell indicator (denoted as cell indicator #B) in the scheduling DCI. In some embodiments, cell indicator #B may point to one entry of a cell combination table, which includes at least one entry with each entry corresponding to one scheduled cell combination. Each scheduled cell combination may include one or more cell indexes, thereby indicating the scheduled cells. The cell combination table may be configured by RRC signaling, preconfigured or predefined.

[00108] The one or more channels (e.g., PDSCHs or PUSCHs) scheduled on each scheduled cell as well as the corresponding time domain resources for the scheduled channels are indicated by a TDRA field (e.g., a single TDRA field) in the scheduling DCI. The TDRA field (denoted as TDRA field #B) may point to an entry from a TDRA list (denoted as TDRA list #B) for cell set #1 for multi-cell and multi-channel scheduling.

[00109] In some embodiments, TDRA list #B may be configured by RRC signaling, preconfigured or predefined, and may be associated with the DCI. TDRA list #B may include at least one entry, each of which may include a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in cell set #1. For example, referring to FIG. 2, each entry of TDRA list #B may include fourth sets of TDRA indexes respectively corresponding to CCs 251-254.

[00110] The plurality of sets of TDRA indexes in each entry may be ordered according to cell indexes of cells in cell set #1, for example, according to an ascending or descending order of the corresponding cell indexes. Within each set of TDRA indexes, the TDRA index(es) may be ordered according to time (e.g., an ascending or descending order of transmission time). For example, the first TDRA index may correspond to the earliest scheduled PDSCH or PUSCH, the second TDRA index may correspond to the second earliest PDSCH or PUSCH, ..., the last TDRA index may correspond to the

last scheduled PDSCH or PUSCH. For example, the first TDRA index may correspond to the last scheduled PDSCH or PUSCH, the second TDRA index may correspond to the second last PDSCH or PUSCH, ..., the last TDRA index may correspond to the earliest scheduled PDSCH or PUSCH.

[00111] In some embodiments, each TDRA index in a set of TDRA indexes may correspond to one channel (e.g., PDSCH or PUSCH) on the cell corresponding to the set of TDRA indexes. Each TDRA index in a set of TDRA indexes may indicate an applicable TDRA index. That is, TDRA list #B may include only applicable TDRA index. The number of TDRA indexes in one set of TDRA indexes may be independent (e.g., different) from that in another set of TDRA indexes. For example, referring to FIG. 2, in one entry of TDRA list #B, CC 251 may be configured with one TDRA index, CC 252 may be configured with three TDRA indexes, CC 253 may be configured with six TDRA indexes and CC 254 may be configured with four TDRA indexes. The number of TDRA indexes in a set of TDRA indexes may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the set of TDRA indexes.

[00112] A TDRA index in a set of TDRA indexes may indicate (e.g., point to) an entry of a TDRA list for single-cell scheduling for a cell corresponding to the set of TDRA indexes. Each TDRA index in a set of TDRA indexes may correspond to one TDRA information set (e.g., one configuration of {SLIV, mapping type, K0 or K2}) in the TDRA list for single-cell scheduling for the cell corresponding to the set of TDRA indexes. Each TDRA index may be an integer value larger than or equal to 0 and may not exceed the largest TDRA index in the TDRA list for single-cell scheduling for the cell. The number of channels scheduled on a cell may be dependent on the number of TDRA indexes in the corresponding set of TDRA indexes.

[00113] Table 3A below shows an exemplary TDRA list for multi-cell and multi-channel scheduling. It should be understood that Table 3A is only for illustrative purposes, and should not be construed as limiting the embodiments of the present disclosure. Assuming that a BS configures cell set #1 including cell #1 to cell #4 for a UE, the BS may further configure the TDRA list shown in Table 3A for cell set #1 via RRC signaling.

Table 3A: TDRA list for multi-cell and multi-channel scheduling

Entry index	TDRA index for cell #1	TDRA index for cell #2			TDRA index for cell #3						TDRA index for cell #4			
0	a_0^1	b_0^1	b_0^2		c_0^1	c_0^2	c_0^3	c_0^4			d_0^1	d_0^2		
1	a_1^1	b_1^1	b_1^2		c_1^1	c_1^2	c_1^3	c_1^4	c_1^5	c_1^6	d_1^1	d_1^2	d_1^3	d_1^4
2	a_2^1	b_2^1	b_2^2	b_2^3	c_2^1	c_2^2	c_2^3	c_2^4	c_2^5	c_2^6	d_2^1	d_2^2	d_2^3	d_2^4
3	a_3^1	b_3^1			c_3^1	c_3^2					d_3^1	d_3^2		
4	a_4^1	b_4^1	b_4^2	b_4^3	c_4^1	c_4^2	c_4^3	c_4^4			d_4^1	d_4^2	d_4^3	
5	a_5^1	b_5^1	b_5^2		c_5^1	c_5^2	c_5^3				d_5^1	d_5^2	d_5^3	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

[00114] In Table 3A, parameters (e.g., a_0^1 and b_0^2) may indicate applicable TDRA indexes. The applicable TDRA indexes (e.g., a_0^1 and b_0^2) may be integer values larger than or equal to 0. Each applicable TDRA index may represent the TDRA index for a corresponding cell in a TDRA list configured for the corresponding cell (e.g., the TDRA lists for single-cell scheduling for the corresponding cell). For example, each TDRA index for a cell may correspond to one PDSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K0}) in the TDRA list applicable for DCI format 1_1 for the cell, or one PUSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K2}) in the TDRA list applicable for DCI format 0_1 for the cell. Within each entry of the TDRA list, the plurality sets of TDRA indexes for cell #1 to cell #4 are ordered in an ascending order of the serving cell indexes of cell #1 to cell #4, and TDRA indexes in each set of TDRA indexes are ordered in an ascending order of transmission time.

[00115] For example, a_0^1 in the first entry of the TDRA list in Table 3A may represent the TDRA index for cell #1 in a TDRA list specifically configured for cell #1; a_2^1 in the third entry of the TDRA list in Table 3A may represent the TDRA index for cell #1 in the TDRA list specifically configured for cell #1; b_0^1 and b_0^2 in the first entry of the TDRA list in Table 3A may represent two TDRA indexes for cell #2 in a TDRA list specifically configured for cell #2; c_2^1 , c_2^2 , c_2^3 , c_2^4 , c_2^5 , and c_2^6 in the third entry of the TDRA list in Table 3A may represent the TDRA indexes for cell #3 in a TDRA list specifically configured for cell #3; and d_2^1 , d_2^2 , d_2^3 , and d_2^4 in the third entry of the TDRA list in Table 3A may represent the TDRA indexes for cell #4 in a TDRA list

specifically configured for cell #4.

[00116] In some embodiments, each TDRA index in a set of TDRA indexes may indicate an applicable or inapplicable TDRA index. Each applicable or inapplicable TDRA index may correspond to one channel (e.g., PDSCH or PUSCH); however, an inapplicable TDRA index implicitly indicates that the corresponding channel is not scheduled. The number of TDRA indexes in one set of TDRA indexes may be independent (e.g., different) from that in another set of TDRA indexes. The number of applicable (or inapplicable) TDRA indexes in one set of TDRA indexes may be independent (e.g., different) from that in another set of TDRA indexes. For example, referring to FIG. 2, in one entry of TDRA list #B, CC 251 may be configured with one applicable TDRA index, CC 252 may be configured with three applicable TDRA indexes, CC 253 may be configured with six applicable TDRA indexes and CC 254 may be configured with four applicable TDRA indexes. The number of TDRA indexes in a set of TDRA indexes may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the set of TDRA indexes. In some embodiments, the number of applicable and inapplicable TDRA indexes in a set of TDRA indexes being equal to the maximum number of channels schedulable by a single DCI on the corresponding cell can facilitate the encapsulation of the signaling.

[00117] An applicable TDRA index in a set of TDRA indexes may indicate (e.g., point to) an entry of a TDRA list for single-cell scheduling for a cell corresponding to the set of TDRA indexes. Each applicable TDRA index in a set of TDRA indexes may correspond to one TDRA information set (e.g., one configuration of {SLIV, mapping type, K0 or K2}) in the TDRA list for single-cell scheduling for the cell corresponding to the set of TDRA indexes. Each applicable TDRA index may be an integer value larger than or equal to 0 and may not exceed the largest TDRA index in the TDRA list for single-cell scheduling for the cell. Each inapplicable TDRA index may indicate a minus value (e.g., -1), thereby indicating that the corresponding channel is not scheduled. The number of channels scheduled on a cell may be dependent on the number of applicable TDRA indexes in the corresponding set of TDRA indexes.

[00118] Table 3B below shows an exemplary TDRA list for multi-cell and multi-

channel scheduling. It should be understood that Table 3B is only for illustrative purposes, and should not be construed as limiting the embodiments of the present disclosure. Assuming that a BS configures cell set #1 including cell #1 to cell #4 for a UE, the BS may further configure the TDRA list shown in Table 3B for cell set #1 via RRC signaling.

Table 3B: TDRA list for multi-cell and multi-channel scheduling

Entry index	TDRA index for cell #1	TDRA index for cell #2			TDRA index for cell #3						TDRA index for cell #4			
0	a_0^1	b_0^1	b_0^2	-1	c_0^1	c_0^2	c_0^3	c_0^4	-1	-1	d_0^1	d_0^2	-1	-1
1	a_1^1	b_1^1	b_1^2	-1	c_1^1	c_1^2	c_1^3	c_1^4	c_1^5	c_1^6	d_1^1	d_1^2	d_1^3	d_1^4
2	a_2^1	b_2^1	b_2^2	b_2^3	c_2^1	c_2^2	c_2^3	c_2^4	c_2^5	c_2^6	d_2^1	d_2^2	d_2^3	d_2^4
3	a_3^1	b_3^1	-1	-1	c_3^1	c_3^2	-1	-1	-1	-1	d_3^1	d_3^2	-1	-1
4	a_4^1	b_4^1	b_4^2	b_4^3	c_4^1	c_4^2	c_4^3	c_4^4	-1	-1	d_4^1	d_4^2	d_4^3	-1
5	a_5^1	b_5^1	b_5^2	-1	c_5^1	c_5^2	c_5^3	-1	-1	-1	d_5^1	d_5^2	d_5^3	-1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

[00119] In Table 3B, the value of "-1" may indicate an inapplicable TDRA index and the remaining parameters (e.g., a_0^1 and b_0^2) may indicate applicable TDRA indexes. The applicable TDRA indexes (e.g., a_0^1 and b_0^2) may be integer values larger than or equal to 0. Each applicable TDRA index may represent the TDRA index for a corresponding cell in a TDRA list configured for the corresponding cell (e.g., the TDRA lists for single-cell scheduling for the corresponding cell). For example, each applicable TDRA index for a cell may correspond to one PDSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K0}) in the TDRA list applicable for DCI format 1_1 for the cell, or one PUSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K2}) in the TDRA list applicable for DCI format 0_1 for the cell. The inapplicable TDRA index value of "-1" indicates that the corresponding PDSCH or PUSCH is not scheduled. Within each entry of the TDRA list, the plurality sets of TDRA indexes for cell #1 to cell #4 are ordered in an ascending order of the serving cell indexes of cell #1 to cell #4, and TDRA indexes in each set of TDRA indexes are ordered in an ascending order of transmission time.

[00120] For example, a_0^1 in the first entry of the TDRA list in Table 3B may represent

the TDRA index for cell #1 in a TDRA list specifically configured for cell #1; a_2^1 in the third entry of the TDRA list in Table 3B may represent the TDRA index for cell #1 in the TDRA list specifically configured for cell #1; b_0^1 and b_0^2 in the first entry of the TDRA list in Table 3B may represent two TDRA indexes for cell #2 in a TDRA list specifically configured for cell #2; c_2^1 , c_2^2 , c_2^3 , c_2^4 , c_2^5 , and c_2^6 in the third entry of the TDRA list in Table 3B may represent the TDRA indexes for cell #3 in a TDRA list specifically configured for cell #3; and d_2^1 , d_2^2 , d_2^3 , and d_2^4 in the third entry of the TDRA list in Table 3B may represent the TDRA indexes for cell #4 in a TDRA list specifically configured for cell #4.

[00121] In some embodiments, a size of TDRA field #B (e.g., the number of bits of TDRA field #B) in the DCI may be dependent on the number of entries in TDRA list #B. For example, assuming that there are Y' entries in TDRA list #B for cell set #1, then the TDRA field may require $\lceil \log_2 Y' \rceil$ bits for pointing out one entry from the Y' entries.

[00122] In some embodiments, for a cell which is not indicated as a scheduled cell by cell indicator #B, the corresponding set of TDRA indexes for this cell, as indicated by TDRA field #B, is neglected or ignored when determining the time domain resources for co-scheduled channels. For example, referring to Table 3A, TDRA field #B in a DCI may point to the second entry (i.e., entry index = 1) and cell indicator #B in the DCI may indicate that cell #1 is not scheduled, then the TDRA index of a_1^1 for cell #1 is ignored. That is, it makes no sense to determine the time domain resources on an unscheduled cell.

[00123] In this way, the time domain resource allocations for all cells of the set of cells are fully reused and signaling overhead can be greatly reduced.

[00124] In some embodiments of the present disclosure, in the case of multi-cell and multi-channel scheduling, the co-scheduled cells among cell set #1, the one or more channels (e.g., PDSCHs or PUSCHs) scheduled on each scheduled cell as well as the corresponding time domain resources for all the scheduled channels on all the co-scheduled cells are indicated by a set of TDRA fields in the scheduling DCI. Each TDRA field may correspond to a cell in cell set #1 and may point to an entry from a

TDRA list for the corresponding cell. All TDRA lists of cells in cell set #1 thus form a set of TDRA lists (denoted as TDRA list set #C) for cell set #1.

[00125] In some embodiments, each TDRA list in TDRA list set #C may be configured by RRC signaling, preconfigured or predefined, and may be associated with the DCI. Each TDRA list in TDRA list set #C may be configured independently of one another.

[00126] In some embodiments, each TDRA list in TDRA list set #C may correspond to a TDRA list for multi-channel scheduling for a corresponding cell in cell set #1. Each TDRA list for multi-channel scheduling may include at least one entry, each of which may indicate one or more TDRA information sets (e.g., one or more configurations of {SLIV, mapping type, K0 or K2}) for multi-channel scheduling on the corresponding cell. The one or more TDRA information sets may be ordered according to time (e.g., an ascending or descending order of transmission time). For example, the first TDRA information set may correspond to the earliest scheduled PDSCH or PUSCH, the second TDRA information set may correspond to the second earliest PDSCH or PUSCH, ..., the last TDRA information set may correspond to the last scheduled PDSCH or PUSCH. For example, the first TDRA information set may correspond to the last scheduled PDSCH or PUSCH, the second TDRA information set may correspond to the second last PDSCH or PUSCH, ..., the last TDRA information set may correspond to the earliest scheduled PDSCH or PUSCH.

[00127] In some embodiments, each TDRA information set may correspond to one channel (e.g., PDSCH or PUSCH) on a corresponding cell. Each TDRA list in TDRA list set #C may include only applicable TDRA information set. The number of TDRA information sets in each entry of a TDRA list in TDRA list set #C may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the TDRA list in TDRA list set #C.

[00128] The number of TDRA information sets in one TDRA list in TDRA list set #C may be independent (e.g., different) from that in another TDRA list. For example, referring to FIG. 2, CC 251 may be configured with one TDRA information set, CC 252 may be configured with three TDRA information sets, CC 253 may be configured with six TDRA information sets and CC 254 may be configured with four TDRA information sets. The number of channels (e.g., PDSCH or PUSCH) scheduled on a

cell may be dependent on the number of TDRA information sets in the indicated entry in a corresponding TDRA list. In some embodiments, an entry with no TDRA information set, when indicated, may imply that the cell is not scheduled. In some embodiments, a TDRA field having an invalid or inapplicable value may indicate that the corresponding cell is not scheduled.

[00129] Table 4A-1 to Table 4A-4 below show exemplary TDRA lists for multi-channel scheduling. It should be understood that these tables are only for illustrative purposes, and should not be construed as limiting the embodiments of the present disclosure. Assuming that a BS configures cell set #1 including cell #1 to cell #4 for a UE, the BS may further configure the TDRA lists shown in Table 4A-1 to Table 4A-4 for cell #1 to cell #4 in cell set #1 via RRC signaling.

Table 4A-1: TDRA list for multi-channel scheduling

Entry index	TDRA index for cell #1
0	a_0^1
1	a_1^1
2	a_2^1
3	a_3^1
4	a_4^1
5	a_5^1
...	...

Table 4A-2: TDRA list for multi-channel scheduling

Entry index	TDRA index for cell # 2		
0	b_0^1	b_0^2	
1	b_1^1	b_1^2	
2	b_2^1	b_2^2	b_2^3
3	b_3^1		
4	b_4^1	b_4^2	b_4^3
5	b_5^1	b_5^2	
...	...	...	...

Table 4A-3: TDRA list for multi-channel scheduling

Entry index	TDRA index for cell # 3					
0	c_0^1	c_0^2	c_0^3	c_0^4		
1	c_1^1	c_1^2	c_1^3	c_1^4	c_1^5	c_1^6
2	c_2^1	c_2^2	c_2^3	c_2^4	c_2^5	c_2^6
3	c_3^1	c_3^2				
4	c_4^1	c_4^2	c_4^3	c_4^4		
5	c_5^1	c_5^2	c_5^3			
...	...	...	...	...	...	...

Table 4A-4: TDRA list for multi-channel scheduling

Entry index	TDRA index for cell # 4			
0	d_0^1	d_0^2		
1	d_1^1	d_1^2	d_1^3	d_1^4
2	d_2^1	d_2^2	d_2^3	d_2^4
3	d_3^1	d_3^2		
4	d_4^1	d_4^2	d_4^3	
5	d_5^1	d_5^2	d_5^3	
...	...	...	...	...

[00130] According to the above embodiments, parameters (e.g., a_0^1 , b_0^2 , c_1^1 and d_5^2) in Table 4A-1 to Table 4A-4 may indicate applicable TDRA information sets. For example, each applicable TDRA information set may correspond to one PDSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K0}) or one PUSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K2}). Within each entry of the TDRA lists in Table 4A-1 to Table 4A-4, one or multiple TDRA information sets are ordered in an ascending order of time.

[00131] For example, a_0^1 in the first entry of the TDRA list in Table 4A-1 may represent one TDRA information set for cell #1, which may correspond to one channel scheduled on cell #1; b_0^1 and b_0^2 in the first entry of the TDRA list in Table 4A-2 may represent two TDRA information sets for cell #2, which may correspond to two channels scheduled on cell #2; c_2^1 , c_2^2 , c_2^3 , c_2^4 , c_2^5 , and c_2^6 in the third entry of the TDRA list in Table 4A-3 may represent six TDRA information sets for cell #3, which may correspond to six channels scheduled on cell #3; and d_2^1 , d_2^2 , d_2^3 , and d_2^4 in the

third entry of the TDRA list in Table 4A-4 may represent four TDRA information sets for cell #4, which may correspond to four channels scheduled on cell #4.

[00132] In some embodiments, each entry in a TDRA list in TDRA list set #C may include applicable or inapplicable TDRA information set. Each applicable or inapplicable TDRA information set may correspond to one channel (e.g., PDSCH or PUSCH); however, an inapplicable TDRA information set implicitly indicates that the corresponding channel is not scheduled. The number of TDRA information sets in each entry of a TDRA list in TDRA list set #C may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the TDRA list in TDRA list set #C. In some embodiments, the number of applicable and inapplicable TDRA information sets in each entry of a TDRA list being equal to the maximum number of channels schedulable by a single DCI on the corresponding cell can facilitate the encapsulation of the signaling.

[00133] The number of TDRA information sets in one TDRA list in TDRA list set #C may be independent (e.g., different) from that in another TDRA list. The number of applicable (or inapplicable) TDRA information sets in one TDRA list in TDRA list set #C may be independent (e.g., different) from that in another TDRA list. For example, referring to FIG. 2, CC 251 may be configured with one TDRA information set, CC 252 may be configured with three TDRA information sets, CC 253 may be configured with six TDRA information sets and CC 254 may be configured with four TDRA information sets. The number of channels (e.g., PDSCH or PUSCH) scheduled on a cell may be dependent on the number of applicable TDRA information sets in the indicated entry in a corresponding TDRA list. In some embodiments, an entry with only inapplicable TDRA information set, when indicated, may imply that the cell is not scheduled. In some embodiments, a TDRA field having an invalid or inapplicable value may indicate that the corresponding cell is not scheduled.

[00134] Table 4B-1 to Table 4B-4 below show exemplary TDRA lists for multi-channel scheduling. It should be understood that these tables are only for illustrative purposes, and should not be construed as limiting the embodiments of the present disclosure. Assuming that a BS configures cell set #1 including cell #1 to cell #4 for a UE, the BS may further configure the TDRA lists shown in Table 4B-1 to Table 4B-4 for cell #1 to

cell #4 in cell set #1 via RRC signaling.

Table 4B-1: TDRA list for multi-channel scheduling

Entry index	TDRA index for cell #1
0	a_0^1
1	a_1^1
2	a_2^1
3	a_3^1
4	a_4^1
5	a_5^1
...	...

Table 4B-2: TDRA list for multi-channel scheduling

Entry index	TDRA index for cell #2		
0	b_0^1	b_0^2	-1
1	b_1^1	b_1^2	-1
2	b_2^1	b_2^2	b_2^3
3	b_3^1	-1	-1
4	b_4^1	b_4^2	b_4^3
5	b_5^1	b_5^2	-1
...	...	...	...

Table 4B-3: TDRA list for multi-channel scheduling

Entry index	TDRA index for cell #3					
0	c_0^1	c_0^2	c_0^3	c_0^4	-1	-1
1	c_1^1	c_1^2	c_1^3	c_1^4	c_1^5	c_1^6
2	c_2^1	c_2^2	c_2^3	c_2^4	c_2^5	c_2^6
3	c_3^1	c_3^2	-1	-1	-1	-1
4	c_4^1	c_4^2	c_4^3	c_4^4	-1	-1
5	c_5^1	c_5^2	c_5^3	-1	-1	-1
...	...	...	...	...	...	...

Table 4B-4: TDRA list for multi-channel scheduling

Entry index	TDRA index for cell #4			
0	d_0^1	d_0^2	-1	-1
1	d_1^1	d_1^2	d_1^3	d_1^4
2	d_2^1	d_2^2	d_2^3	d_2^4
3	d_3^1	d_3^2	-1	-1
4	d_4^1	d_4^2	d_4^3	-1
5	d_5^1	d_5^2	d_5^3	-1
...	...	...	...	...

[00135] According to the above embodiments, the value of "-1" in Table 4B-1 to Table 4B-4 may correspond to an inapplicable TDRA information set and indicate that the corresponding PDSCH or PUSCH is not scheduled, and the remaining parameters (e.g., a_0^1 , b_0^2 , c_1^1 and d_5^2) in Table 4B-1 to Table 4B-4 may indicate applicable TDRA information sets. For example, each applicable TDRA information set may correspond to one PDSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K0}) or one PUSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K2}). Within each entry of the TDRA lists in Table 4B-1 to Table 4B-4, one or multiple TDRA information sets are ordered in an ascending order of time.

[00136] For example, a_0^1 in the first entry of the TDRA list in Table 4B-1 may represent one TDRA information set for cell #1, which may correspond to one channel scheduled on cell #1; b_0^1 and b_0^2 in the first entry of the TDRA list in Table 4B-2 may represent two TDRA information sets for cell #2, which may correspond to two channels scheduled on cell #2; c_2^1 , c_2^2 , c_2^3 , c_2^4 , c_2^5 , and c_2^6 in the third entry of the TDRA list in Table 4B-3 may represent six TDRA information sets for cell #3, which may correspond to six channels scheduled on cell #3; and d_2^1 , d_2^2 , d_2^3 , and d_2^4 in the third entry of the TDRA list in Table 4B-4 may represent four TDRA information sets for cell #4, which may correspond to four channels scheduled on cell #4.

[00137] In some embodiments, each TDRA list in TDRA list set #C may include at least one entry, each of which may include a set of TDRA indexes for a corresponding cell in cell set #1. An applicable TDRA index for a cell may indicate (e.g., point to) an entry of a TDRA list for single-cell scheduling for the cell. That is, an applicable

TDRA index in a TDRA list may correspond to one TDRA information set (e.g., one configuration of {SLIV, mapping type, K0 or K2}) in the TDRA list for single-cell scheduling for the corresponding cell. An applicable TDRA index may be an integer value larger than or equal to 0 and may not exceed the largest TDRA index in the TDRA list for single-cell scheduling for the corresponding cell. TDRA indexes in a set of TDRA indexes may be ordered according to time (e.g., an ascending or descending order of transmission time).

[00138] In some embodiments, each TDRA index may correspond to one channel (e.g., PDSCH or PUSCH) on a corresponding cell. Each TDRA list in TDRA list set #C may include only applicable TDRA index. The number of TDRA index in each entry of a TDRA list in TDRA list set #C may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the TDRA list in TDRA list set #C.

[00139] The number of TDRA indexes in one TDRA list in TDRA list set #C may be independent (e.g., different) from that in another TDRA list. For example, referring to FIG. 2, CC 251 may be configured with one TDRA index, CC 252 may be configured with three TDRA indexes, CC 253 may be configured with six TDRA indexes and CC 254 may be configured with four TDRA indexes. The number of channels (e.g., PDSCH or PUSCH) scheduled on a cell may be dependent on the number of TDRA indexes in the indicated entry in a corresponding TDRA list in TDRA list set #C. In some embodiments, an entry with no TDRA index, when indicated, may imply that the cell is not scheduled. In some embodiments, a TDRA field having an invalid or inapplicable value may indicate that the corresponding cell is not scheduled.

[00140] According to the above embodiments, each parameter (e.g., a_0^1 , b_0^1 , c_2^1 or d_2^1) in Table 4A-1 to Table 4A-4 may indicate an applicable TDRA index, for example, representing a TDRA index for a corresponding cell in a TDRA list configured for the cell (e.g., the TDRA lists for single-cell scheduling for the cell). For example, each applicable TDRA index may correspond to one PDSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K0}) or one PUSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K2}). Within each entry of the TDRA lists in Table 4A-1 to Table 4A-4, one or

multiple TDRA indexes are ordered in an ascending order of time.

[00141] For example, a_0^1 in the first entry of the TDRA list in Table 4A-1 may represent the TDRA index for cell #1 in a TDRA list specifically configured for cell #1; b_0^1 and b_0^2 in the first entry of the TDRA list in Table 4A-2 may represent two TDRA indexes for cell #2 in a TDRA list specifically configured for cell #2; c_2^1 , c_2^2 , c_2^3 , c_2^4 , c_2^5 , and c_2^6 in the third entry of the TDRA list in Table 4A-3 may represent six TDRA indexes for cell #3 in a TDRA list specifically configured for cell #3; and d_2^1 , d_2^2 , d_2^3 , and d_2^4 in the third entry of the TDRA list in Table 4A-4 may represent four TDRA indexes for cell #4 in a TDRA list specifically configured for cell #4.

[00142] In some embodiments, each TDRA index in a TDRA list in TDRA list set #C may indicate an applicable or inapplicable TDRA index. Each applicable or inapplicable TDRA index may correspond to one channel (e.g., PDSCH or PUSCH); however, an inapplicable TDRA index implicitly indicates that the corresponding channel is not scheduled. The number of TDRA indexes in each entry of a TDRA list in TDRA list set #C may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the TDRA list in TDRA list set #C. In some embodiments, the number of applicable and inapplicable TDRA indexes in each entry of a TDRA list being equal to the maximum number of channels schedulable by a single DCI on the corresponding cell can facilitate the encapsulation of the signaling.

[00143] The number of TDRA indexes in one TDRA list in TDRA list set #C may be independent (e.g., different) from that in another TDRA list. The number of applicable (or inapplicable) TDRA indexes in one TDRA list in TDRA list set #C may be independent (e.g., different) from that in another TDRA list. The number of channels (e.g., PDSCH or PUSCH) scheduled on a cell may be dependent on the number of applicable TDRA indexes in the indicated entry in a corresponding TDRA list in TDRA list set #C. In some embodiments, an entry with only inapplicable TDRA index, when indicated, may imply that the cell is not scheduled. In some embodiments, a TDRA field having an invalid or inapplicable value may indicate that the corresponding cell is not scheduled.

[00144] According to the above embodiments, the value of "-1" in Table 4B-1 to Table 4B-4 may correspond to an inapplicable TDRA index and may indicate that the corresponding channel is not scheduled; and each of the remaining parameters (e.g., a_0^1 , b_0^1 , c_2^1 or d_2^1) in Table 4B-1 to Table 4B-4 may indicate an applicable TDRA index, for example, representing a TDRA index for a corresponding cell in a TDRA list configured for the cell (e.g., the TDRA lists for single-cell scheduling for the cell). For example, each applicable TDRA index may correspond to one PDSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K0}) or one PUSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K2}). Within each entry of the TDRA lists in Table 4B-1 to Table 4B-4, one or multiple TDRA indexes are ordered in an ascending order of time.

[00145] For example, a_0^1 in the first entry of the TDRA list in Table 4B-1 may represent the TDRA index for cell #1 in a TDRA list specifically configured for cell #1; b_0^1 and b_0^2 in the first entry of the TDRA list in Table 4B-2 may represent two TDRA indexes for cell #2 in a TDRA list specifically configured for cell #2; c_2^1 , c_2^2 , c_2^3 , c_2^4 , c_2^5 , and c_2^6 in the third entry of the TDRA list in Table 4B-3 may represent six TDRA indexes for cell #3 in a TDRA list specifically configured for cell #3; and d_2^1 , d_2^2 , d_2^3 , and d_2^4 in the third entry of the TDRA list in Table 4B-4 may represent four TDRA indexes for cell #4 in a TDRA list specifically configured for cell #4.

[00146] In some embodiments, a size of the entire TDRA field (e.g., the number of bits of the entire TDRA field) in a DCI may be dependent on the number of entries in each TDRA list in TDRA list set #C. For example, assuming that cell set #1 include four cells and there are Y1, Y2, Y3 and Y4 entries respectively configured in the corresponding TDRA lists for the four cells, then the entire TDRA field may require $\lceil \log_2 Y1 \rceil + \lceil \log_2 Y2 \rceil + \lceil \log_2 Y3 \rceil + \lceil \log_2 Y4 \rceil$ bits for separately pointing out one entry from the corresponding number of entries (i.e., Y1, Y2, Y3 and Y4 entries).

[00147] In this way, the time domain resource allocations for all cells of the set of cells are fully reused and signaling overhead can be greatly reduced.

[00148] In some embodiments of the present disclosure, in the case of multi-cell and multi-channel scheduling, the co-scheduled cells among cell set #1 are indicated by a

cell indicator (denoted as cell indicator #D) in the scheduling DCI. In some embodiments, cell indicator #D may point to one entry of a cell combination table, which includes at least one entry with each entry corresponding to one scheduled cell combination. Each scheduled cell combination may include one or more cell indexes, thereby indicating the scheduled cells. The cell combination table may be configured by RRC signaling, preconfigured or predefined.

[00149] The one or more channels (e.g., PDSCHs or PUSCHs) scheduled on each scheduled cell as well as the corresponding time domain resources for the scheduled channels are indicated by a set of TDRA fields in the scheduling DCI. Each TDRA field may correspond to a cell in cell set #1 and may point to an entry from a TDRA list for the corresponding cell. All TDRA lists of cells in cell set #1 thus form a set of TDRA lists (denoted as TDRA list set #D) for cell set #1.

[00150] In some embodiments, each TDRA list in TDRA list set #D may be configured by RRC signaling, preconfigured or predefined, and may be associated with the DCI. Each TDRA list in TDRA list set #D may be configured independently of one another.

[00151] In some embodiments, each TDRA list in TDRA list set #D may correspond to a TDRA list for multi-channel scheduling for a corresponding cell in cell set #1. Each TDRA list for multi-channel scheduling may include at least one entry, each of which may indicate one or more TDRA information sets (e.g., one or more configurations of {SLIV, mapping type, K0 or K2}) for multi-channel scheduling on the corresponding cell. The one or more TDRA information sets may be ordered according to time (e.g., an ascending or descending order of transmission time). For example, the first TDRA information set may correspond to the earliest scheduled PDSCH or PUSCH, the second TDRA information set may correspond to the second earliest PDSCH or PUSCH, ..., the last TDRA information set may correspond to the last scheduled PDSCH or PUSCH. For example, the first TDRA information set may correspond to the last scheduled PDSCH or PUSCH, the second TDRA information set may correspond to the second last PDSCH or PUSCH, ..., the last TDRA information set may correspond to the earliest scheduled PDSCH or PUSCH.

[00152] In some embodiments, each TDRA information set may correspond to one channel (e.g., PDSCH or PUSCH) on a corresponding cell. Each TDRA list in TDRA

list set #D may include only applicable TDRA information set. The number of TDRA information sets in each entry of a TDRA list in TDRA list set #D may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the TDRA list in TDRA list set #D.

[00153] The number of TDRA information sets in one TDRA list in TDRA list set #D may be independent (e.g., different) from that in another TDRA list. For example, referring to FIG. 2, CC 251 may be configured with one TDRA information set, CC 252 may be configured with three TDRA information sets, CC 253 may be configured with six TDRA information sets and CC 254 may be configured with four TDRA information sets. The number of channels (e.g., PDSCH or PUSCH) scheduled on a cell may be dependent on the number of TDRA information sets in the indicated entry in a corresponding TDRA list.

[00154] The exemplary TDRA lists for multi-channel scheduling as shown in Table 4A-1 to Table 4A-4 may apply here. For example, assuming that a BS configures cell set #1 including cell #1 to cell #4 for a UE, the BS can further configure TDRA list set #D including the TDRA lists shown in Table 4A-1 to Table 4A-4 for cell #1 to cell #4 via RRC signaling. Each parameter (e.g., a_0^1 , b_0^1 , c_2^1 or d_2^1) in Table 4A-1 to Table 4A-4 corresponds to one applicable TDRA information set, for example, one PDSCH time domain resource allocation (i.e., {SLIV, mapping type, K0}) or one PUSCH time domain resource allocation (i.e., {SLIV, mapping type, K2}). A DCI may indicate the time domain resources on each cell by using a TDRA field pointing to an entry of a corresponding TDRA list, which may include one or more TDRA information sets, with each corresponding to a channel scheduled on the cell.

[00155] In some embodiments, each entry in a TDRA list in TDRA list set #D may include applicable or inapplicable TDRA information set. Each applicable or inapplicable TDRA information set may correspond to one channel (e.g., PDSCH or PUSCH); however, an inapplicable TDRA information set implicitly indicates that the corresponding channel is not scheduled. The number of TDRA information sets in each entry of a TDRA list in TDRA list set #D may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the TDRA list in TDRA list set #D. In some embodiments,

the number of applicable and inapplicable TDRA information sets in each entry of a TDRA list being equal to the maximum number of channels schedulable by a single DCI on the corresponding cell can facilitate the encapsulation of the signaling.

[00156] The number of TDRA information sets in one TDRA list in TDRA list set #D may be independent (e.g., different) that in another TDRA list. The number of applicable (or inapplicable) TDRA information sets in one TDRA list in TDRA list set #D may be independent (e.g., different) that in another TDRA list. For example, referring to FIG. 2, CC 251 may be configured with one TDRA information set, CC 252 may be configured with three TDRA information sets, CC 253 may be configured with six TDRA information sets and CC 254 may be configured with four TDRA information sets. The number of channels (e.g., PDSCH or PUSCH) scheduled on a cell may be dependent on the number of applicable TDRA information sets in the indicated entry in a corresponding TDRA list.

[00157] The exemplary TDRA lists for multi-channel scheduling as shown in Table 4B-1 to Table 4B-4 may apply here. For example, assuming that a BS configures cell set #1 including cell #1 to cell #4 for a UE, the BS can further configure TDRA list set #D including the TDRA lists shown in Table 4B-1 to Table 4B-4 for cell #1 to cell #4 via RRC signaling. The value of "-1" in Table 4B-1 to Table 4B-4 corresponds to an inapplicable TDRA information set and indicates that the corresponding PDSCH or PUSCH is not scheduled. Each of the remaining parameters (e.g., a_0^1 , b_0^1 , c_2^1 or d_2^1) in Table 4B-1 to Table 4B-4 corresponds to an applicable TDRA information set. For example, each applicable TDRA information set may correspond to one PDSCH time domain resource allocation (i.e., {SLIV, mapping type, K0}) or one PUSCH time domain resource allocation (i.e., {SLIV, mapping type, K2}). Within each entry of the TDRA lists in Table 4B-1 to Table 4B-4, one or multiple TDRA information sets are ordered in an ascending order of time. A DCI may indicate the time domain resources on each cell by using a TDRA field pointing to an entry of a corresponding TDRA list, which may include one or more TDRA information sets, with each corresponding to a channel.

[00158] In some embodiments, each TDRA list in TDRA list set #D may include at least one entry, each of which may include a set of TDRA indexes for a corresponding

cell in cell set #1. An applicable TDRA index in the set of TDRA indexes for a cell may indicate (e.g., point to) an entry of a TDRA list for single-cell scheduling for the cell. That is, each TDRA index may correspond to one TDRA information set (e.g., one configuration of {SLIV, mapping type, K0 or K2}) in the TDRA list for single-cell scheduling for the corresponding cell. An applicable TDRA index may be an integer value larger than or equal to 0 and may not exceed the largest TDRA index in the TDRA list for single-cell scheduling for the corresponding cell. TDRA indexes in a set of TDRA indexes may be ordered according to time (e.g., an ascending or descending order of transmission time).

[00159] In some embodiments, each TDRA index may correspond to one channel (e.g., PDSCH or PUSCH) on a corresponding cell. Each TDRA list in TDRA list set #D may include only applicable TDRA index. The number of TDRA index in each entry of a TDRA list in TDRA list set #D may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the TDRA list in TDRA list set #D.

[00160] The number of TDRA indexes in one TDRA list in TDRA list set #D may be independent (e.g., different) from that in another TDRA list. For example, referring to FIG. 2, CC 251 may be configured with one TDRA index, CC 252 may be configured with three TDRA indexes, CC 253 may be configured with six TDRA indexes and CC 254 may be configured with four TDRA indexes. The number of channels (e.g., PDSCH or PUSCH) scheduled on a cell may be dependent on the number of TDRA indexes in the indicated entry in a corresponding TDRA list in TDRA list set #D.

[00161] The exemplary TDRA lists for multi-channel scheduling as shown in Table 4A-1 to Table 4A-4 may apply here. For example, assuming that a BS configures cell set #1 including cell #1 to cell #4 for a UE, the BS can further configure TDRA list set #D including the TDRA lists shown in Table 4A-1 to Table 4A-4 for cell #1 to cell #4 via RRC signaling. According to the above embodiments, each parameter (e.g., a_0^1 , b_0^1 , c_2^1 or d_2^1) in Table 4A-1 to Table 4A-4 may indicate an applicable TDRA index, for example, representing a TDRA index for a corresponding cell in a TDRA list configured for the cell (e.g., the TDRA lists for single-cell scheduling for the cell). For example, each applicable TDRA index may correspond to one PDSCH time domain

resource allocation (i.e., one TDRA information set {SLIV, mapping type, K0}) or one PUSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K2}). Within each entry of the TDRA lists in Table 4A-1 to Table 4A-4, one or multiple TDRA indexes are ordered in an ascending order of time.

[00162] In some embodiments, each TDRA index in a TDRA list in TDRA list set #D may indicate an applicable or inapplicable TDRA index. Each applicable or inapplicable TDRA index may correspond to one channel (e.g., PDSCH or PUSCH); however, an inapplicable TDRA index implicitly indicates that the corresponding channel is not scheduled. The number of TDRA indexes in each entry of a TDRA list in TDRA list set #D may be equal to or smaller than the maximum number of channels (e.g., PDSCHs or PUSCHs) schedulable by a single DCI on the cell corresponding to the TDRA list in TDRA list set #D. In some embodiments, the number of applicable and inapplicable TDRA indexes in each entry of a TDRA list being equal to the maximum number of channels schedulable by a single DCI on the corresponding cell can facilitate the encapsulation of the signaling.

[00163] The number of TDRA indexes in one TDRA list in TDRA list set #D may be independent (e.g., different) from that in another TDRA list. The number of applicable (or inapplicable) TDRA indexes in one TDRA list in TDRA list set #D may be independent (e.g., different) from that in another TDRA list. The number of channels (e.g., PDSCH or PUSCH) scheduled on a cell may be dependent on the number of applicable TDRA indexes in the indicated entry in a corresponding TDRA list in TDRA list set #D.

[00164] The exemplary TDRA lists for multi-channel scheduling as shown in Table 4B-1 to Table 4B-4 may apply here. For example, assuming that a BS configures cell set #1 including cell #1 to cell #4 for a UE, the BS can further configure TDRA list set #D including the TDRA lists shown in Table 4B-1 to Table 4B-4 for cell #1 to cell #4 via RRC signaling. According to the above embodiments, the value of "-1" in Table 4B-1 to Table 4B-4 corresponds to an inapplicable TDRA index and thus indicates that the corresponding channel is not scheduled, and each of the remaining parameters (e.g., a_0^1 , b_0^1 , c_2^1 or d_2^1) in Table 4B-1 to Table 4B-4 may indicate an applicable TDRA index, for example, representing a TDRA index for a corresponding cell in a TDRA list

configured for the cell (e.g., the TDRA lists for single-cell scheduling for the cell). For example, each applicable TDRA index may correspond to one PDSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K0}) or one PUSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K2}). Within each entry of the TDRA lists in Table 4B-1 to Table 4B-4, one or multiple TDRA indexes are ordered in an ascending order of time.

[00165] In some embodiments, a size of the entire TDRA field (e.g., the number of bits of the entire TDRA field) in a DCI may be dependent on the number of entries in each TDRA list in TDRA list set #D. For example, assuming that cell set #1 include four cells and there are Y1', Y2', Y3' and Y4' entries respectively configured in the corresponding TDRA lists for the four cells, then the entire TDRA field may require $\lceil \log_2 Y1' \rceil + \lceil \log_2 Y2' \rceil + \lceil \log_2 Y3' \rceil + \lceil \log_2 Y4' \rceil$ bits for separately pointing out one entry from the corresponding number of entries (i.e., Y1', Y2', Y3' and Y4' entries).

[00166] In some embodiments, for a cell which is not indicated as a scheduled cell by cell indicator #D, the corresponding TDRA information set(s) or the corresponding set of TDRA indexes for this cell, as indicated by a corresponding TDRA field in the DCI, is neglected or ignored when determining the time domain resources for co-scheduled channels. For example, referring to Table 4A-1, a TDRA field corresponding to cell #1 in a DCI may point to the second entry (i.e., entry index = 1) and cell indicator #D in the DCI may indicate that cell #1 is not scheduled, then the parameter (e.g., a TDRA information set or a TDRA index) a_1^1 for cell #1 is ignored. That is, it makes no sense to determine the time domain resources on an unscheduled cell.

[00167] In this way, the time domain resource allocations for all cells of the set of cells are fully reused and signaling overhead can be greatly reduced.

[00168] In some embodiments of the present disclosure, to support the multi-cell and multi-channel scheduling mechanism, a DCI may include a scheduling mode indicator. The scheduling mode indicator can indicate one scheduling mode from at least the following modes: mode #1 for single-channel scheduling on a single cell; mode #2 for multi-channel scheduling on a single cell; mode #3 for multi-cell scheduling with a single channel scheduled per a scheduled cell; and mode #4 for multi-cell scheduling

with one or more channels scheduled per a scheduled cell. The scheduling mode indicator may require at least two bits. For example, bit values of “00”, “01”, “10” and “11” may indicate mode #1 to mode #4, respectively.

[00169] The DCI may further include a TDRA field (e.g., a single TDRA field) to indicate the time domain resources for the scheduled channel(s) on the scheduled cell(s) among cell set #1. For example, the TDRA field (denoted as TDRA field #E) in the DCI may indicate (point to) an entry of a TDRA list (denoted as TDRA list #E) corresponding to the scheduling mode as indicated by the scheduling mode indicator.

[00170] In response to the scheduling mode indicator indicating mode #1, TDRA list #E may correspond to a TDRA list for single-cell scheduling. That is, TDRA field #E may indicate a TDRA index which points to an entry from a TDRA list for single-cell scheduling for the scheduled cell.

[00171] In response to the scheduling mode indicator indicating mode #2, TDRA list #E may correspond to a TDRA list for multi-channel scheduling. That is, TDRA field #E may indicate a TDRA index which points to an entry from a TDRA list for multi-channel scheduling for the scheduled cell.

[00172] In response to the scheduling mode indicator indicating mode #3, TDRA list #E may correspond to a TDRA list specific for multi-cell scheduling with a single channel scheduled per a scheduled cell. For example, the TDRA list may include at least one entry, each of which includes a set of TDRA indexes with each TDRA index corresponding to a cell in cell set #1. The TDRA indexes in the set of TDRA indexes in each entry may be ordered according to cell indexes of cells in cell set #1, for example, according to an ascending or descending order of the corresponding cell indexes. The number of TDRA indexes in a set of TDRA indexes may be equal to the number of cells in cell set #1. An applicable TDRA index in the set of TDRA indexes may indicate (e.g., point to) an entry of a TDRA list for single-cell scheduling for a corresponding cell. That is, an applicable TDRA index may correspond to one TDRA information set (e.g., one configuration of {SLIV, mapping type, K0 or K2}) in the TDRA list for single-cell scheduling for the corresponding cell. An applicable TDRA index may be an integer value larger than or equal to 0 and may not exceed the largest TDRA index in the TDRA list for single-cell scheduling for the corresponding cell. An inapplicable

TDRA index in the set of TDRA indexes may indicate a minus value (e.g., -1). In some examples, the inapplicable TDRA index can indicate that the corresponding cell is not scheduled.

[00173] Table 5 below shows an exemplary TDRA list for mode #3. It should be understood that Table 5 is only for illustrative purposes, and should not be construed as limiting the embodiments of the present disclosure. Assuming that a BS configures cell set #1 including cell #1 to cell #4 for a UE, the BS may further configure the TDRA list shown in Table 5 for cell set #1 via RRC signaling.

Table 5: TDRA list for multi-cell scheduling with a single channel scheduled per a scheduled cell

Entry index	TDRA index for cell#1	TDRA index for cell #2	TDRA index for cell #3	TDRA index for cell #4
0	a_0^1	b_0^1	-1	-1
1	a_1^1	-1	c_1^1	d_1^1
2	a_2^1	b_2^1	c_2^1	d_2^1
3	a_3^1	-1	c_3^1	d_3^1
4	a_4^1	b_4^1	-1	d_4^1
5	a_5^1	b_5^1	c_5^1	-1
...	...	...	...	...

[00174] In Table 5, the value of "-1" may indicate an inapplicable TDRA index and the remaining parameters (e.g., a_0^1 and b_2^1) may indicate applicable TDRA indexes. Each applicable TDRA index may represent the TDRA index for a corresponding cell in a TDRA list configured for the corresponding cell (e.g., the TDRA lists for single-cell scheduling for the corresponding cell). For example, each applicable TDRA index for a cell may correspond to one PDSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K0}) in the TDRA list applicable for DCI format 1_1 for the cell, or one PUSCH time domain resource allocation (i.e., one TDRA information set {SLIV, mapping type, K2}) in the TDRA list applicable for DCI format 0_1 for the cell. In some examples, the inapplicable TDRA index value of "-1" may indicate that the corresponding cell is not scheduled. Within each entry of the TDRA list, TDRA indexes for cell #1 to cell #4 are ordered in an ascending order of the serving cell indexes.

[00175] For example, a_0^1 in the first entry of the TDRA list in Table 5 may represent the TDRA index for cell #1 in a TDRA list for single-cell scheduling for cell #1; b_2^1 in the third entry of the TDRA list in Table 5 may represent the TDRA index for cell #2 in a TDRA list for single-cell scheduling for cell #2; c_3^1 in the fourth entry of the TDRA list in Table 5 may represent the TDRA indexes for cell #3 in a TDRA list for single-cell scheduling for cell #3; and d_4^1 in the fifth entry of the TDRA list in Table 5 may represent the TDRA indexes for cell #4 in a TDRA list for single-cell scheduling for cell #4.

[00176] In response to the scheduling mode indicator indicating mode #4, TDRA list #E may correspond to a TDRA list for multi-cell and multi-channel scheduling. For example, the TDRA list may include at least one entry, each of which include a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in cell set #1. For example, TDRA list #A or TDRA list #B as described above may apply here.

[00177] The size of TDRA field #E (e.g., the number of bits of TDRA field #E) in a DCI may be dependent on the maximum number of entries among the plurality of TDRA lists corresponding to the plurality of scheduling modes. Denoting the maximum number of entries as N , TDRA field #E may require $\lceil \log_2 N \rceil$ bits for pointing out one entry out of a maximum of N entries.

[00178] Various method can be employed for indicating the cell(s) scheduled by the DCI. In some examples, the DCI may indicate the cell index(es) of the scheduled cell(s). For example, when only a single cell is scheduled, the DCI may directly indicate the cell index of the single cell. In some examples, the DCI may include a cell indicator to indicate one scheduled cell combination. The cell indicator can be applied to all scheduling modes. For example, cell indicator #B or cell indicator #D as described above may apply here. In some examples, the cell(s) scheduled by the DCI can be implicitly indicated. For example, the scheduled cell(s) can be determined based on the scheduling mode indicator and TDRA field #E. For example, applicable TDRA index or applicable TDRA information set for a cell, as indicated by TDRA field #E, implies that the cell is scheduled. For example, applicable frequency domain resource allocation (FDRA) value for a cell, as indicated by the DCI, implies that the

cell is scheduled.

[00179] FIG. 3 illustrates a flowchart of method 300 for wireless communication in accordance with some embodiments of the present disclosure. Details described in all of the foregoing embodiments of the present disclosure are applicable for the embodiments shown in FIG. 3. In some examples, method 300 may be performed by an intermediate node between an IoT device and a BS. For example, method 300 may be performed by a UE. In some embodiments, the UE may execute a set of instructions to control the functional elements of the UE to perform the described functions or operations. In some examples, a processor of the UE may cause the UE to perform method 300.

[00180] At 311, a UE may receive signaling for configuring a first set of cells, which is co-schedulable by a single DCI. At 313, the UE may receive the DCI scheduling a second set of cells in the first set of cells, wherein the DCI indicates TDRA information for the second set of cells. For example, the DCI indicates TDRA information for the second set of cells from a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells.

[00181] At 315, the UE may determine time domain resources on the second set of cells based on the TDRA information. At 317, the UE may receive downlink transmission or transmit uplink transmission in the determined time domain resources. For example, the UE may receive downlink channels in the determined time domain resources in response to the DCI scheduling the downlink channels. For example, the UE may transmit uplink channels in the determined time domain resources in response to the DCI scheduling the uplink channels.

[00182] In some embodiments, the single TDRA list includes at least one entry, and each entry of the at least one entry includes a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.

[00183] In some embodiments, each TDRA list of the set of TDRA lists includes at least one entry, and each entry of the at least one entry includes a set of TDRA indexes corresponding to a cell in the first set of cells.

[00184] In some embodiments, in the case that the DCI indicates the TDRA information for the second set of cells from the single TDRA list, the DCI includes a third indicator indicating a mode of the following scheduling modes of the DCI: a first mode for single-channel scheduling on a single cell; a second mode for multi-channel scheduling on a single cell; a third mode for multi-cell scheduling with a single channel scheduled per a scheduled cell; and a fourth mode for multi-cell scheduling with one or more channels scheduled per a scheduled cell; and wherein the DCI further includes a fourth indicator indicating an entry in the single TDRA list corresponding to the indicated mode.

[00185] In some embodiments, the single TDRA list corresponds to a TDRA list for single-cell scheduling in response to the third indicator indicating the first mode. In some embodiments, the single TDRA list corresponds to a TDRA list for multi-channel scheduling in response to the third indicator indicating the second mode. In some embodiments, the single TDRA list corresponds to a third TDRA list in response to the third indicator indicating the third mode, the third TDRA list including at least one entry, each of which includes a set of TDRA indexes with each TDRA index corresponding to a cell in the first set of cells. In some embodiments, the single TDRA list corresponds to a fourth TDRA list in response to the third indicator indicating the fourth mode, the fourth TDRA list including at least one entry, each of which includes including a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.

[00186] In some embodiments, each TDRA index of a set of TDRA indexes indicates an entry of a TDRA list for single-cell scheduling or an inapplicable TDRA index. In some embodiments, each TDRA index of the set of TDRA indexes indicates the entry of the TDRA list for single-cell scheduling.

[00187] In some embodiments, the plurality of sets of TDRA indexes is ordered according to cell indexes of cell(s) in the first set of cells.

[00188] In some embodiments, TDRA index(es) in a set of TDRA indexes is ordered according to time.

[00189] In some embodiments, a number of TDRA indexes in a set of TDRA indexes

is equal to or smaller than a maximum number of channels schedulable by the DCI on a corresponding cell in the first set of cells.

[00190] In some embodiments, the DCI includes a first indicator indicating a first entry of the at least one entry, the first entry including a first number of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the second set of cells and a second number of sets of TDRA indexes for remaining cell(s) in the first set of cells. A number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA indexes in a corresponding set of TDRA indexes of the first number of sets of TDRA indexes.

[00191] In some embodiments, the second number of sets of TDRA indexes include only inapplicable TDRA indexes. In some embodiments, the DCI further includes a second indicator indicating the second set of cells and determining the time domain resources on the second set of cells includes ignoring the second number of sets of TDRA indexes.

[00192] In some embodiments, a size of the first indicator is dependent on a number of entries in the single TDRA list.

[00193] In some embodiments, each TDRA list of the set of TDRA lists corresponds to a TDRA list for multi-channel scheduling for a corresponding cell in the first set of cells, and each TDRA list for multi-channel scheduling includes at least one entry, with each entry indicating one or more TDRA information sets for multi-channel scheduling on the corresponding cell.

[00194] In some embodiments, the one or more TDRA information sets for multi-channel scheduling on the corresponding cell indicate only applicable TDRA information set or indicate applicable TDRA information set or inapplicable TDRA information set.

[00195] In some embodiments, the one or more TDRA information sets for multi-channel scheduling on the corresponding cell are ordered according to time.

[00196] In some embodiments, a number of TDRA information sets in each entry of

the TDRA list for multi-channel scheduling is equal to or smaller than a maximum number of channels schedulable by the DCI on the corresponding cell in the first set of cells.

[00197] In some embodiments, the DCI includes a plurality of first indicators each corresponding to a cell in the first set of cells and a TDRA list of the set of TDRA lists. A number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA information sets or a number of applicable TDRA indexes in a corresponding TDRA list of the set of TDRA lists.

[00198] In some embodiments, a first indicator corresponding to a cell in the second set of cell indicates at least one applicable TDRA information set or at least one applicable TDRA index and a first indicator corresponding to a cell in remaining cell(s) in the first set of cells indicates an inapplicable value, only inapplicable TDRA information set, empty TDRA information set, only inapplicable TDRA index or empty TDRA index. In some embodiments, the DCI further includes a second indicator indicating the second set of cells and determining the time domain resources on the second set of cells includes ignoring first indicator(s) corresponding to the remaining cell(s) in the first set of cells.

[00199] In some embodiments, a size of each first indicator is dependent on a number of entries in a corresponding TDRA list of the set of TDRA lists.

[00200] In some embodiments, the second set of cells is determined based on the third indicator and the fourth indicator; or wherein the DCI further includes a second indicator indicating the second set of cells.

[00201] It should be appreciated by persons skilled in the art that the sequence of the operations in exemplary method 300 may be changed and some of the operations in exemplary method 300 may be eliminated or modified, without departing from the spirit and scope of the disclosure.

[00202] FIG. 4 illustrates a flowchart of method 400 for wireless communication in accordance with some embodiments of the present disclosure. Details described in all of the foregoing embodiments of the present disclosure are applicable for the

embodiments shown in FIG. 4. In some examples, method 400 may be performed by a BS. In some embodiments, the BS may execute a set of instructions to control the functional elements of the BS to perform the described functions or operations. In some examples, a processor of the BS may cause the BS to perform method 400.

[00203] At 411, a BS may transmit, to a UE, signaling for configuring a first set of cells, which is co-schedulable by a single DCI. At 413, the BS may transmit, to the UE, the DCI scheduling a second set of cells in the first set of cells and assigning time domain resources for the second set of cells. The time domain resources for the second set of cells may be indicated by TDRA information from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells. At 415, the BS may transmit downlink transmission or receive uplink transmission in the time domain resources. For example, the BS may transmit downlink channels in the time domain resources in response to the DCI scheduling the downlink channels. For example, the BS may receive uplink channels in the time domain resources in response to the DCI scheduling the uplink channels.

[00204] In some embodiments, the single TDRA list includes at least one entry, and each entry of the at least one entry includes a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.

[00205] In some embodiments, each TDRA list of the set of TDRA lists includes at least one entry, and each entry of the at least one entry includes a set of TDRA indexes corresponding to a cell in the first set of cells.

[00206] In some embodiments, in the case that the DCI indicates the TDRA information for the second set of cells from the single TDRA list, the DCI includes a third indicator indicating a mode of the following scheduling modes of the DCI: a first mode for single-channel scheduling on a single cell; a second mode for multi-channel scheduling on a single cell; a third mode for multi-cell scheduling with a single channel scheduled per a scheduled cell; and a fourth mode for multi-cell scheduling with one or more channels scheduled per a scheduled cell. The DCI further includes a fourth indicator indicating an entry in the single TDRA list corresponding to the indicated mode.

[00207] In some embodiments, the single TDRA list corresponds to a TDRA list for single-cell scheduling in response to the third indicator indicating the first mode. In some embodiments, the single TDRA list corresponds to a TDRA list for multi-channel scheduling in response to the third indicator indicating the second mode. In some embodiments, the single TDRA list corresponds to a third TDRA list in response to the third indicator indicating the third mode, the third TDRA list including at least one entry, each of which includes a set of TDRA indexes with each TDRA index corresponding to a cell in the first set of cells. In some embodiments, the single TDRA list corresponds to a fourth TDRA list in response to the third indicator indicating the fourth mode, the fourth TDRA list including at least one entry, each of which includes including a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.

[00208] In some embodiments, each TDRA index of a set of TDRA indexes indicates an entry of a TDRA list for single-cell scheduling or an inapplicable TDRA index. In some embodiments, each TDRA index of the set of TDRA indexes indicates the entry of the TDRA list for single-cell scheduling.

[00209] In some embodiments, the plurality of sets of TDRA indexes is ordered according to cell indexes of cell(s) in the first set of cells.

[00210] In some embodiments, TDRA index(es) in a set of TDRA indexes is ordered according to time.

[00211] In some embodiments, a number of TDRA indexes in a set of TDRA indexes is equal to or smaller than a maximum number of channels schedulable by the DCI on a corresponding cell in the first set of cells.

[00212] In some embodiments, the DCI includes a first indicator indicating a first entry of the at least one entry, the first entry including a first number of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the second set of cells and a second number of sets of TDRA indexes for remaining cell(s) in the first set of cells. A number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA indexes in a corresponding set of TDRA indexes of the first number of sets of TDRA indexes.

[00213] In some embodiments, the second number of sets of TDRA indexes include only inapplicable TDRA indexes. In some embodiments, the DCI further includes a second indicator indicating the second set of cells.

[00214] In some embodiments, a size of the first indicator is dependent on a number of entries in the single TDRA list.

[00215] In some embodiments, each TDRA list of the set of TDRA lists corresponds to a TDRA list for multi-channel scheduling for a corresponding cell in the first set of cells, and each TDRA list for multi-channel scheduling includes at least one entry, with each entry indicating one or more TDRA information sets for multi-channel scheduling on the corresponding cell.

[00216] In some embodiments, the one or more TDRA information sets for multi-channel scheduling on the corresponding cell indicate only applicable TDRA information set or indicate applicable TDRA information set or inapplicable TDRA information set.

[00217] In some embodiments, the one or more TDRA information sets for multi-channel scheduling on the corresponding cell are ordered according to time.

[00218] In some embodiments, a number of TDRA information sets in each entry of the TDRA list for multi-channel scheduling is equal to or smaller than a maximum number of channels schedulable by the DCI on the corresponding cell in the first set of cells.

[00219] In some embodiments, the DCI includes a plurality of first indicators each corresponding to a cell in the first set of cells and a TDRA list of the set of TDRA lists. A number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA information sets or a number of applicable TDRA indexes in a corresponding TDRA list of the set of TDRA lists.

[00220] In some embodiments, a first indicator corresponding to a cell in the second set of cell indicates at least one applicable TDRA information set or at least one applicable TDRA index and a first indicator corresponding to a cell in remaining cell(s)

in the first set of cells indicates an inapplicable value, only inapplicable TDRA information set, empty TDRA information set, only inapplicable TDRA index or empty TDRA index. In some embodiments, the DCI further includes a second indicator indicating the second set of cells.

[00221] In some embodiments, a size of each first indicator is dependent on a number of entries in a corresponding TDRA list of the set of TDRA lists.

[00222] In some embodiments, the second set of cells is determined based on the third indicator and the fourth indicator. In some embodiments, the DCI further includes a second indicator indicating the second set of cells.

[00223] It should be appreciated by persons skilled in the art that the sequence of the operations in exemplary method 400 may be changed and some of the operations in exemplary method 400 may be eliminated or modified, without departing from the spirit and scope of the disclosure.

[00224] FIG. 5 illustrates an example of a UE 500 in accordance with aspects of the present disclosure. The UE 500 may include a processor 502, a memory 504, a controller 506, and a transceiver 508. The processor 502, the memory 504, the controller 506, or the transceiver 508, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[00225] The processor 502, the memory 504, the controller 506, or the transceiver 508, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[00226] The processor 502 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In

some implementations, the processor 502 may be configured to operate the memory 504. In some other implementations, the memory 504 may be integrated into the processor 502. The processor 502 may be configured to execute computer-readable instructions stored in the memory 504 to cause the UE 500 to perform various functions of the present disclosure.

[00227] The memory 504 may include volatile or non-volatile memory. The memory 504 may store computer-readable, computer-executable code including instructions when executed by the processor 502 cause the UE 500 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as the memory 504 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[00228] In some implementations, the processor 502 and the memory 504 coupled with the processor 502 may be configured to cause the UE 500 to perform one or more of the functions described herein (e.g., executing, by the processor 502, instructions stored in the memory 504). For example, the processor 502 may support wireless communication at the UE 500 in accordance with examples as disclosed herein. For example, the UE 500 may be configured to support means for performing the operations as described with respect to FIG. 1-4.

[00229] For example, the UE 500 may be configured to support: a means for receiving signaling for configuring a first set of cells, which is co-schedulable by a single DCI; a means for receiving the DCI scheduling a second set of cells in the first set of cells, wherein the DCI indicates TDRA information for the second set of cells from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells; a means for determining time domain resources on the second set of cells based on the TDRA information; and a means for receiving downlink transmission or transmitting uplink transmission in the determined time domain resources.

[00230] The controller 506 may manage input and output signals for the UE 500. The

controller 506 may also manage peripherals not integrated into the UE 500. In some implementations, the controller 506 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 506 may be implemented as part of the processor 502.

[00231] In some implementations, the UE 500 may include at least one transceiver 508. In some other implementations, the UE 500 may have more than one transceiver 508. The transceiver 508 may represent a wireless transceiver. The transceiver 508 may include one or more receiver chains 510, one or more transmitter chains 512, or a combination thereof.

[00232] A receiver chain 510 may be configured to receive signals (e.g., control information, data, or packets) over a wireless medium. For example, the receiver chain 510 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 510 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 510 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 510 may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[00233] A transmitter chain 512 may be configured to generate and transmit signals (e.g., control information, data, or packets). The transmitter chain 512 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmitter chain 512 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 512 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[00234] It should be appreciated by persons skilled in the art that the components in

exemplary UE 500 may be changed, for example, some of the components in exemplary UE 500 may be omitted or modified or a new component(s) may be added to exemplary UE 500, without departing from the spirit and scope of the disclosure. For example, in some embodiments, the UE 500 may not include the controller 506.

[00235] FIG. 6 illustrates an example of a processor 600 in accordance with aspects of the present disclosure. The processor 600 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 600 may include a controller 602 configured to perform various operations in accordance with examples as described herein. The processor 600 may optionally include at least one memory 604, which may be, for example, an L1/L2/L3 cache. Additionally, or alternatively, the processor 600 may optionally include one or more arithmetic-logic units (ALUs) 606. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[00236] The processor 600 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g., receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 600) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

[00237] The controller 602 may be configured to manage and coordinate various operations (e.g., signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 600 to cause the processor 600 to support various operations in accordance with examples as described herein. For example, the controller 602 may operate as a control unit of the processor 600, generating control signals that manage the operation of various components of the processor 600. These control signals include enabling

or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[00238] The controller 602 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 604 and determine a subsequent instruction(s) to be executed to cause the processor 600 to support various operations in accordance with examples as described herein. The controller 602 may be configured to track memory address of instructions associated with the memory 604. The controller 602 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 602 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 600 to cause the processor 600 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 602 may be configured to manage flow of data within the processor 600. The controller 602 may be configured to control transfer of data between registers, ALUs, and other functional units of the processor 600.

[00239] The memory 604 may include one or more caches (e.g., memory local to or included in the processor 600 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementations, the memory 604 may reside within or on a processor chipset (e.g., local to the processor 600). In some other implementations, the memory 604 may reside external to the processor chipset (e.g., remote to the processor 600).

[00240] The memory 604 may store computer-readable, computer-executable code including instructions that, when executed by the processor 600, cause the processor 600 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 602 and/or the processor 600 may be configured to execute computer-readable instructions stored in the memory 604 to cause the processor 600 to perform various functions. For example, the processor 600 and/or the controller 602 may be coupled with or to the memory 604, the processor 600, the controller 602, and the memory 604 may be configured to perform various functions described herein. In some examples, the processor 600 may include multiple processors and the memory

604 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[00241] The one or more ALUs 606 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 606 may reside within or on a processor chipset (e.g., the processor 600). In some other implementations, the one or more ALUs 606 may reside external to the processor chipset (e.g., the processor 600). One or more ALUs 606 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 606 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 606 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 606 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 606 to handle conditional operations, comparisons, and bitwise operations.

[00242] The processor 600 may support wireless communication in accordance with examples as disclosed herein.

[00243] For example, the processor 600 may be configured to support means for performing the operations as described with respect to FIG. 3. For example, the processor 600 may be configured to or operable to support: a means for receiving signaling for configuring a first set of cells, which is co-schedulable by a single DCI; a means for receiving the DCI scheduling a second set of cells in the first set of cells, wherein the DCI indicates TDRA information for the second set of cells from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells; a means for determining time domain resources on the second set of cells based on the TDRA information; and a means for receiving downlink transmission or transmitting uplink transmission in the determined time domain resources.

[00244] For example, the processor 600 may be configured to support means for

performing the operations as described with respect to FIG. 4. For example, the processor 600 may be configured to or operable to support: a means for transmitting, to a UE, signaling for configuring a first set of cells, which is co-schedulable by a single DCI; a means for transmitting, to the UE, the DCI scheduling a second set of cells in the first set of cells and assigning time domain resources for the second set of cells by indicating TDRA information from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells; and a means for transmitting downlink transmission or receiving uplink transmission in the time domain resources.

[00245] It should be appreciated by persons skilled in the art that the components in exemplary processor 600 may be changed, for example, some of the components in exemplary processor 600 may be omitted or modified or a new component(s) may be added to exemplary processor 600, without departing from the spirit and scope of the disclosure. For example, in some embodiments, the processor 600 may not include the ALUs 606.

[00246] FIG. 7 illustrates an example of an NE 700 in accordance with aspects of the present disclosure. The NE 700 may include a processor 702, a memory 704, a controller 706, and a transceiver 708. The processor 702, the memory 704, the controller 706, or the transceiver 708, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[00247] The processor 702, the memory 704, the controller 706, or the transceiver 708, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a DSP, an ASIC, or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[00248] The processor 702 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 702 may be configured to operate the memory

704. In some other implementations, the memory 704 may be integrated into the processor 702. The processor 702 may be configured to execute computer-readable instructions stored in the memory 704 to cause the NE 700 to perform various functions of the present disclosure.

[00249] The memory 704 may include volatile or non-volatile memory. The memory 704 may store computer-readable, computer-executable code including instructions when executed by the processor 702 cause the NE 700 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as the memory 704 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[00250] In some implementations, the processor 702 and the memory 704 coupled with the processor 702 may be configured to cause the NE 700 to perform one or more of the functions described herein (e.g., executing, by the processor 702, instructions stored in the memory 704). For example, the processor 702 may support wireless communication at the NE 700 in accordance with examples as disclosed herein. For example, the NE 700 may be configured to support means for performing the operations as described with respect to FIG. 4.

[00251] For example, the NE 700 may be configured to support: a means for transmitting, to a UE, signaling for configuring a first set of cells, which is co-schedulable by a single DCI; a means for transmitting, to the UE, the DCI scheduling a second set of cells in the first set of cells and assigning time domain resources for the second set of cells by indicating TDRA information from: a single TDRA list for the first set of cells, or a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells; and a means for transmitting downlink transmission or receiving uplink transmission in the time domain resources.

[00252] The controller 706 may manage input and output signals for the NE 700. The controller 706 may also manage peripherals not integrated into the NE 700. In some

implementations, the controller 706 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 706 may be implemented as part of the processor 702.

[00253] In some implementations, the NE 700 may include at least one transceiver 708. In some other implementations, the NE 700 may have more than one transceiver 708. The transceiver 708 may represent a wireless transceiver. The transceiver 708 may include one or more receiver chains 710, one or more transmitter chains 712, or a combination thereof.

[00254] A receiver chain 710 may be configured to receive signals (e.g., control information, data, or packets) over a wireless medium. For example, the receiver chain 710 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 710 may include at least one amplifier (e.g., an LNA) configured to amplify the received signal. The receiver chain 710 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 710 may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[00255] A transmitter chain 712 may be configured to generate and transmit signals (e.g., control information, data, or packets). The transmitter chain 712 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as AM, FM, or digital modulation schemes like PSK or QAM. The transmitter chain 712 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 712 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[00256] It should be appreciated by persons skilled in the art that the components in exemplary NE 700 may be changed, for example, some of the components in exemplary NE 700 may be omitted or modified or a new component(s) may be added to exemplary NE 700, without departing from the spirit and scope of the disclosure. For example,

in some embodiments, the NE 700 may not include the controller 706.

[00257] Those having ordinary skill in the art would understand that the operations or steps of the methods described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. Additionally, in some aspects, the operations or steps of the methods may reside as one or any combination or set of codes and/or instructions on a non-transitory computer-readable medium, which may be incorporated into a computer program product.

[00258] While this disclosure has been described with specific embodiments thereof, it is evident that many alternatives, modifications, and variations may be apparent to those skilled in the art. The disclosure is not limited to the examples and designs described herein but is to be accorded with the broadest scope consistent with the principles and novel features disclosed herein. For example, various components of the embodiments may be interchanged, added, or substituted in other embodiments. Also, all of the elements of each figure are not necessary for the operation of the disclosed embodiments. For example, one of ordinary skill in the art of the disclosed embodiments would be enabled to make and use the teachings of the disclosure by simply employing the elements of the independent claims. Accordingly, embodiments of the disclosure as set forth herein are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the disclosure.

[00259] In this document, the terms "DCI" and "DCI format" may be used interchangeably. The terms "includes," "including," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that includes a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by "a," "an," or the like does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that includes the element. Also, the term "another" is

defined as at least a second or more. The term "having" or the like, as used herein, is defined as "including." Expressions such as "A and/or B" or "at least one of A and B" may include any and all combinations of words enumerated along with the expression. For instance, the expression "A and/or B" or "at least one of A and B" may include A, B, or both A and B. The wording "the first," "the second" or the like is only used to clearly illustrate the embodiments of the present disclosure, but is not used to limit the substance of the present disclosure.

WHAT IS CLAIMED:

1. A user equipment (UE), comprising:
 - at least one memory; and
 - at least one processor coupled with the at least one memory and configured to cause the UE to:
 - receive signaling for configuring a first set of cells, which is co-schedulable by a single downlink control information (DCI);
 - receive the DCI scheduling a second set of cells in the first set of cells, wherein the DCI indicates time domain resource allocation (TDRA) information for the second set of cells from:
 - a single TDRA list for the first set of cells, or
 - a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells;
 - determine time domain resources on the second set of cells based on the TDRA information; and
 - receive downlink transmission or transmit uplink transmission in the determined time domain resources.
2. The UE of Claim 1, wherein the single TDRA list comprises at least one entry, and each entry of the at least one entry comprises a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.
3. The UE of Claim 1, wherein each TDRA list of the set of TDRA lists comprises at least one entry, and each entry of the at least one entry comprises a set of TDRA indexes corresponding to a cell in the first set of cells.

4. The UE of Claim 1, wherein in the case that the DCI indicates the TDRA information for the second set of cells from the single TDRA list, the DCI comprises a third indicator indicating a mode of the following scheduling modes of the DCI:

a first mode for single-channel scheduling on a single cell;

a second mode for multi-channel scheduling on a single cell;

a third mode for multi-cell scheduling with a single channel scheduled per a scheduled cell; and

a fourth mode for multi-cell scheduling with one or more channels scheduled per a scheduled cell; and

wherein the DCI further comprises a fourth indicator indicating an entry in the single TDRA list corresponding to the indicated mode.

5. The UE of Claim 4, wherein the single TDRA list corresponds to a TDRA list for single-cell scheduling in response to the third indicator indicating the first mode;

wherein the single TDRA list corresponds to a TDRA list for multi-channel scheduling in response to the third indicator indicating the second mode;

wherein the single TDRA list corresponds to a third TDRA list in response to the third indicator indicating the third mode, the third TDRA list comprising at least one entry, each of which comprises a set of TDRA indexes with each TDRA index corresponding to a cell in the first set of cells; and

wherein the single TDRA list corresponds to a fourth TDRA list in response to the third indicator indicating the fourth mode, the fourth TDRA list comprising at least one entry, each of which comprises comprising a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.

6. The UE of any of Claims 2, 3 and 5, wherein each TDRA index of a set of TDRA indexes indicates an entry of a TDRA list for single-cell scheduling or an inapplicable TDRA index; or

wherein each TDRA index of the set of TDRA indexes indicates the entry of the TDRA list for single-cell scheduling.

7. The UE of Claim 2, wherein the DCI comprises a first indicator indicating a first entry of the at least one entry, the first entry comprising a first number of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the second set of cells and a second number of sets of TDRA indexes for remaining cell(s) in the first set of cells; and

wherein a number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA indexes in a corresponding set of TDRA indexes of the first number of sets of TDRA indexes.

8. The UE of Claim 1, wherein each TDRA list of the set of TDRA lists corresponds to a TDRA list for multi-channel scheduling for a corresponding cell in the first set of cells, and each TDRA list for multi-channel scheduling comprises at least one entry, with each entry indicating one or more TDRA information sets for multi-channel scheduling on the corresponding cell.

9. The UE of Claim 1, wherein the DCI comprises a plurality of first indicators each corresponding to a cell in the first set of cells and a TDRA list of the set of TDRA lists; and

wherein a number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA information sets or a number of applicable TDRA indexes in a corresponding TDRA list of the set of TDRA lists.

10. The UE of Claim 9, wherein a first indicator corresponding to a cell in the second set of cell indicates at least one applicable TDRA information set or at least one applicable TDRA index and a first indicator corresponding to a cell in remaining cell(s) in the first set of cells indicates an inapplicable value, only inapplicable TDRA

information set, empty TDRA information set, only inapplicable TDRA index or empty TDRA index; or

wherein the DCI further comprises a second indicator indicating the second set of cells and determining the time domain resources on the second set of cells comprises ignoring first indicator(s) corresponding to the remaining cell(s) in the first set of cells.

11. A base station (BS), comprising:

at least one memory; and

at least one processor coupled with the at least one memory and configured to cause the BS to:

transmit, to a user equipment (UE), signaling for configuring a first set of cells, which is co-schedulable by a single downlink control information (DCI);

transmit, to the UE, the DCI scheduling a second set of cells in the first set of cells and assigning time domain resources for the second set of cells by indicating time domain resource allocation (TDRA) information from:

a single TDRA list for the first set of cells, or

a set of TDRA lists for the first set of cells, each TDRA list of the set of TDRA lists corresponding to a cell in the first set of cells; and

transmit downlink transmission or receive uplink transmission in the time domain resources.

12. The BS of Claim 11, wherein the single TDRA list comprises at least one entry, and each entry of the at least one entry comprises a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.

13. The BS of Claim 11, wherein each TDRA list of the set of TDRA lists comprises at least one entry, and each entry of the at least one entry comprises a set of TDRA indexes corresponding to a cell in the first set of cells.

14. The BS of Claim 11, wherein in the case that the DCI indicates the TDRA information from the single TDRA list, the DCI comprises a third indicator indicating a mode of the following scheduling modes of the DCI:

a first mode for single-channel scheduling on a single cell;

a second mode for multi-channel scheduling on a single cell;

a third mode for multi-cell scheduling with a single channel scheduled per a scheduled cell; and

a fourth mode for multi-cell scheduling with one or more channels scheduled per a scheduled cell; and

wherein the DCI further comprises a fourth indicator indicating an entry in the single TDRA list corresponding to the indicated mode.

15. The BS of Claim 14, wherein the single TDRA list corresponds to a TDRA list for single-cell scheduling in response to the third indicator indicating the first mode;

wherein the single TDRA list corresponds to a TDRA list for multi-channel scheduling in response to the third indicator indicating the second mode;

wherein the single TDRA list corresponds to a third TDRA list in response to the third indicator indicating the third mode, the third TDRA list comprising at least one entry, each of which comprises a set of TDRA indexes with each TDRA index corresponding to a cell in the first set of cells; and

wherein the single TDRA list corresponds to a fourth TDRA list in response to the third indicator indicating the fourth mode, the fourth TDRA list comprising at least one entry, each of which comprises comprising a plurality of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the first set of cells.

16. The BS of any of Claims 12, 13 and 15, wherein each TDRA index of a set of TDRA indexes indicates an entry of a TDRA list for single-cell scheduling or an inapplicable TDRA index; or

wherein each TDRA index of the set of TDRA indexes indicates the entry of the TDRA list for single-cell scheduling.

17. The BS of Claim 12, wherein the DCI comprises a first indicator indicating a first entry of the at least one entry, the first entry comprising a first number of sets of TDRA indexes with each set of TDRA indexes corresponding to a cell in the second set of cells and a second number of sets of TDRA indexes for remaining cell(s) in the first set of cells; and

wherein a number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA indexes in a corresponding set of TDRA indexes of the first number of sets of TDRA indexes.

18. The BS of Claim 11, wherein each TDRA list of the set of TDRA lists corresponds to a TDRA list for multi-channel scheduling for a corresponding cell in the first set of cells, and each TDRA list for multi-channel scheduling comprises at least one entry, with each entry indicating one or more TDRA information sets for multi-channel scheduling on the corresponding cell.

19. The BS of Claim 11, wherein the DCI comprises a plurality of first indicators each corresponding to a cell in the first set of cells and a TDRA list of the set of TDRA lists; and

wherein a number of channels scheduled on a cell in the second set of cells is dependent on a number of applicable TDRA information sets or a number of applicable TDRA indexes in a corresponding TDRA list of the set of TDRA lists.

20. The BS of Claim 19, wherein a first indicator corresponding to a cell in the second set of cell indicates at least one applicable TDRA information set or at least one applicable TDRA index and a first indicator corresponding to a cell in remaining cell(s) in the first set of cells indicates an inapplicable value, only inapplicable TDRA

information set, empty TDRA information set, only inapplicable TDRA index or empty TDRA index; or

wherein the DCI further comprises a second indicator indicating the second set of cells.

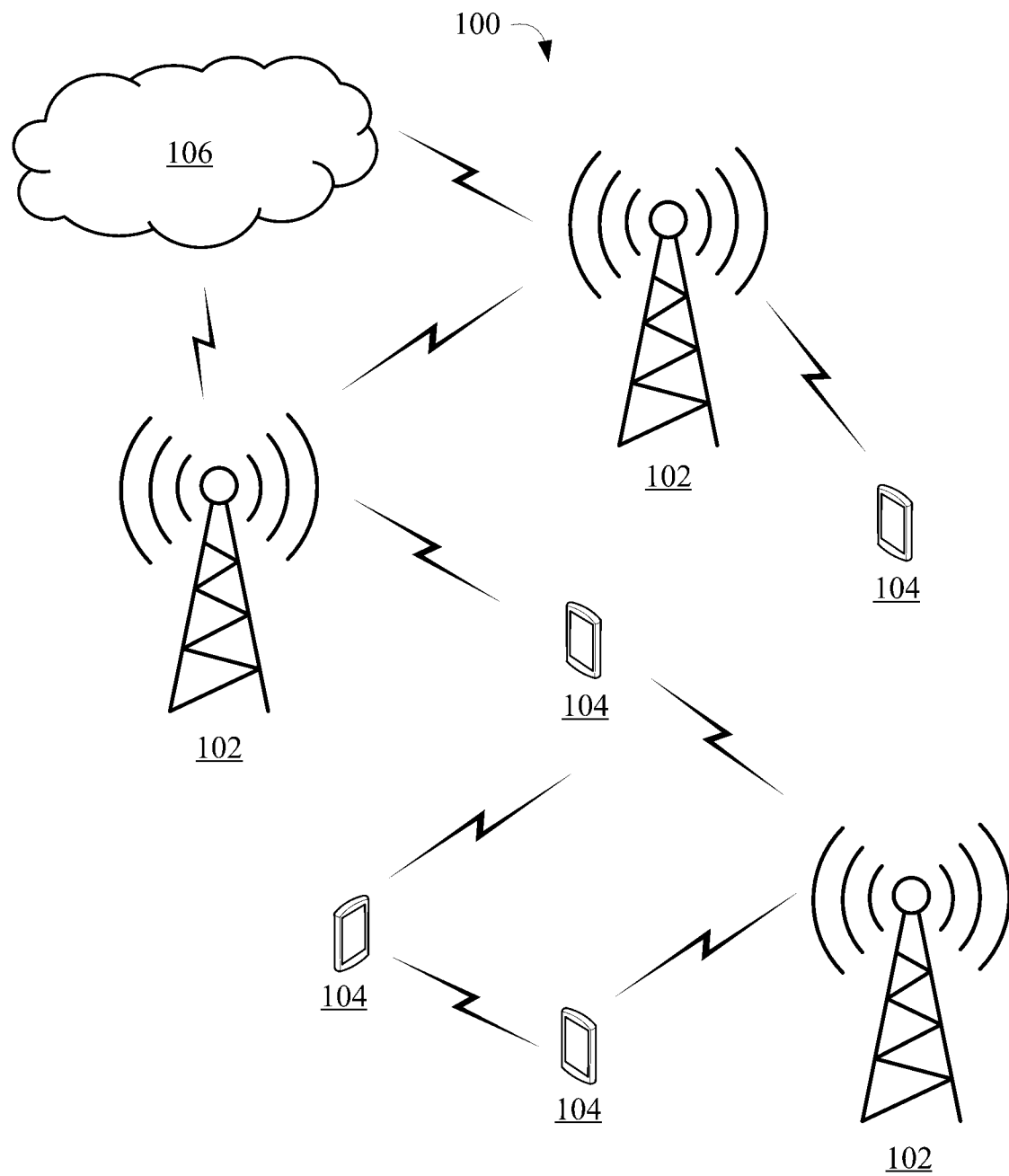


FIG. 1

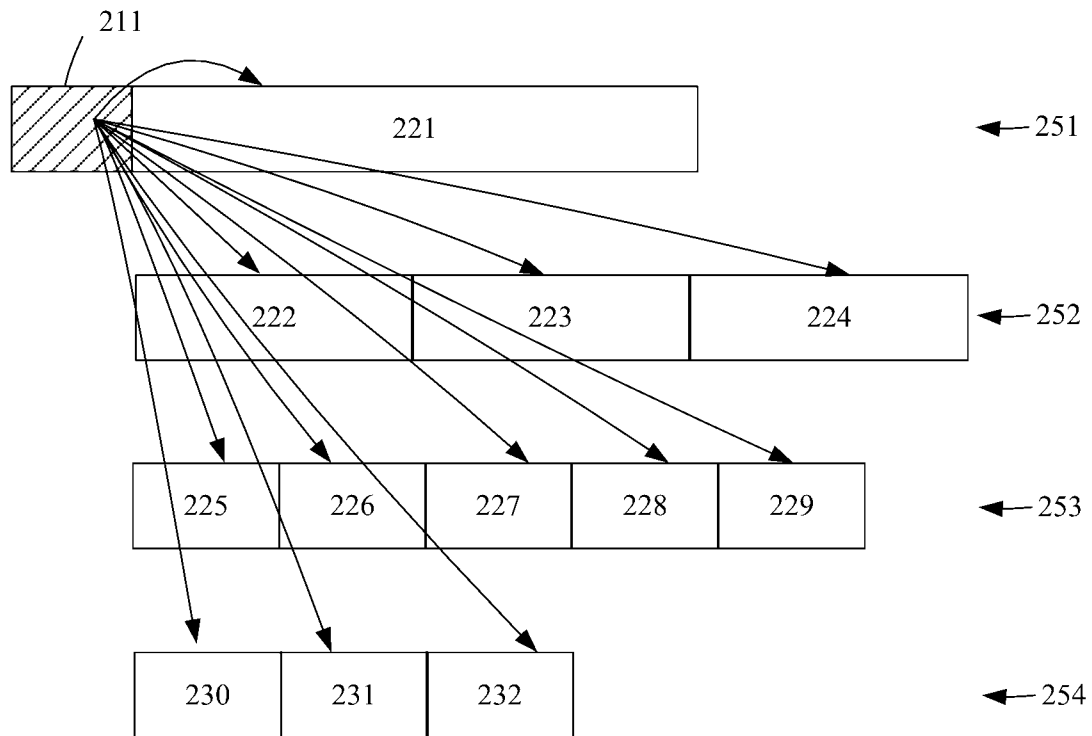


FIG. 2

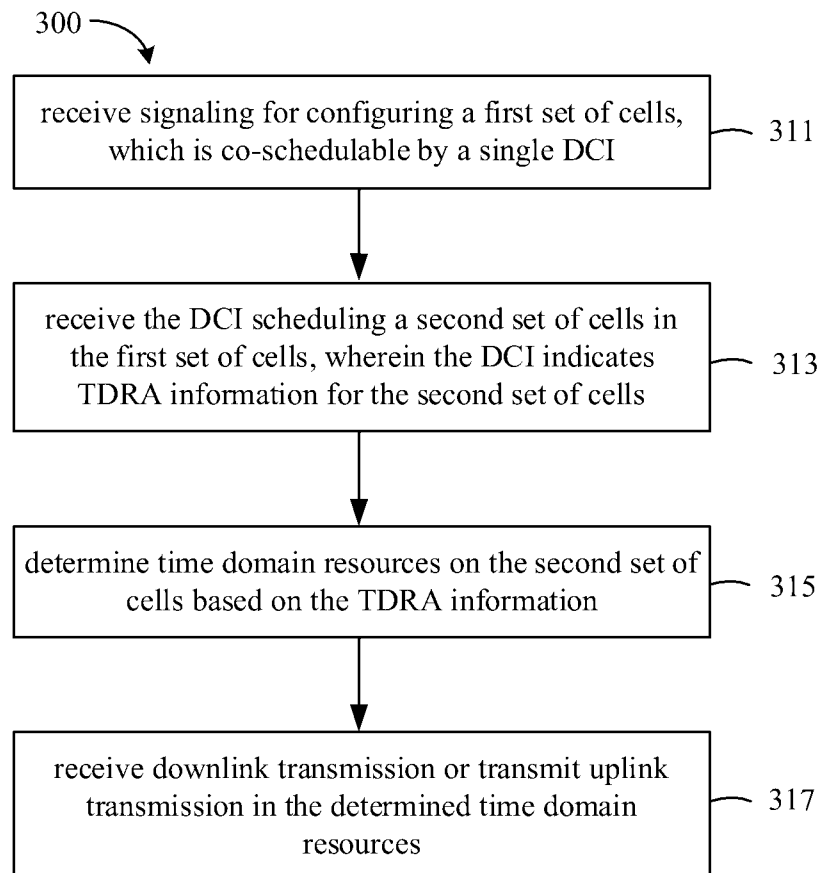


FIG. 3

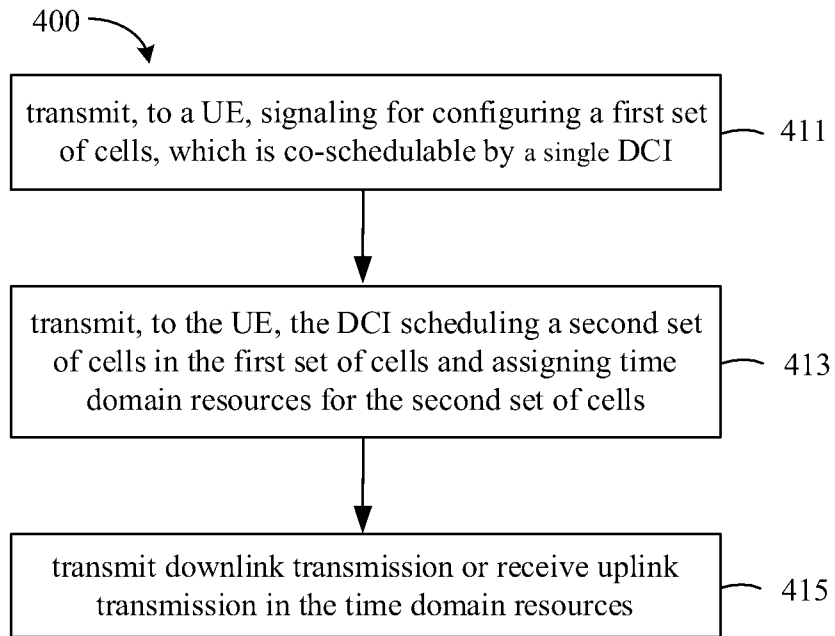


FIG. 4

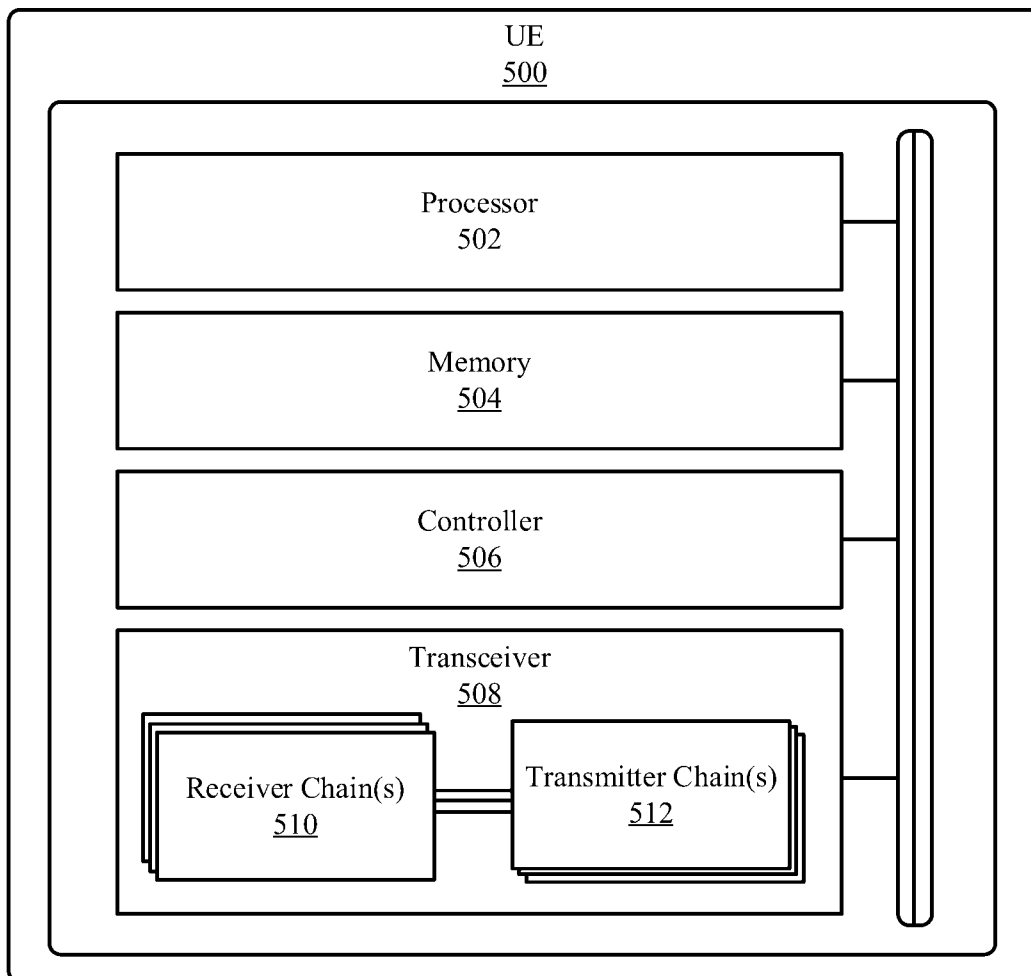


FIG. 5

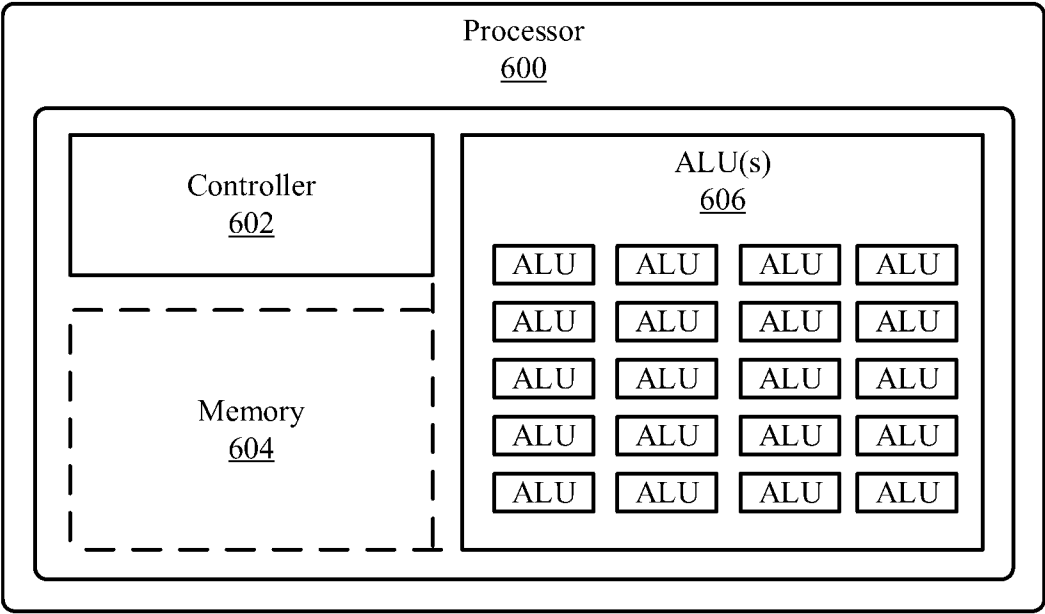


FIG. 6

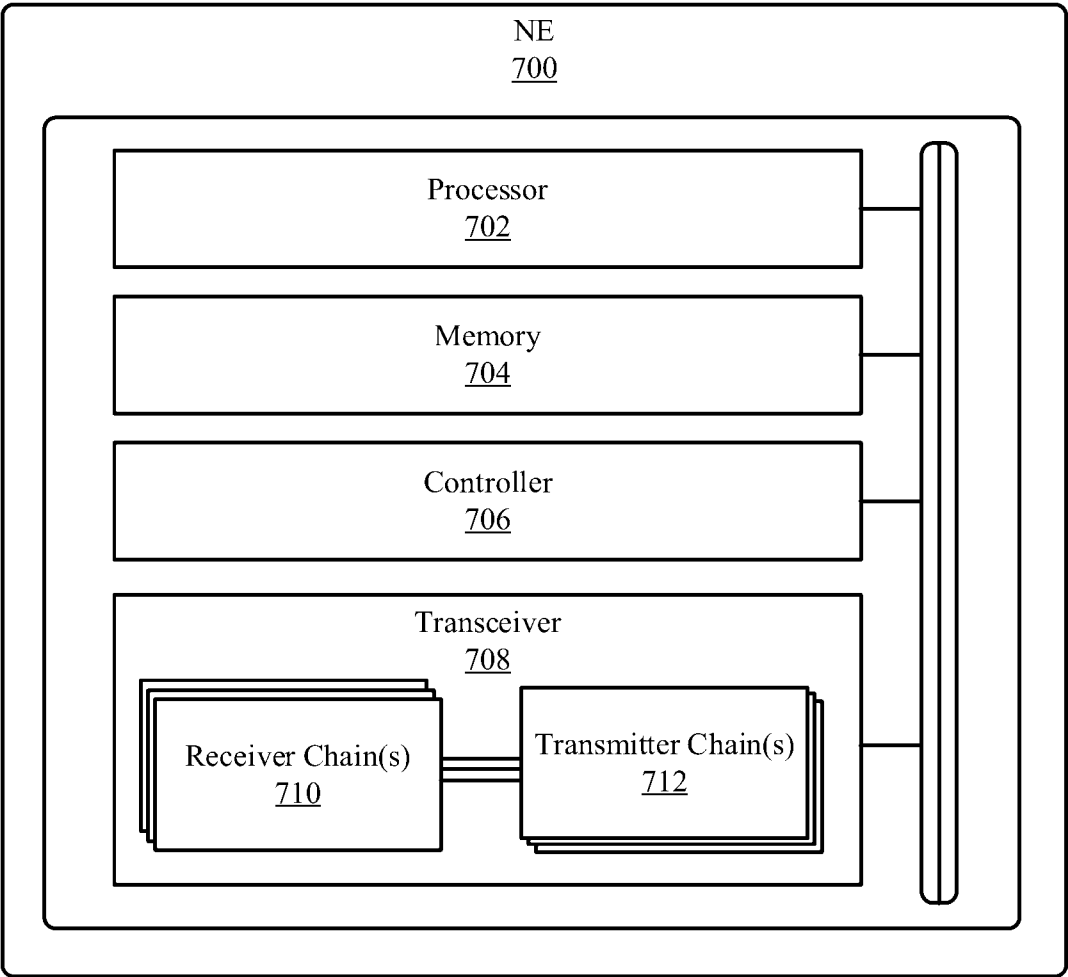


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2024/106728

A. CLASSIFICATION OF SUBJECT MATTER H04W 72/232(2023.01)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) IPC:H04W 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) 3GPP,CNXTX,DWPI,ENTXT,ENTXTC:cell,channel,DCI,single,TDRA,multi+,set,DCI,schedul+,PDSCH,PUSCH,list,table,co-schedul+,entry,index		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	OPPO. "Discussion on multi-cell PUSCH/PDSCH scheduling with a single DCI" 3GPP TSG RAN WG1 #112 R1-2300289, 03 March 2023 (2023-03-03), section 2	1-20
X	APPLE INC. "On remaining issues for multi-cell PUSCH/PDSCH scheduling with a single DCI" 3GPP TSG RAN WG1 Meeting #112 R1-2301362, 03 March 2023 (2023-03-03), section 2	1-20
X	US 2023276441 A1 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)) 31 August 2023 (2023-08-31) description, paragraphs 136-195	1-20
A	CN 118140442 A (SAMSUNG ELECTRONICS CO., LTD.) 04 June 2024 (2024-06-04) the whole document	1-20
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “D” document cited by the applicant in the international application “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family		
Date of the actual completion of the international search 02 April 2025		Date of mailing of the international search report 09 April 2025
Name and mailing address of the ISA/CN CHINA NATIONAL INTELLECTUAL PROPERTY ADMINISTRATION 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China		Authorized officer DONG,ZhenXing Telephone No. (+86) 010-53961757

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2024/106728

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2023276441	A1	31 August 2023	EP	4193763	A1	14 June 2023
				WO	2022029297	A1	10 February 2022
CN	118140442	A	04 June 2024	US	2023129120	A1	27 April 2023
				KR	20240087847	A	19 June 2024
				EP	4399824	A1	17 July 2024
				WO	2023063707	A1	20 April 2023
				IN	202417028824	A	22 November 2024