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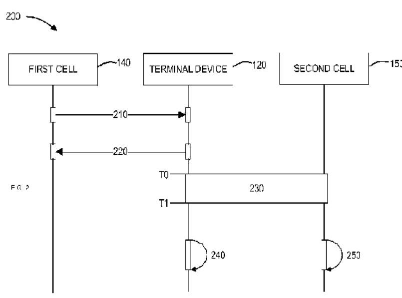

(57) **Abstract:** Embodiments of the present disclosure relate to methods, devices and computer readable media of communication. A terminal device receives, from a network device, a first control command indicating a TCI state associated with a first cell. The terminal device determines a QCL-TypeA RS applied for a second cell according to the indicated TCI state from a first slot after a predefined timing, wherein the second cell is different from the first cell. In this way, at least the determined QCL-TypeA RS can be applied for the second cell; accordingly, a beam for the second cell can be obtained according to the TCI state indicated by the first cell.

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METHOD, DEVICE AND COMPUTER STORAGE MEDIUM OF COMMUNICATION

TECHNICAL FIELD

[0001] Embodiments of the present disclosure generally relate to the field of telecommunication, and in particular, to methods, devices and computer storage media of communication for inter-cell mobility.

BACKGROUND

[0002] In traditional cellular networks, each network device is associated with a coverage area or a cell. The network may maintain the communication between a serving cell and a terminal device in the cell until a handover (HO) procedure is triggered. Current solutions about UE mobility include intra-cell mobility and inter-cell mobility. Intra-cell mobility involves management of cell-specific communication resources and cell-specific configurations, in which the serving cell is not changed. In inter-cell mobility, also referred to as mobility management, a terminal device releases its link with a source cell and establishes a new link with a target cell. Conventional inter-cell mobility involves higher-layer signaling exchange between the terminal device and network equipment to achieve the change of serving cell, and thus has a long latency, a large overhead and a long interruption time. Thus, how to reduce the latency, the overhead and the interruption time during the inter-cell mobility is a problem to be solved.

SUMMARY

[0003] In general, embodiments of the present disclosure provide methods, devices and computer storage media of communication for obtaining a beam for the target cell for L1/L2-based inter-cell mobility.

[0004] In a first aspect, there is provided a communication method implemented at a terminal device. The method comprises: receiving, from a network device, a first control command indicating a transmission configuration indicator (TCI) state associated with a first cell; and determining a quasi-colocation-typeA reference signal (QCL-TypeA RS) applied for a second cell according to the indicated TCI state from a first slot after a predefined timing, wherein the second cell is different from the first cell.

[0005] In a second aspect, there is provided a communication method implemented at a network device. The method comprises: transmitting to a terminal device, a first control command indicating a TCI state on a first cell, wherein the indicated TCI state is associated with the first cell; wherien a QCL-TypeA RS applied for the second cell is determined according to the indicated TCI state from a first slot after a predefined timing, and wherein the second cell is different from the first cell.

[0006] In a third aspect, there is provided a terminal device. The terminal device comprises a processor; and a memory coupled to the processor and storing instructions thereon, the instructions, when executed by the processor, causing the terminal device to perform acts comprising the method according to the first aspect of the present disclosure.

[0007] In a fourth aspect, there is provided a network device. The network device comprises a processor; and a memory coupled to the processor and storing instructions thereon, the instructions, when executed by the processor, causing the network device to perform acts comprising the method according to the second aspect of the present disclosure.

[0008] In a fifth aspect, there is provided a computer readable medium having instructions stored thereon. The instructions, when executed on at least one processor, cause the at least one processor to perform the method according to the first aspect of the present disclosure or the method according to the second aspect of the present disclosure.

[0009] Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Through the more detailed description of some embodiments of the present disclosure in the accompanying drawings, the above and other objects, features and advantages of the present disclosure will become more apparent, wherein:

[0011] FIG. 1 illustrates an example environment in which some embodiments of the present disclosure can be implemented;

[0012] FIG. 2 illustrates a schematic diagram illustrating a process of communication according to some embodiments of the present disclosure;

[0013] FIG. 3 illustrates an example method of communication implemented at a terminal device in accordance with some embodiments of the present disclosure;

[0014] FIG. 4 illustrates an example method of communication implemented at a network device in accordance with some embodiments of the present disclosure; and

[0015] FIG. 5 is a simplified block diagram of a device that is suitable for implementing embodiments of the present disclosure.

[0016] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[0017] Principle of the present disclosure will now be described with reference to some embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitations as to the scope of the disclosure. The disclosure described herein can be implemented in various manners other than the ones described below.

[0018] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0019] As used herein, the term ‘terminal device’ refers to any device having wireless or wired communication capabilities. Examples of the terminal device include, but not limited to, user equipment (UE), personal computers, desktops, mobile phones, cellular phones, smart phones, personal digital assistants (PDAs), portable computers, tablets, wearable devices, internet of things (IoT) devices, Ultra-reliable and Low Latency Communications (URLLC) devices, Internet of Everything (IoE) devices, machine type communication (MTC) devices, device on vehicle for V2X communication where X means pedestrian, vehicle, or infrastructure/network, devices for Integrated Access and Backhaul (IAB), Small Data Transmission (SDT), mobility, Multicast and Broadcast Services (MBS), positioning, dynamic/flexible duplex in commercial networks, reduced capability (RedCap), Space borne vehicles or Air borne vehicles in Non-terrestrial networks (NTN) including Satellites and High Altitude Platforms (HAPs) encompassing Unmanned Aircraft Systems (UAS), eXtended Reality (XR) devices including different types of realities such as Augmented Reality (AR), Mixed Reality (MR) and Virtual Reality (VR), the unmanned aerial vehicle (UAV) commonly known as a drone which is an aircraft without any human pilot, devices on high speed train (HST), or image capture devices such as digital cameras, sensors, gaming devices, music storage and playback appliances, or Internet appliances enabling wireless or wired Internet access and browsing and the like. The ‘terminal device’ can further has ‘multicast/broadcast’ feature, to support public safety and mission critical, V2X applications, transparent IPv4/IPv6 multicast delivery, IPTV, smart TV, radio services, software delivery over wireless, group communications and IoT applications. It may also incorporated one or multiple Subscriber Identity Module (SIM) as known as Multi-SIM. The term “terminal device” can be used interchangeably with a UE, a mobile station, a subscriber station, a mobile terminal, a user terminal or a wireless device.

[0020] The term “network device” refers to a device which is capable of scheduling or hosting a cell or coverage where terminal devices can communicate. Examples of a network device include, but not limited to, a Node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a next generation NodeB (gNB), a transmission reception point (TRP), a remote radio unit (RRU), a radio head (RH), a remote radio head (RRH), an IAB node, a low power node such as a femto node, a pico node, a reconfigurable intelligent surface (RIS), Network-controlled Repeaters, and the like.

[0021] The terminal device or the network device may have Artificial intelligence (AI) or Machine learning capability. It generally includes a model which has been trained from numerous collected data for a specific function, and can be used to predict some information.

[0022] The terminal or the network device may work on several frequency ranges, e.g. FR1 (410 MHz to 7125 MHz), FR2 (24.25GHz to 71GHz), frequency band larger than 100GHz as well as Tera Hertz (THz). It can further work on licensed/unlicensed/shared spectrum. The terminal device may have more than one connections with the network devices under Multi-Radio Dual Connectivity (MR-DC) application scenario. The terminal device or the network device can work on full duplex, flexible duplex and cross division duplex modes.

[0023] The network device may have the function of network energy saving, Self-Organising Networks (SON)/ Minimization of Drive Tests (MDT). The terminal may have the function of power saving.

[0024] The embodiments of the present disclosure may be performed in test equipment, e.g. signal generator, signal analyzer, spectrum analyzer, network analyzer, test terminal device, test network device, channel emulator.

[0025] The embodiments of the present disclosure may be performed according to any generation communication protocols either currently known or to be developed in the future. Examples of the communication protocols include, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G) communication protocols, 5.5G, 5G-Advanced networks, or the sixth generation (6G) networks.

[0026] In one embodiment, the terminal device may be connected with a first network device and a second network device. One of the first network device and the second network device may be a master node and the other one may be a secondary node. The first network device and the second network device may use different radio access technologies (RATs). In one embodiment, the first network device may be a first RAT device and the second network device may be a second RAT device. In one embodiment, the first RAT device is eNB and the second RAT device is gNB. Information related with different RATs may be transmitted to the terminal device from at least one of the first network device or the second network device. In one embodiment, first information may be transmitted to the terminal device from the first network device and second information may be transmitted to the terminal device from the second network device directly or via the first network device. In one embodiment, information related with configuration for the terminal device configured by the second network device may be transmitted from the second network device via the first network device. Information related with reconfiguration for the terminal device configured by the second network device may be transmitted to the terminal device from the second network device directly or via the first network device.

[0027] As used herein, the singular forms ‘a’, ‘an’ and ‘the’ are intended to include the plural forms as well, unless the context clearly indicates otherwise. The term ‘includes’ and its variants are to be read as open terms that mean ‘includes, but is not limited to.’ The term ‘based on’ is to be read as ‘at least in part based on.’ The term ‘one embodiment’ and ‘an embodiment’ are to be read as ‘at least one embodiment.’ The term ‘another embodiment’ is to be read as ‘at least one other embodiment.’ The terms ‘first,’ ‘second,’ and the like may refer to different or same objects. Other definitions, explicit and implicit, may be included below.

[0028] In some examples, values, procedures, or apparatus are referred to as 'best,' 'lowest,' 'highest,' 'minimum,' 'maximum,' or the like. It will be appreciated that such descriptions are intended to indicate that a selection among many used functional alternatives can be made, and such selections need not be better, smaller, higher, or otherwise preferable to other selections.

[0029] The term "circuitry" used herein may refer to hardware circuits and/or combinations of hardware circuits and software. For example, the circuitry may be a combination of analog and/or digital hardware circuits with software/firmware. As a further example, the circuitry may be any portions of hardware processors with software including digital signal processor(s), software, and memory (ies) that work together to cause an apparatus, such as a terminal device or a network device, to perform various functions. In a still further example, the circuitry may be hardware circuits and or processors, such as a microprocessor or a portion of a microprocessor, that requires software/firmware for operation, but the software may not be present when it is not needed for operation. As used herein, the term circuitry also covers an implementation of merely a hardware circuit or processor(s) or a portion of a hardware circuit or processor(s) and its (or their) accompanying software and/or firmware.

[0030] In the context of the present application, the term "PSCell" refers to a SpCell of a secondary cell group (SCG), the term "PCell" refers to a SpCell of a master cell group (MCG), and the term "SpCell" refers to a primary cell of a SCG or MCG. The term "SCell" refers to a secondary cell of a SCG or MCG.

[0031] In the context of the present application, the terms "TCI state(s) associated with a cell", "TCI state(s) configured for a cell", "TCI state(s) for a cell" and "TCI state(s) of a cell" can be used interchangeably and refer to TCI state(s) applied to the cell, or in other words, TCI state(s) applied to a UL/DL channel or signal in the cell.

[0032] In the context of the present application, the term "L1" refers to a physical (PHY) layer. The term "L2" refers to a link layer, a data link layer, a medium access control (MAC) layer, a radio link control (RLC) layer, or a packet data convergence protocol (PDCP) layer. L2 implements communications protocols that use L1 PHY operations and physical addresses of nodes.

[0033] In the context of the present application, the term "inter-cell change", "inter-cell mobility", "switching of serving cell" and "serving cell change" refer to that the terminal device switches from cell A to cell B, that is, the terminal device will use or apply the relevant configuration of Cell B (such as the RRC configuration/parameter related to Cell B), which means that cell B will serve the terminal device (that is, the terminal device will communicate with cell B for interaction of control signaling and data information).

[0034] As mentioned above, how to reduce the latency, the overhead and the interruption time during the inter-cell mobility is a problem to be solved. One potential solution may be implemented in such a manner that the serving cell change may occur at the same time as the beam change or switch. For example, serving cell change and the beam change may be indicated simultaneously by a L1/L2 signaling or respectively but in a very short period of time by a L1/L2 signaling. In intra-cell mobility without serving cell change, beam change may be achieved in such a manner that a cell may indicate a set of TCI states to be applied to a channel or reference signal for a long time in the future, and a terminal device may switch beams autonomously according to orders and application time associated with TCI states in the indicated set of TCI states. However, , since information about the QCL-TypeA RS (e.g., Doppler shift, Doppler spread, average delay, delay spread) cannot be not applied across cells, the QCL-TypeA RS in the indicated TCI state cannot be applied for the target cell after serving cell change in L1/L2-based inter-cell mobility. There is no mechanism for obtaining a beam for the target cell for L1/L2-based inter-cell mobility.

[0035] Embodiments of the present disclosure provide a solution for solving the above and other potential issues. In the solution, a terminal device receives, from a network device, a first control command indicating a TCI state associated with a first cell. The terminal device determines a QCL-TypeA RS applied for a second cell according to the indicated TCI state from a first slot after a predefined timing, wherein the second cell is different from the first cell. In this way, at least the determined QCL-TypeA RS can be applied for the second cell; accordingly, a beam for the second cell can be obtained according to the TCI state indicated by the first cell.

[0036] Principles and implementations of the present disclosure will be described in detail below with reference to the figures.

[0037] FIG. 1 illustrates an example environment 100 in which example embodiments of the present disclosure can be implemented. As shown in Fig. 1, the environment 100, which may be a part of a communication network, comprises a first network device 110, a terminal device 120 and a second network device 130. The first network device 110 may be a gNB, or a NetWork (NW) or a TRP, which schedules a first cell or a first bandwidth part (BWP) 140. The second network device 130 may be a gNB, or a NetWork (NW) or a TRP, which schedules a second cell or a second BWP 150.

[0038] As shown in FIG. 1, a communication link may be formed between the first cell 140 and the terminal device 120 located at the first position P1. When the terminal device 120 moves from the first position P1 to the second position P2, the terminal device 120 may measure the quality of the beam from the second cell 150 and provides a measurement report to the first network device 110 for determining whether to perform a HO procedure of the serving cell. When the quality of the beam from the second cell 150 is better, the first network device 110 may determine to hand over the terminal device 120 from the first cell 140 to the second cell 150. The first network device 110 and the first cell 140 may be referred to as a source network device and a source cell, respectively. The second network device 130 and the second cell 150 may be referred to as a target network device and a target cell, respectively.

[0039] It is to be understood that the above embodiment is given for the purpose of illustration without suggesting any limitations to the present disclosure. In some embodiments, the HO procedure of the serving cell may be triggered due to other reasons than the position movement of the terminal device, and may be determined by measuring other measurement parameters and based on other decision conditions. In some embodiments, the network device could comprise multiple cells, such as the first cell and second cell.

[0040] The terminal device 120 may communicate with the source cell 140 or the target cell 150 via a channel such as a wireless communication channel. The communications in the environment 100 may conform to any suitable standards including, but not limited to, Long Term Evolution (LTE), LTE-Evolution, LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), Code Division Multiple Access (CDMA) and Global System for Mobile Communications (GSM) and the like. Furthermore, the communications may be performed according to any generation communication protocols either currently known or to be developed in the future. Examples of the communication protocols include, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G), 5.5G, 5G-Advanced networks, or the sixth generation (6G) communication protocols.

[0041] Communication in a direction from the terminal device 120 towards the source cell 140 or the target cell 150 is referred to as uplink (UL) communication, while communication in a reverse direction from the source cell 140 or the target cell 150 towards the terminal device 120 is referred to as downlink (DL) communication. The wireless communication channel may comprise a physical uplink control channel (PUCCH), a physical uplink shared channel (PUSCH), a physical random-access channel (PRACH), a physical downlink control channel (PDCCH), a physical downlink shared channel (PDSCH) and a physical broadcast channel (PBCH).

[0042] In some scenarios, when it is determined to perform a HO procedure on the terminal device 120, the source cell 140 may indicate a new TCI state to the terminal device 120. The terminal device 120 may obtain or determine at least the QCL-TypeA RS that can be applied for the target cell according to the TCI state indicated by the source cell 140 and apply the TCI state in the target cell.

[0043] Embodiments of the present disclosure provide a solution of obtaining a TCI state that can be applied for the target cell in L1/L2-based inter-cell mobility. The solution will be described in detail with reference to FIGs. 2 to 4 below.

[0044] FIG. 2 illustrates a schematic diagram illustrating a process 200 of communication according to some embodiments of the present disclosure. For the purpose of discussion, the process 200 will be described with reference to FIG. 1. The process 200 may involve the source cell 140, the terminal device 120 and the target cell 150 as illustrated in FIG. 1.

[0045] For the terminal device 120, the source cell 140 is associated with a first PCI and the target cell 150 is associated with a second PCI different from the first PCI. In the context of the present application, the terms “PCI associated with a cell”, “PCI corresponding to a cell” and “PCI of a cell” can be used interchangeably and refer to a specific PCI assigned to the cell. In the context of the present application, the term “additional PCI” or “second PCI” can be used interchangeably and refer to the PCI of the cell to which the terminal device is to switch, i.e., target cell. And the PCI of the target cell is different from that of the source cell.

[0046] As shown in FIG. 2, the source cell 140 transmits (210), to the terminal device 120, a first control command indicating a TCI state. In some embodiments, the TCI state indicated by the source cell 140 derives from a set of TCI states configured for the source cell 140.

[0047] In some embodiments, the source cell 140 may carry the first control command in a medium access control (MAC) control element (CE) on a PDSCH to indicate the TCI state. In some embodiments, the source cell 140 may carry the first control command in a downlink control information (DCI) on a PDCCH to indicate the TCI state.

[0048] In some embodiments, the TCI state may be configured with a QCL-TypeD RS associated with the Synchronization Signal and PBCH block (SSB) having an additional PCI. The additional PCI may be the PCI associated with the SSB associated with the QCL-TypeD RS (e.g., channel state information RS (CSI-RS) for beam management (BM)) configured in the indicated TCI state. Specifically, "the SSB associated with the QCL-TypeD RS" means that the SSB is QCL-RS of the QCL-TypeD RS, e.g., QCL-TypeC RS or QCL-TypeD RS in the TCI state applied for the QCL-TypeD RS.

[0049] In some embodiments, the indicated TCI state may be associated with an additional PCI. The target cell 150 may be determined according to the additional PCI associated with the indicated TCI state.

[0050] In some embodiments, the first control command may indicates the TCI state and the additional PCI. In some embodiments, the first control command (e.g., DCI or MAC-CE) indicates the indicated TCI state and a first indication information at the same time. The first indication information includes at least the additional PCI and an indicator. The indicator is used to indicate that the UE needs to switch the serving cell from the current source cell to the cell corresponding to the indicated additional PCI. The target cell 150 may be determined according to the additional PCI indicated by the first control command.

[0051] In some embodiments, the indicated TCI state is associated with a plurality of PCIs, which correspond to a plurality of cells, respectively. The terminal device 120 may determine a PCI among the plurality of PCIs, wherein a serving cell for the terminal device is to be changed from the source cell 140 to a cell corresponding to the PCI. The terminal device 120 then determines the target cell 150 according to the determined PCI.

[0052] Upon reception of the first control command to indicate the TCI state, the terminal device 120 may transmit (220), to the source cell 140, a PUCCH carrying a hybrid automatic repeat request (HARQ) information corresponding to the first control command.

[0053] Assuming that a delay for the first control command to take effect is 3 ms. At a timing T0 after 3 ms after the PUCCH transmission carrying the HARQ information, the terminal device 120 performs (230) a serving cell change, i.e., a HO procedure. In some embodiments, the terminal device 120 needs to perform a random access (RA) process to obtain UL timing. In some embodiments, the terminal device 120 does not need to perform the RA process and the UL timing can be obtained by using other manners.

[0054] The terminal device 120 determines (240) a QCL-TypeA RS applied for the target cell 150 according to the indicated TCI state from a first slot after a predefined timing, wherein the target cell 150 is different from the source cell 140. In this way, the TCI state indicated to the terminal device 120 may be applied for the target cell 150 after the serving cell change is completed.

[0055] In some embodiments, the QCL-TypeA RS may be determined according to a reference signal type of the QCL-TypeA RS, a resource identifier (ID) of the QCL-TypeA RS and a cell ID or a BWP ID of the target cell 150. In some embodiments, the reference signal type of the QCL-TypeA RS may be determined according to a reference signal type information of the QCL-TypeA RS, and the reference signal type information of the QCL-TypeA RS is configured in the indicated TCI state. For example, the reference signal type information of the QCL-TypeA RS configured in the indicated TCI state may indicates that the QCL-TypeA RS is a CSI-RS or a SSB. In some embodiments, the resource ID of the QCL-TypeA RS may be determined according to a resource ID information (e.g., CSI-RS-ResourceId or SSB-Index) of the QCL-TypeA RS, and the resource ID information of the QCL-TypeA RS is configured in the indicated TCI state. In some embodiments, the target cell 150 determined according to the PCI may be a PCell or PSCell corresponding to the PCI, or a cell with cell ID equal to 0 corresponding to the PCI. In some embodiments, the target cell 150 determined according to the PCI may be a BWP with BWP ID equal to 0 in the cell. For example, the reference type and resource ID of the QCL-TypeA RS configured in the indicated TCI state may be set to be “CSI-RS” and “2” respectively; in this case, the terminal device 120 may determine that the QCL-TypeA RS is the CSI-RS having the resource ID = 2 in the PCell corresponding to the additional PCI associated with the indicated TCI state. In the context of the present application, the term “target cell” refers to a PCell, PSCell or a cell with cell ID equal to 0 (i.e., ServCellIndex =0).

[0056] In some embodiments, the terminal device 120 may determine at least one of a QCL-TypeD RS, a path loss RS (PL-RS, e.g., pathlossReferenceRS configured in the TCI state) or an UL power control information (e.g., ul-powerControl configured in TCI state) for the target cell 150 according to the indicated TCI state. The QCL-TypeD RS, PL-RS or UL power control information may be applied for DL/UL signal (e.g., PDCCH/PDSCH/CSI-RS/PUCCH/PUSCH/SRS) configured or transmitted in the target cell 150. For example, the UE may determine the QCL-TypeD RS according to the additional PCI and the reference type and resource ID of the QCL-TypeD RS configured in the indicated TCI state. To determine the PL-RS or UL power control information, the UE may determine the QCL-TypeD RS according to the additional PCI and the PL-RS ID (e.g., PUSCH-PathlossReferenceRS-Id) or the UL power control information ID (e.g., Uplink-powerControlId) configured in the indicated TCI state.

[0057] In some embodiments, the terminal device 120 may determine the QCL-TypeA RS applied for the target cell 150 in accordance with a determination that a predefined trigger condition is met.

[0058] In some embodiments, the terminal device 120 may determine the QCL-TypeA RS applied for the target cell 150 if a first trigger condition that the indicated TCI state is associated with an additional PCI is met. For example, the indicated TCI state may be associated with a QCL-TypeD RS associated with a SSB having an additional PCI. The SSB may be QCL-RS of the QCL-TypeD RS, e.g., QCL-TypeC RS or QCL-TypeD RS in the TCI state applied for the QCL-TypeD RS.

[0059] In some embodiments, the terminal device 120 may determine the QCL-TypeA RS applied for the target cell 150 if a second trigger condition is met that the first control command indicates a serving cell change to be performed on the terminal device 120.

[0060] In some embodiments, the terminal device 120 may determine the QCL-TypeA RS applied for the target cell 150 if a third trigger condition that a cell ID or a BWP ID of the target cell 150 is not configured in the indicated TCI state is met. For example, the BWP ID or cell ID of the target cell 150 configured in the indicated TCI state is absent.

[0061] In some embodiments, the terminal device 120 may determine the QCL-TypeA RS applied for the target cell 150 if a fourth trigger condition that the terminal device 120 receives a second control command (e.g., DCI or MAC-CE) after receiving the first control command is met. The second control command may indicate that a serving cell change is to be performed on the terminal device 120. In other words, the control command indicating the TCI state may be different from the control command indicating the serving cell change.

[0062] It is to be understood that the above trigger conditions are merely examples, and are not intended for limitation. The determination of the QCL-TypeA RS may be performed in response to any other suitable trigger conditions or a combination of the above trigger conditions, and the present disclosure does not limit this aspect.

[0063] It is to be understood that the timing of the signaling process of FIG. 2 is shown only for ease of illustration and is not intended to be limiting. For example, the step 240 may be performed before the step 230 is completed (e.g. before T1) or after the step 230 is completed (e.g., after T1). In other words, the terminal device 120 may determine the QCL-TypeA RS according to an additional PCI associated with the indicated TCI state after or before the serving cell change is completed.

[0064] In some embodiments, the predefined timing may comprise a first timing when the RA procedure is completed successfully in the target cell 150. In some examples, the RA procedure may be performed to obtain a new UL timing advance (TA) for the target cell 150. Therefore, "serving cell change is completed" can be represented by "RA procedure is completed successfully". For example, the first timing may be a timing when the terminal device 120 transmits, to the target cell 150, a HARQ-ACK information in a PUCCH transmission corresponding to a PDSCH carrying a terminal device contention resolution identity (e.g., Contention Based Random Access (CBRA)) or a random access response (RAR) message (e.g., Non Contention or Contention Free Random Access (CFRA)). Alternatively, the first timing may be a timing when the terminal device 120 receives, from the target cell 150, a PDCCH carrying a RAR message.

[0065] In some embodiments, the terminal device 120 does not need to perform the RA process and the UL timing can be obtained based on some predefined criteria or the implementation at the terminal device 120. The predefined timing may comprise a second timing associated with the terminal device receiving a PDCCH/PDSCH transmission addressed to a cell-radio network temporary identifier (C-RNTI). The C-RNTI may be a new C-RNTI that is different from the existing/current C-RNTI. For example, the second timing may be a timing when the terminal device 120 receives, from the target cell 150, the PDCCH/PDSCH transmission addressed to the C-RNTI. Alternatively, the second timing may be a timing when the terminal device 120 transmits, to the target cell 150, a PUSCH transmission scheduled by the PDCCH transmission addressed to the C-RNTI or a timing when the terminal device 120 transmits, to the target cell 150, a HARQ information corresponding to the PDSCH transmission addressed to the C-RNTI.

[0066] In some embodiments, the predefined timing may comprise a third timing when the terminal device transmits a physical uplink control channel (PUCCH) carrying a channel state information (CSI) report in the target cell 150. The "serving cell change is completed" may be reflected in that the terminal device has completed at least one CSI report in the target cell. Specifically, the CSI report may be triggered by a PDCCH/PDSCH transmitted from the target cell. In the context of the present application, the term "CSI report in the target cell" indicates at least one of: the CSI report carrying L1-RSRP/L1-SINR, or not carrying L1-RSRP/L1-SINR; the CSI resources (e.g., CSI-RS/SSB resource) associated with the CSI report being configured in the target cell (i.e., the CSI resources being associated with the PCI); the CSI report being triggered by a PDCCH/PDSCH with CRC scrambled by a new RNTI corresponding to the target cell (e.g., C-RNTI of the target cell that is different from the C-RNTI of the source cell).

[0067] In some embodiments, the predefined timing may comprise the second timing or the third timing if the terminal device 120 reports a first capability that the terminal device 120 does not need to perform the RA procedure; and the predefined timing may comprise the first timing if the first capability is not reported.

[0068] In some embodiments, the predefined timing may comprise the second timing or the third timing if the terminal device 120 is configured with a first configuration (e.g., "disableRandomAccess") that the terminal device 120 does not need to perform the RA procedure or if the terminal device 120 is not configured with a second configuration (e.g., "enableRandomAccess") that the terminal device 120 does not need to perform the RA procedure; and the predefined timing may comprise the first timing if the terminal device 120 is not configured with the first configuration or if the terminal device 120 is configured with the second configuration.

[0069] In some embodiments, the predefined timing may comprise a fourth timing during the RA procedure in the target cell 150. The terminal device 120 needs to receive DL channels or signals transmitted from the target cell 150 before serving cell change is completed. For example, during serving cell change (e.g., RA process), PDCCH and PDSCH transmission may be necessary. In some embodiments, beams for PDCCH and PDSCH transmission (e.g., QCL-RS, QCL-TypeA/D RS) may be determined according to the SSB applied for PRACH transmission. In order to improve the reliability of these DL/UL transmissions, the terminal device 120 may obtain QCL-TypeA RS before serving cell change is completed to apply it to the DL transmissions. For example, the terminal device 120 may transmit the RA preamble (Msg1) in a PRACH to the target cell 150, or the terminal device 120 may receive an RAR message with a PDCCH/PDSCH (Msg2) from the target cell 150, or the terminal device 120 may transmit a PUSCH scheduled by a RAR UL grant to the target cell 150.

[0070] In some embodiments, if the fourth trigger condition is met, the predefined timing may comprise a timing when the terminal device 120 receives the second control command or a predefined duration after the terminal device 120 transmits a HARQ information (e.g., HARQ-ACK/NACK) in a PUCCH transmission corresponding to the second control command. The predefined duration may be configured by the source cell 140 and depends on a capability reported by the terminal device 120. For example, the predefined duration may refer to the time required for the terminal device 120 to process the second control command, e.g., 3ms for processing a MAC-CE.

[0071] In some embodiments, if the second trigger condition is met, the predefined timing may comprise a timing when the terminal device 120 receives the first control command from the source cell 140 or a predefined duration after the terminal device 120 receives the first control command. For example, the predefined duration may be configured by the source cell 140 and depends on a capability reported by the terminal device 120. For example, the predefined duration may be equal to Y symbols (e.g., BeamAppTime_r17 symbols).

[0072] In some embodiments, the target cell 150 may receive a first configuration information about a TCI state indicated by a source cell 140, wherein the source cell 140 is different from a target cell 150. The target cell 150 may receive the first configuration at the same time as the timing that the terminal device 120 receives the first control command. The target cell 150 may receive the first configuration from the source cell 140 or other node depending on the communication connection between the first network device 110 and the second network device 130.

[0073] The target cell 150 determines (250) a QCL-TypeA RS applied for the target cell 150 according to the indicated TCI state from a first slot after a predefined timing. The target cell 150 may determine the QCL-TypeA RS in the same manner, at the same predefined timing and under the same predefined triggering condition as the terminal device 120 determines the QCL-TypeA RS, and thus a detailed description thereof is omitted. In this way, the TCI state indicated to the target cell 150 may be applied in the target cell 150 after the serving cell change of the terminal device 120 is completed.

[0074] For example, an example implementation may in which the first control command is DCI be embodied as follows:

- When the UE would transmit the last symbol of a PUCCH with HARQ-ACK information corresponding to the DCI carrying the *TCI-State* indication and without DL assignment, or corresponding to the PDSCH scheduling by the DCI carrying the *TCI -State* indication, and if the *indicated TCI-State* is different from the previously indicated one, the indicated *[TCI-State]* with *[tci-StateId_r17]* should be applied starting from the first slot that is at least BeamAppTime_r17 symbols after the last symbol of the PUCCH. The first slot and the BeamAppTime_r17 symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. The UE can assume one indicated *[TCI-State]* with *[tci-StateId_r17]* for DL and UL, for DL only, or for UL only at a time. If the indicated TCI-State is associated with an *[additionalPCI-r17]* or (and) if the cell for QCL-TypeA source RS in a QCL-Info of the TCI state is not configured or (and) if the DCI indicates serving cell change, the UE assumes that QCL-TypeA RS source RS is configured in the cell corresponding to *[additionalPCI-r17]* starting from the first slot after (or before) serving cell change is completed.

[0075] For example, an example implementation in which the first control command is MAC-CE may be embodied as follows:

- When the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation command, the indicated mapping between TCI states and codepoints of the DCI field '*Transmission Configuration Indication*' should be applied starting from the first slot that is after slot n + $3N_{slot}^{subframe,\mu}$ where μ is the SCS configuration for the PUCCH. If *tci-PresentInDCI* is set to 'enabled' or *tci-PresentDCI-1-2* is configured for the CORESET scheduling the PDSCH, and the time offset between the reception of the DL DCI and the corresponding PDSCH is equal to or greater than *timeDurationForQCL* if applicable, after a UE receives an initial higher layer configuration of TCI states and before reception of the activation command, the UE may assume that the DM-RS ports of PDSCH of a serving cell are quasi co-located with the SS/PBCH block determined in the initial access procedure with respect to *qcl-Type* set to 'typeA', and when applicable, also with respect to *qcl-Type* set to 'typeD'. If the activated *[TCI-State]* is associated with an *[additionalPCI-r17]* or (and) if the cell for QCI -TypeA source RS in a QCL-Info of the TCI state is not configured or (and) if the activation command indicates serving cell change, the UE assumes that QCL-typeA RS source RS is configured in the cell corresponding to *[additionalPCI-r17]* starting from the first slot after (or before) serving cell change.

[0076] For example, an example implementation in which the first control command is DCI may be embodied as follows:

- When the UE would transmit the last symbol of a PUCCEI with HARQ-ACK information corresponding to the DCI carrying the *TCI-State* indication and without DL assignment, or corresponding to the PDSCH scheduling by the DCI carrying the *TCI-State* indication, and if the *indicated TCI-State* is different from the previously indicated one, the indicated *[TCI-State]* with *[tci-StateId_r17]* should be applied starting from the first slot that is at least BeamAppTime_r17 symbols after the last symbol of the PUCCH. The first slot and the BeamAppTime_r17 symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. The UE can assume one indicated *[TCI-State]* with *[tci-StateId_r17]* for DL and UL, for DL only, or for UL only at a time. If the indicated TCI-State is associated with an *[additionalPCI-r17]* or (and) if the cell for QCL-TypeA source RS in a QCL-Info of the TCI state is not configured or (and) if the DCI indicates serving cell change, the UE assumes that QCL-TypeA RS source RS is configured in the cell corresponding to *[additionalPCI-r17]* starting from the first slot after RA procedure is completed successfully if the UE is configured with enableRandomAcccssForHO.

[0077] For example, an example implementation in which the first control command is DCI may be embodied as follows:

- When the UE would transmit the last symbol of a PUCCH with HARQ-ACK information corresponding to the DCI carrying the *TCI-State* indication and without DL assignment, or corresponding to the PDSCH scheduling by the DCI carrying the *TCI -State* indication, and if the *indicated TCI-State* is different from the previously indicated one, the indicated *[TCI-State]* with *[tci-StateId_r17]* should be applied starting from the first slot that is at least BeamAppTime_r17 symbols after the last symbol of the PUCCH. The first slot and the BeamAppTime_r17 symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. The UE can assume one indicated *[TCI-State]* with *[tci-StateId_r17]* for DL and UL, for DL only, or for UL only at a time. If the indicated TCI-State is associated with an *[additionalPCI-r17]* or (and) if the cell for QCL-TypeA source RS in a QCL-Info of the TCI state is not configured, and when the UE receives a DCI indicating serving cell change, the UE assumes that QCL-TypeA RS source RS is configured in the cell corresponding to *[additionalPCI-r17]* starting from the first slot after (or before) serving cell change.

[0078] For example, an example implementation in which the first control command is MAC-CE may be embodied as follows:

- When the UE would transmit the last symbol of a PUCCH with HARQ-ACK information corresponding to the DCI carrying the *TCI-State* indication and without DL assignment, or corresponding to the PDSCH scheduling by the DCI carrying the *TCI -State* indication, and if the *indicated TCI-State* is different from the previously indicated one, the indicated *[TCI-State]* with *[tci-StateId_r17]* should be applied starting from the first slot that is at least BeamAppTime_r17 symbols after the last symbol of the PUCCH. The first slot and the BeamAppTime_r17 symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. The UE can assume one indicated *[TCI-State]* with *[tci-StateId_r17]* for DL and UL, for DL only, or for UL only at a time. When the UE receives an activation command indicating serving cell change and an [additional PCI-r17] or (and) if the cell for QCL-TypeA/D source RS in a QCL-Info of the TCI state is not configured, the UE assumes that QCL-TypeA/D RS source RS is configured in the cell corresponding to [additional PCI-r17] starting from the first slot after (or before) serving cell change.

- When the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation command, the indicated mapping between TCI states and codepoints of the DCI field '*Transmission Configuration Indication*' should be applied starting from the first slot that is after slot n + $3N_{slot}^{subframe,\mu}$ where μ is the SCS configuration for the PUCCH. If *tci-PresentInDCI* is set to 'enabled' or *tci-PresentDCI-1-2* is configured for the CORESET scheduling the PDSCH, and the time offset between the reception of the DL DCI and the corresponding PDSCH is equal to or greater than *timeDurationForQCL* if applicable, after a UE receives an initial higher layer configuration of TCI states and before reception of the activation command, the UE may assume that the DM-RS ports of PDSCH of a serving cell are quasi co-located with the SS/PBCH block determined in the initial access procedure with respect to *qcl-Type* set to 'typeA', and when applicable, also with respect to *qcl-Type* set to 'typeD'. When the UE receives an activation command indicating serving cell change and an [additional PCI- r17] or (and) if the cell for QCL-TypeA/D source RS in a QCL-Info of the TCI state is not configured, the UE assumes that QCL-TypeA/D RS source RS is configured in the cell corresponding to [additional PCI-r17] starting from the first slot after (or before) serving cell change.

[0079] For example, an example implementation in which the first control command is DCI or MAC-CE may be embodied as follows:

- If a UE is provided TCI-State_r17 and for an indicated TCI-State_r17 as described in [6, TS 38.214],
  - in clauses 7.1.1, 7.2.1 and 7.3.1, the RS index q_d for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission, is provided by PL-RS associated with or included in the indicated *TCI-StateID_r17*,
    - in clauses 7.1.1, if *p0-Alpha-CLID-PUSCH-Set* is provided, the values of $P_{O\_UE\_PUSCH,b,f,c}(j)$, $\alpha_{b,f,c}(j)$, and the PUSCH power control adjustment state l are provided by *p0-Alpha-CLID-PUSCH-Set* associated with the indicated *TCI-StateID_r17*;
    - in clauses 7.2.1, if *p0-Alpha-CLID-PUCCH-Set* is provided, the values of

$P_{O\_PUSCH,b,f,c}(q_u)$ and the PUCCH power control adjustment state l are provided by *p0-Alpha-CLID-PUCCH-Set* associated with the indicated *TCI-StateID_r17*;

- in clauses 7.3.1, if *p0-Alpha-CLID-SRS-Set* is provided, the values of $P_{O\_SRS,b,f,c}(q_s)$, $\alpha_{SRS,b,f,c}(q_s)$, and the SRS power control adjustment state l are provided by *p0-Alpha-CLID-SRS-Set* associated with the indicated *TCI-StateID_r17*;

- If the indicated TCI-State_r17 is associated with an *[additionalPCI-r17]*, and when the UE receives a DCI or MAC-CE indicating serving cell change, the UE assumes that the RS index q_d for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission, the values of $P_{O\_UE\_PUSCH,b,f,c}(j)$, $\alpha_{b,f,c}(j)$, and the PUSCH power control adjustment state l, the values of $P_{O\_PUSCH,b,f,c}(q_u)$ and the PUCCH power control adjustment state l, and the values of $P_{O\_SRS,b,f,c}(q_s)$, $\alpha_{SRS,b,f,c}(q_s)$, and the SRS power control adjustment state l are configured in the cell corresponding to *[additionalPCI-r17]* starting from the first slot after (or before) serving cell change.

[0080] For example, an example implementation in which the first control command is DCI or MAC-CE may be embodied as follows:

- If a UE is provided TCI-State_r17 and for an indicated TCI-State_r17 as described in [6, TS 38.214],
  - in clauses 7.1.1, 7.2.1 and 7.3.1, the RS index q_d for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission, is provided by PL-RS associated with or included in the indicated *TCI-StateID_r17*,
    - in clauses 7.1.1, if *p0-Alpha-CLID-PUSCH-Set* is provided, the values of $P_{O\_UE\_PUSCH,b,f,c}(j)$, $\alpha_{b,f,c}(j)$, and the PUSCH power control adjustment state l are provided by *p0-Alpha-CLID-PUSCH-Set* associated with the indicated *TCI-StateID_r17*;
    - in clauses 7.2.1, if *p0-Alpha-CLID-PUCCH-Set* is provided, the values of $P_{O\_PUSCH,b,f,c}(q_u)$ and the PUCCH power control adjustment state l are provided by *p0-Alpha-CLID-PUCCH-Set* associated with the indicated *TCI-StateID_r17*;

- in clauses 7.3.1, if *p0-Alpha-CLID-SRS-Set* is provided, the values of $P_{O\_SRS,b,f,c}(q_s)$, $\alpha_{SRS,b,f,c}(q_s)$, and the SRS power control adjustment state l are provided by *p0-Alpha-CLID-SRS-Set* associated with the indicated *TCI-StateID_r17*;

■ When the UE receives a DCI or MAC-CE indicating serving cell change and an *[additionalPCI-r17]*, the UE assumes that the RS index q_d for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission, the values of $P_{O\_UE\_PUSCH,b,f,c}(j)$, $\alpha_{b,f,c}(j)$, and the PUSCH power control adjustment state l, the values of $P_{O\_PUSCH,b,f,c}(q_u)$ and the PUCCH power control adjustment state l, and the values of $P_{O\_SRS,b,f,c}(q_s)$, $\alpha_{SRS,b,f,c}(q_s)$, and the SRS power control adjustment state l are configured in the cell corresponding to *[additionalPCI-r17]* starting from the first slot after (or before) serving cell change.

[0081] In this way, at least the determined QCL-TypeA RS can be applied in the target cell 150 according to the TCI state indicated by the source cell 140. The terminal device 120 may apply the TCI state in the target cell 150 after the serving cell change is completed. In this way, the saving of signaling overhead for beam indication after serving cell change may be facilitated and the latency and the interruption time during the L1/L2-based inter-cell mobility may be reduced.

[0082] Accordingly, embodiments of the present disclosure provide methods of communication implemented at a terminal device, a source cell and a target cell. These methods will be described below with reference to FIG. 3.

[0083] FIG. 3 illustrates an example method 300 of communication implemented at a terminal device in accordance with some embodiments of the present disclosure. For the purpose of discussion, the method 300 will be described with reference to FIG. 1. It is to be understood that the method 300 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present disclosure is not limited in this regard.

[0084] At block 310, the terminal device 120 receives, from the source cell 140, a first control command indicating a TCI state associated with the source cell 140.

[0085] At block 320, the terminal device 120 determines a QCL-TypeA RS applied for the target cell 150 according to the indicated TCI state from a first slot after a predefined timing. The target cell 150 is different from the source cell 140.

[0086] In some embodiments, the indicated TCI state is associated with a PCI. The terminal device 120 may determine a reference signal type of the QCL-TypeA RS and a resource ID of the QCL-TypeA RS according to a reference signal type information and a resource ID information of the QCL-TypeA RS, the reference signal type information and the resource ID information of the QCL-TypeA RS are configured in the indicated TCI state. The terminal device 120 may determine the target cell 150 according to the PCI associated with the indicated TCI state. The terminal device 120 may determine the QCL-TypeA RS applied for the target cell 150 according to the reference signal type of the QCL-TypeA RS, the resource ID of the QCL-TypeA RS and a cell ID of the target cell 150.

[0087] In some embodiments, the first control command may indicate a PCI. The terminal device 120 may determine a reference signal type of the QCL-TypeA RS and a resource ID of the QCL-TypeA RS according to a reference signal type information and a resource ID information of the QCL-TypeA RS, the reference signal type information and the resource ID information of the QCL-TypeA RS are configured in the indicated TCI state. The terminal device 120 may determine the target cell 150 according to the PCI indicated by the first control command. The terminal device 120 may determine the QCL-TypeA RS applied for the target cell 150 according to the reference signal type of the QCL-TypeA RS, the resource ID of the QCL-TypeA RS and a cell ID of the target cell 150.

[0088] In some embodiments, the indicated TCI state may be associated with a plurality of PCIs corresponding to a plurality of cells respectively. The terminal device 120 may determine a PCI among the plurality of PCIs, wherein a serving cell for the terminal device is to be changed from the source cell 140 to a cell corresponding to the PCI. The terminal device 120 may determine the target cell 150 according to the PCI. The terminal device 120 may determine a reference signal type of the QCL-TypeA RS and a resource ID of the QCL-TypeA RS according to a reference signal type information and a resource ID information of the QCL-TypeA RS, the reference signal type information and the resource ID information of the QCL-TypeA RS are configured in the indicated TCI state. The terminal device 120 may determine the QCL-TypeA RS applied for the target cell 150 according to the reference signal type of the QCL-TypeA RS, the resource ID of the QCL-TypeA RS and a cell ID of the target cell 150.

[0089] In some embodiments, the terminal device 120 may determine target cell 150 to be a PCell or PSCell corresponding to the PCI, or a cell with cell ID=0 corresponding to the PCI.

[0090] In some embodiments, the terminal device 120 may determine at least one of a QCL-TypeD RS, a path loss RS or an uplink power control information for the target cell 150 according to the indicated TCI state.

[0091] In some embodiments, the terminal device 120 may determine the QCL-TypeA RS applied for the target cell 150 according to the indicated TCI state in accordance with a determination that a predefined trigger condition is met. The predefined trigger condition may comprise at least one of: the indicated TCI state being associated with a PCI; the first control command indicating that a serving cell change is to be performed on the terminal device; a cell ID of the target cell 150 being not configured in the indicated TCI state; or the terminal device receiving a second control command after receiving the first control command, wherein the second control command indicates that a serving cell change is to be performed on the terminal device.

[0092] In some embodiments, the predefined timing may comprise one of: a first timing when a RA procedure is completed successfully in the target cell 150; a second timing associated with the terminal device receiving a PDCCH/PDSCH transmission addressed to a C-RNTI; a third timing when the terminal device transmits a PUCCH carrying a CSI report in the target cell 150; a fourth timing during the RA procedure in the target cell 150; a fifth timing after a predefined duration after the terminal device transmits a HARQ information corresponding to the first control command; and a sixth timing after a predefined duration after the terminal device transmits a HARQ information corresponding to a second control command, wherein the terminal device receives the second control command after receiving the first control command, wherein the second control command indicates that a serving cell change is to be performed on the terminal device.

[0093] In some embodiments, the first timing may comprise a timing when the terminal device transmits a HARQ information corresponding to a PDSCH carrying a terminal device contention resolution identity or a RAR message, or a timing when the terminal device receives a PDCCH carrying a RAR message.

[0094] In some embodiments, the predefined timing may comprise the second timing or the third timing if the terminal device reports a first capability that the terminal device does not need to perform the RA procedure. The predefined timing may comprise the first timing if the first capability is not reported.

[0095] In some embodiments, the predefined timing may comprise the second timing or the third timing if the terminal device is configured with a first configuration that the terminal device does not need to perform the RA procedure or if the terminal device is not configured with a second configuration that the terminal device needs to perform the RA procedure. The predefined timing may comprise first timing if the terminal device is not configured with the first configuration or if the terminal device is configured with the second configuration.

[0096] In some embodiments, the second timing may comprise one of: a timing when the terminal device receives the PDCCH/PDSCH transmission addressed to the C-RNTI; a timing when the terminal device transmits a PUSCH transmission scheduled by the PDCCH transmission addressed to the C-RNTI; and a timing when the terminal device transmits a HARQ information corresponding to the PDSCH transmission addressed to the C-RNTI.

[0097] With the method 300, at least the determined QCL-TypeA RS can be applied in the target cell 150 according to the TCI state indicated by the source cell 140. The terminal device 120 may apply the TCI state in the target cell 150 after the serving cell change is completed. Other details are similar with that described in connection with FIG. 2 and thus are not repeated here for concise.

[0098] FIG. 4 illustrates an example method 400 of communication implemented at a network device in accordance with some embodiments of the present disclosure. For example, the method 400 may be performed at the source cell 140 as shown in FIG. 1. For the purpose of discussion, in the following, the method 400 will be described with reference to FIG. 1. It is to be understood that the method 400 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present disclosure is not limited in this regard.

[0099] As shown in FIG. 4, at block 410, the source cell 140 transmits, to the terminal device 120, a first control command indicating a TCI state, wherein the indicated TCI state is associated with the source cell 140. A QCL-TypeA RS applied for the target cell 150 is determined according to the indicated TCI state from a first slot after a predefined timing. The source cell 140 is different from the target cell 150.

[00100] In some embodiments, the indicated TCI state may be associated with a PCI. The reference signal type of the QCL-TypeA RS and a resource ID of the QCL-TypeA RS according to a reference signal type information and a resource ID information of the

QCL-TypeA RS may be determined. The reference signal type information and the resource ID information of the QCL-TypeA RS are configured in the indicated TCI state. The target cell 150 may be determined according to the PCI associated with the indicated TCI state. The QCL-TypeA RS applied for the target cell 150 may be determined according to the reference signal type of the QCL-TypeA RS, the resource ID of the QCL-TypeA RS and a cell ID of the target cell 150.

[00101] In some embodiments, the target cell 150 may be determined to be a PCell or PSCell corresponding to the PCI, or a cell with cell ID=0 corresponding to the PCI.

[00102] In some embodiments, at least one of a QCL-TypeD RS, a path loss RS or an uplink power control information for the target cell 150 may be determined according to the indicated TCI state.

[00103] In some embodiments, the QCL-TypeA RS applied for the target cell 150 may be determined according to the indicated TCI state in accordance with a determination that a predefined trigger condition is met. The predefined trigger condition may comprise at least one of: in accordance with a determination that a predefined trigger condition is met, determining the QCL-TypeA RS applied for the target cell 150 according to the indicated TCI state, wherein the predefined trigger condition comprises at least one of: the indicated TCI state being associated with a PCI; a first control command indicating that a serving cell change is to be performed on a terminal device, wherein the terminal device receives, from the first network device, the first control command indicating the TCI state; a cell ID of the target cell 150 being not configured in the indicated TCI state; or the terminal device receiving a second control command after receiving the first control command, wherein the second control command indicates that a serving cell change is to be performed on the terminal device.

[00104] FIG. 5 is a simplified block diagram of a device 500 that is suitable for implementing embodiments of the present disclosure. The device 500 can be considered as a further example implementation of the first network device 110, the terminal device 120 or the second network device 130 as shown in FIG. 1. Accordingly, the device 500 can be implemented at or as at least a part of the first network device 110, the terminal device 120 or the second network device 130.

[00105] As shown, the device 500 includes a processor 510, a memory 520 coupled to the processor 510, a suitable transmitter (TX) and receiver (RX) 540 coupled to the processor

510, and a communication interface coupled to the TX/RX 540. The memory 510 stores at least a part of a program 530. The TX/RX 540 is for bidirectional communications. The TX/RX 540 has at least one antenna to facilitate communication, though in practice an Access Node mentioned in this application may have several ones. The communication interface may represent any interface that is necessary for communication with other network elements, such as X2/Xn interface for bidirectional communications between eNBs/gNBs, S1/NG interface for communication between a Mobility Management Entity (MME)/Access and Mobility Management Function (AMF)/SGW/UPF and the eNB/gNB, Un interface for communication between the eNB/gNB and a relay node (RN), or Uu interface for communication between the eNB/gNB and a terminal device.

[00106] The program 530 is assumed to include program instructions that, when executed by the associated processor 510, enable the device 500 to operate in accordance with the embodiments of the present disclosure, as discussed herein with reference to FIGs. 1 to 4. The embodiments herein may be implemented by computer software executable by the processor 510 of the device 500, or by hardware, or by a combination of software and hardware. The processor 510 may be configured to implement various embodiments of the present disclosure. Furthermore, a combination of the processor 510 and memory 520 may form processing means 550 adapted to implement various embodiments of the present disclosure.

[00107] The memory 520 may be of any type suitable to the local technical network and may be implemented using any suitable data storage technology, such as a non-transitory computer readable storage medium, semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory, as non-limiting examples. While only one memory 520 is shown in the device 500, there may be several physically distinct memory modules in the device 500. The processor 510 may be of any type suitable to the local technical network, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 500 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[00108] In some embodiments, a terminal device comprises circuitry configured to perform method 300.

[00109] In some embodiments, a network device comprises circuitry configured to perform method 400.

[00110] The components included in the apparatuses and/or devices of the present disclosure may be implemented in various manners, including software, hardware, firmware, or any combination thereof. In one embodiment, one or more units may be implemented using software and/or firmware, for example, machine-executable instructions stored on the storage medium. In addition to or instead of machine-executable instructions, parts or all of the units in the apparatuses and/or devices may be implemented, at least in part, by one or more hardware logic components. For example, and without limitation, illustrative types of hardware logic components that can be used include Field-programmable Gate Arrays (FPGAs), Application-specific Integrated Circuits (ASICs), Application-specific Standard Products (ASSPs), System-on-a-chip systems (SOCs), Complex Programmable Logic Devices (CPLDs), and the like.

[00111] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. While various aspects of embodiments of the present disclosure are illustrated and described as block diagrams, flowcharts, or using some other pictorial representation, it will be appreciated that the blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00112] The present disclosure also provides at least one computer program product tangibly stored on a non-transitory computer readable storage medium. The computer program product includes computer-executable instructions, such as those included in program modules, being executed in a device on a target real or virtual processor, to carry out the process or method as described above with reference to FIGs. 1 to 4. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data types. The functionality of the program modules may be combined or split between program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or distributed device. In a distributed device, program modules may be located in both local and remote storage media.

[00113] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. These program codes may be provided to a processor or controller of a general purpose computer, special purpose computer, or other programmable data processing apparatus, such that the program codes, when executed by the processor or controller, cause the functions/operations specified in the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on the machine and partly on a remote machine or entirely on the remote machine or server.

[00114] The above program code may be embodied on a machine readable medium, which may be any tangible medium that may contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device. The machine readable medium may be a machine readable signal medium or a machine readable storage medium. A machine readable medium may include but not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the machine readable storage medium would include an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[00115] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, while several specific implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the present disclosure, but rather as descriptions of features that may be specific to particular embodiments. Certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment may also be implemented in multiple embodiments separately or in any suitable sub-combination.

[00116] Although the present disclosure has been described in language specific to structural features and/or methodological acts, it is to be understood that the present disclosure defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

WHAT IS CLAIMED IS:

1. A communication method implemented at a terminal device, comprising:

receiving, from a network device, a first control command indicating a transmission configuration indicator (TCI) state associated with a first cell; and

determining a quasi-colocation-typeA reference signal (QCL-TypeA RS) applied for a second cell according to the indicated TCI state from a first slot after a predefined timing,

wherein the second cell is different from the first cell.

2. The method of claim 1, wherein the indicated TCI state is associated with a physical cell indicator (PCI), and

wherein determining the QCL-TypeA RS applied for the second cell according to the indicated TCI state comprises:

determining a reference signal type of the QCL-TypeA RS and a resource identifier (ID) of the QCL-TypeA RS according to a reference signal type information and a resource ID information of the QCL-TypeA RS, wherein the reference signal type information and the resource ID information of the QCL-TypeA RS are configured in the indicated TCI state;

determining the second cell according to the PCI associated with the indicated TCI state; and

determining the QCL-TypeA RS applied for the second cell according to the reference signal type of the QCL-TypeA RS, the resource ID of the QCL-TypeA RS and a cell ID of the second cell.

3. The method of claim 1, wherein the first control command indicates a PCI,

wherein determining the QCL-TypeA RS applied for the second cell according to the indicated TCI state comprises:

determining a reference signal type of the QCL-TypeA RS and a resource ID of the QCL-TypeA RS according to a reference signal type information and a resource ID information of the QCL-TypeA RS, wherein the reference signal type information and the resource ID information of the QCL-TypeA RS are configured in the indicated TCI state;

determining the second cell according to the PCI indicated by the first control command; and determining the QCL-TypeA RS applied for the second cell according to the reference signal type of the QCL-TypeA RS, the resource ID of the QCL-TypeA RS and a cell ID of the second cell.

4. The method of claim 1, wherein the indicated TCI state is associated with a plurality of PCIs corresponding to a plurality of cells respectively,

wherein the method further comprises:

determining a PCI among the plurality of PCIs, wherein a serving cell for the terminal device is to be changed from the first cell to a cell corresponding to the PCI; and

determining the second cell according to the PCI;

wherein determining the QCL-TypeA RS applied for the second cell according to the indicated TCI state comprises:

determining a reference signal type of the QCL-TypeA RS and a resource ID of the QCL-TypeA RS according to a reference signal type information and a resource ID information of the QCL-TypeA RS, wherein the reference signal type information and the resource ID information of the QCL-TypeA RS are configured in the indicated TCI state; and

determining the QCL-TypeA RS applied for the second cell according to the reference signal type of the QCL-TypeA RS, the resource ID of the QCL-TypeA RS and a cell ID of the second cell.

5. The method of any of claims 2 to 4, wherein determining the second cell according to the PCI comprises:

determining the second cell to be a PCell or PSCell corresponding to the PCI, or a cell with cell ID=0 corresponding to the PCI.

6. The method of claim 1, further comprising:

determining at least one of a QCL-TypeD RS, a path loss RS or an uplink power control information applied for the second cell according to the indicated TCI state.

7. The method of claim 1, wherein determining the QCL-TypeA RS applied for the second cell according to the indicated TCI state comprises:

in accordance with a determination that a predefined trigger condition is met, determining the QCL-TypeA RS applied for the second cell according to the indicated TCI state, wherein the predefined trigger condition comprises at least one of:

the indicated TCI state being associated with a PCI;

the first control command indicating that a serving cell change is to be performed on the terminal device;

a cell ID of the second cell being not configured in the indicated TCI state; or

the terminal device receiving a second control command after receiving the first control command, wherein the second control command indicates that a serving cell change is to be performed on the terminal device.

8. The method of claim 1, wherein the predefined timing comprises one of:

a first timing when a random access (RA) procedure is completed successfully in the second cell;

a second timing associated with the terminal device receiving a physical downlink control channel/physical downlink shared channel (PDCCH/PDSCH) transmission addressed to a cell-radio network temporary identifier (C-RNTI);

a third timing when the terminal device transmits a physical uplink control channel (PUCCH) carrying a channel state information (CSI) report in the second cell;

a fourth timing during the RA procedure in the second cell;

a fifth timing after a predefined duration after the terminal device transmits a hybrid automatic repeat request (HARQ) information corresponding to the first control command; and

a sixth timing after a predefined duration after the terminal device transmits a HARQ information corresponding to a second control command, wherein the terminal device receives the second control command after receiving the first control command, wherein the second control command indicates that a serving cell change is to be performed on the terminal device.

9. The method of claim 8, wherein the first timing comprises a timing when the terminal device transmits a HARQ information corresponding to a PDSCH carrying a terminal device contention resolution identity or a random access response (RAR) message, or a timing when the terminal device receives a PDCCH carrying a RAR message.

10. The method of claim 8, wherein:

the predefined timing comprises the second timing or the third timing if the terminal device reports a first capability that the terminal device does not need to perform the RA procedure; and

the predefined timing comprises the first timing if the first capability is not reported.

11. The method of claim 8, wherein:

the predefined timing comprises the second timing or the third timing if the terminal device is configured with a first configuration that the terminal device does not need to perform the RA procedure or if the terminal device is not configured with a second configuration that the terminal device needs to perform the RA procedure; and

the predefined timing comprises the first timing if the terminal device is not configured with the first configuration or if the terminal device is configured with the second configuration.

12. The method of claim 8, wherein the second timing comprises one of:

a timing when the terminal device receives the PDCCH/PDSCH transmission addressed to the C-RNTI;

a timing when the terminal device transmits a PUSCH transmission scheduled by the PDCCH transmission addressed to the C-RNTI; and

a timing when the terminal device transmits a HARQ information corresponding to the PDSCH transmission addressed to the C-RNTI.

13. A communication method implemented at a network device, comprising:

transmitting, to a terminal device, a first control command indicating a transmission configuration indicator (TCI) state on a first cell, wherein the indicated TCI state is associated with the first cell;

wherein a quasi-colocation-typeA reference signal (QCL-TypeA RS) applied for a second cell is determined according to the indicated TCI state from a first slot after a predefined timing, and

wherein the second cell is different from the first cell.

14. A terminal device comprising:

a processor; and

a memory coupled to the processor and storing instructions thereon, the instructions, when executed by the processor, causing the terminal device to perform acts comprising the method according to any of claims 1-12.

15. A network device comprising:

a processor; and

a memory coupled to the processor and storing instructions thereon, the instructions, when executed by the processor, causing the network device to perform acts comprising the method according to claims 13.

16. A computer readable medium having instructions stored thereon, the instructions, when executed on at least one processor, causing the at least one processor to perform the method according to any of claims 1-12 or the method according to claim 13.

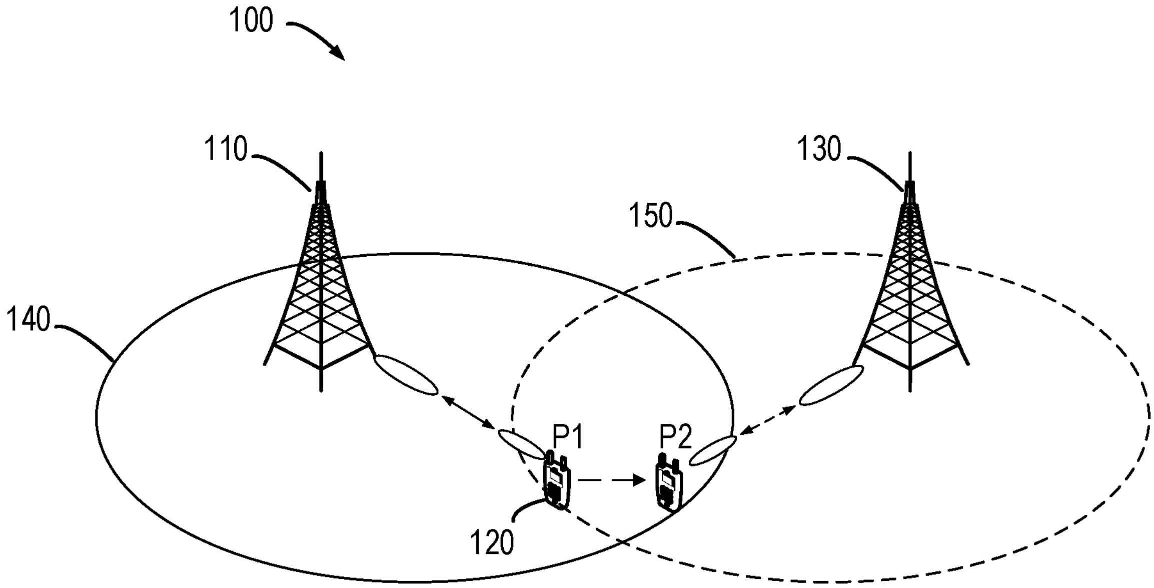

FIG. 1

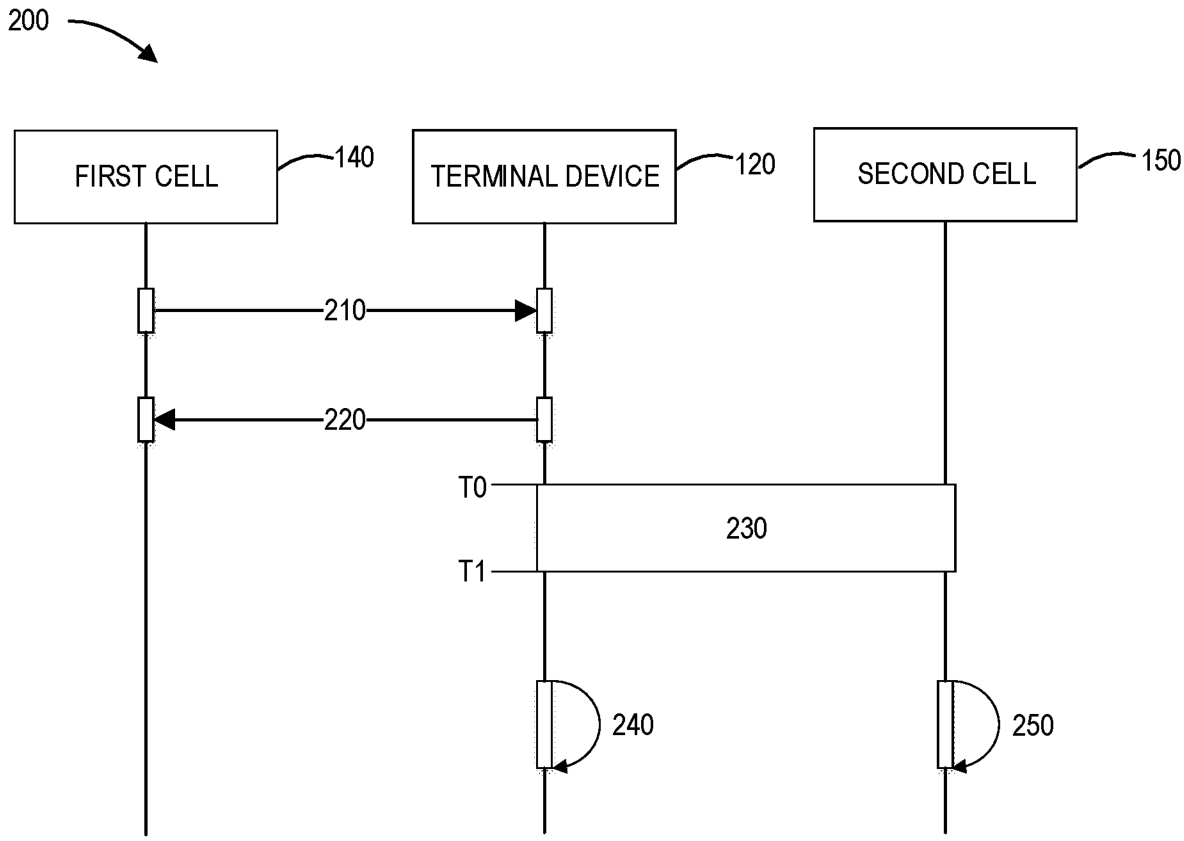
200
FIRST CELL
140
TERMINAL DEVICE
120
SECOND CELL
150
210
220
T0
230
T1
240
250

FIG. 2

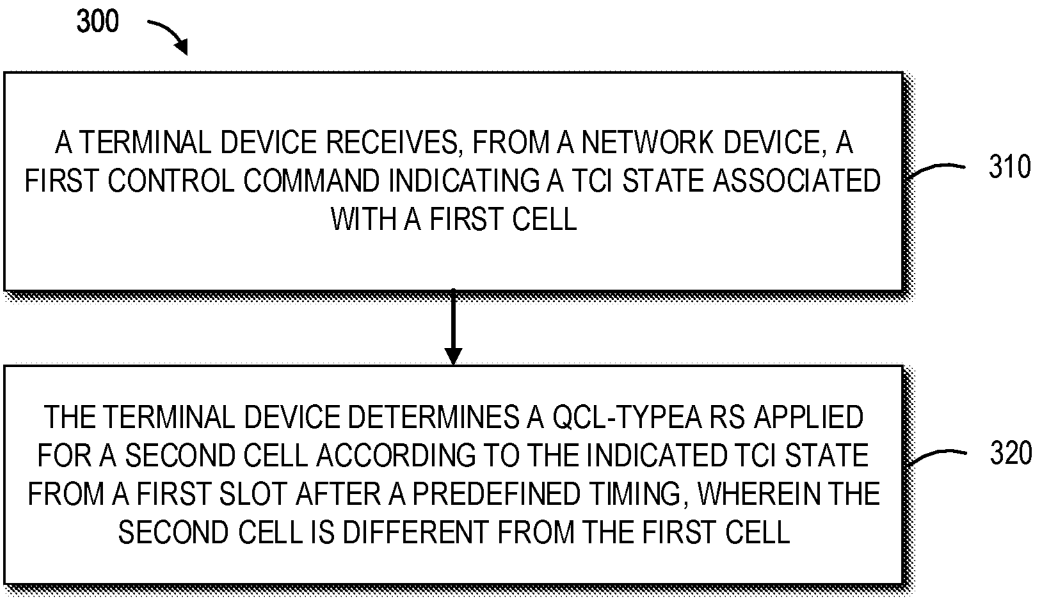
300
A TERMINAL DEVICE RECEIVES, FROM A NETWORK DEVICE, A FIRST CONTROL COMMAND INDICATING A TCI STATE ASSOCIATED WITH A FIRST CELL
310
THE TERMINAL DEVICE DETERMINES A QCL-TYPEA RS APPLIED FOR A SECOND CELL ACCORDING TO THE INDICATED TCI STATE FROM A FIRST SLOT AFTER A PREDEFINED TIMING, WHEREIN THE SECOND CELL IS DIFFERENT FROM THE FIRST CELL
320

FIG. 3

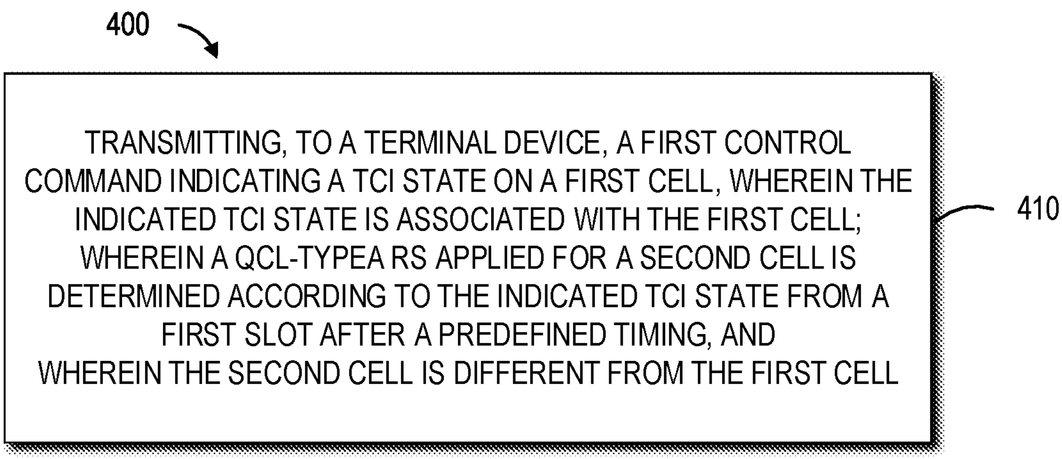
400
TRANSMITTING, TO A TERMINAL DEVICE, A FIRST CONTROL COMMAND INDICATING A TCI STATE ON A FIRST CELL, WHEREIN THE INDICATED TCI STATE IS ASSOCIATED WITH THE FIRST CELL; WHEREIN A QCL-TYPEA RS APPLIED FOR A SECOND CELL IS DETERMINED ACCORDING TO THE INDICATED TCI STATE FROM A FIRST SLOT AFTER A PREDEFINED TIMING, AND WHEREIN THE SECOND CELL IS DIFFERENT FROM THE FIRST CELL
410

FIG. 4

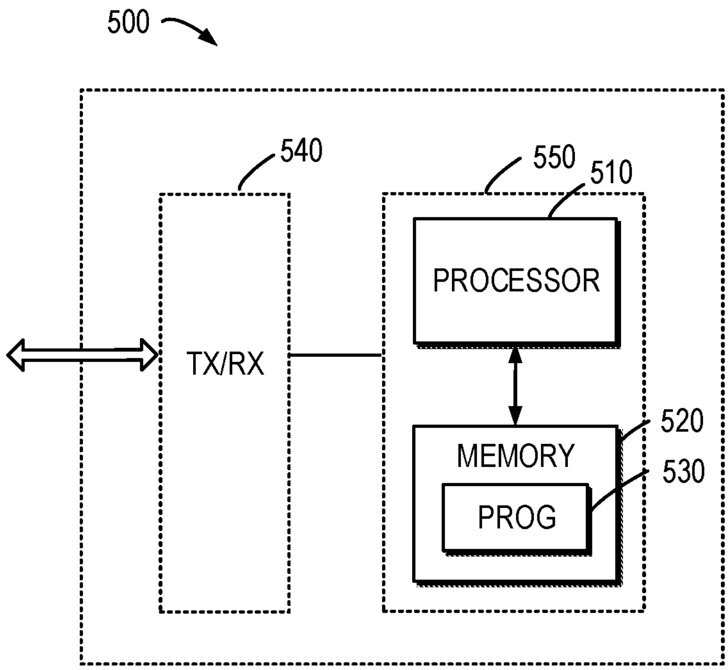

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/093552

A. CLASSIFICATION OF SUBJECT MATTER

H04W 36/00(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W

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)

CNPAT,CNKI,WPI,EPODOC,3GPP:TCI state QCL typeA PCI handover handoff transmission configuration indicator latency delay timing additional quasi

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2022074602 A1 (TELEFONAKTIEBOLAGET LM ERICSSON PUBL) 14 April 2022 (2022-04-14) description, paragraphs 104-112	1-16
A	CN 113595706 A (OPPO GUANGDONG MOBILE TELECOMMUNICATIONS CO., LTD.) 02 November 2021 (2021-11-02) the whole document	1-16
A	CN 113747466 A (APPLE INC.) 03 December 2021 (2021-12-03) the whole document	1-16
A	HUAWEI et al. "Enhancements on inter-cell multi-TRP operations in Rel-17" *3GPP TSG RAN WG1 Meeting #106-e R1-2106465,* 27 August 2021 (2021-08-27), the whole document	1-16
A	CN 113825229 A (HUAWEI TECHNOLOGIES CO., LTD.) 21 December 2021 (2021-12-21) the whole document	1-16

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
18 November 2022	**28 November 2022**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	Authorized officer **TIAN,Linlin**
Facsimile No. **(86-10)62019451**	Telephone No. **86-(10)-53961736**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/093552

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2022074602	A1	14 April 2022	None			
CN	113595706	A	02 November 2021	WO	2020243930	A1	10 December 2020
				CN	113170448	A	23 July 2021
				EP	3968712	A1	16 March 2022
				US	2022095345	A1	24 March 2022
CN	113747466	A	03 December 2021	US	2021378042	A1	02 December 2021
				EP	3917249	A1	01 December 2021
CN	113825229	A	21 December 2021	WO	2021254472	A1	23 December 2021