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(54) **Title:** A METHOD OF SIDE CONTROL INFORMATION CONFIGURATION

(57) **Abstract:** The present disclosure describes methods and devices for configuring side control information of a smart node in a wireless system. A centralized unit of a base station transfers a first message is transferred to a distributed unit of the base station. The first message instructs the distributed unit to generate the side control information. The centralized unit receives a second message from the distributed unit. The second message includes the side control information. The centralized unit transfers a third message including the side control information to the smart node. The smart node transitions to an RRC_INACTIVE or an RRC_IDLE state in response to receiving the third message.

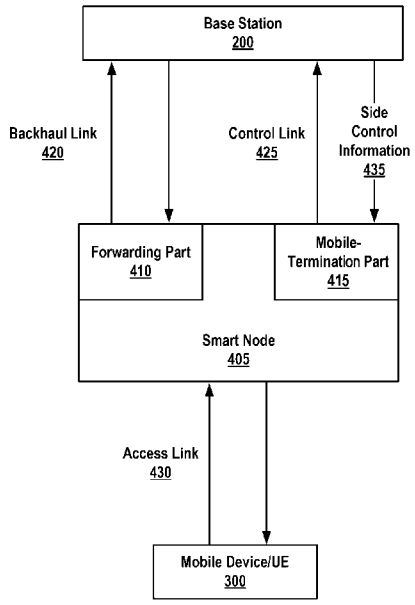

FIG. 4

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A METHOD OF SIDE CONTROL INFORMATION CONFIGURATION

TECHNICAL FIELD

[001] The present subject matter is directed generally to wireless communications. Particularly, the present subject matter relates to methods, devices, and systems for configuring side control information for a smart node when transitioning the smart node to the RRC_INACTIVE or RRC_IDLE states.

BACKGROUND

[002] Coverage may be a fundamental aspect of cellular network deployments. Mobile operators may rely on different types of network nodes to offer blanket coverage in their deployments. As a result, new types of network nodes may be considered to increase mobile operators' flexibility for network deployments. For example, Integrated Access and Backhaul (IAB) was introduced in 5G New Radio (NR) Release 16 (Rel-16) and enhanced in NR Rel-17 as a new type of network node that does not require a wired backhaul. Another type of network node is the radio frequency (RF) repeater, which may simply amplify-and-forward any signal that is received. RF repeaters have seen a wide range of deployments in 2G, 3G, and 4G wireless data communication systems to supplement the coverage provided by regular full-stack cells.

SUMMARY

[003] The present subject matter is directed to a method, device, and system for configuring side control information for a smart node in a wireless communication system.

[004] In some embodiments, a method for configuring side control information for a smart node in a wireless communication system may include transferring a first message from a centralized unit of a base station to a distributed unit of the base station. The first message may instruct the distributed unit to generate the side control information. The method may further include receiving, at the centralized unit, a second message from the distributed unit, wherein the second message comprises the side control information. The method may

further include transferring a third message from the centralized unit to the smart node. The third message may include the side control information. The first message may be a UE context modification request. The second message may be a UE context modification response. The third message may be a radio resource control (RRC) reconfiguration message. The third message may be an RRC release message configured to cause the smart node to transition to an RRC_INACTIVE or an RRC_IDLE state. The first message may further include an indication that the side control information is to be applied to perform forwarding at the smart node when the smart node is in an RRC_IDLE, RRC_INACTIVE, or RRC_CONNECTED state. The first message may further include an instruction to remove at least some configured side control information of the smart node. The at least some configuration side control information may include one or more of: periodic side control information, semi-persistent side control information, or aperiodic side control information. The first message may further include an indication or request for a value of a wake-up timer. The second may further include the value of the wake-up timer. The first message may further include an indication or request for beam information for a backhaul link of the smart node. The second message may further include an ON/OFF indicator. The second message may further include an instruction to release existing side control information configured for the smart node. The second message may further include the beam information. The third message may further include an ON/OFF indicator. The third message may further include beam information for a backhaul link of the smart node. The third message may further include the value of the wake-up timer. The method may further include receiving an RRC reconfiguration complete message from the smart node.

[005] In some other embodiments, an apparatus for wireless communication may include a memory storing instructions and a processing circuitry in communication with the memory. When the processing circuitry executes the instructions, the processing circuitry is configured to carry out the above methods.

[006] In some other embodiments, a device for wireless communication may include a memory storing instructions and a processing circuitry in communication with the memory. When the processing circuitry executes the instructions, the processing circuitry is configured to carry out the above methods.

[007] In some other embodiments, a computer-readable medium comprising instructions which, when executed by a computer, cause the computer to carry out the above methods.

[008] The above and other aspects and their implementations are described in greater detail in the drawings, the descriptions, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[009] FIG. 1 shows an example wireless communication system including a wireless base station and user equipment.

[010] FIG. 2 shows an example of a base station.

[011] FIG. 3 shows an example of user equipment.

[012] FIG. 4 shows an example wireless communication system including a wireless base station, smart node, and user equipment.

[013] FIG. 5 shows an example overall architecture of a Centralized Unit (CU)/Distributed Unit (DU) split of a base station.

[014] FIG. 6 shows an example swim lane diagram of an example communication between a base station having a centralized unit/distributed unit and a smart node.

DETAILED DESCRIPTION

[015] The present subject matter will now be described in detail hereinafter with reference to the accompanied drawings, which form a part of the present subject matter, and which show, by way of illustration, specific examples of embodiments. Please note that the present subject matter may, however, be embodied in a variety of different forms and, therefore, the covered or claimed subject matter is intended to be construed as not being limited to any of the embodiments to be set forth below.

[016] Throughout the specification and claims, terms may have nuanced meanings suggested or implied in context beyond an explicitly stated meaning. Likewise, the phrase “in one embodiment” or “in some embodiments” as used herein does not necessarily refer to the same embodiment and the phrase “in another embodiment” or “in other embodiments” as used

herein does not necessarily refer to a different embodiment. The phrase "in one implementation" or "in some implementations" as used herein does not necessarily refer to the same implementation and the phrase "in another implementation" or "in other implementations" as used herein does not necessarily refer to a different implementation. It is intended, for example, that claimed subject matter includes combinations of exemplary embodiments or implementations in whole or in part.

[017] In general, terminology may be understood at least in part from usage in context. For example, terms, such as "and", "or", or "and/or," as used herein may include a variety of meanings that may depend at least in part upon the context in which such terms are used. Typically, "or" if used to associate a list, such as A, B or C, is intended to mean A, B, and C, here used in the inclusive sense, as well as A, B or C, here used in the exclusive sense. In addition, the term "one or more" or "at least one" as used herein, depending at least in part upon context, may be used to describe any feature, structure, or characteristic in a singular sense or may be used to describe combinations of features, structures, or characteristics in a plural sense. Similarly, terms, such as "a", "an", or "the", again, may be understood to convey a singular usage or to convey a plural usage, depending at least in part upon context. In addition, the term "based on" or "determined by" may be understood as not necessarily intended to convey an exclusive set of factors and may, instead, allow for existence of additional factors not necessarily expressly described, again, depending at least in part on context.

[018] In NR Rel-18, a network-controlled repeater (NCR) is introduced as an enhancement over conventional radio frequency (RF) repeaters with the capability to receive and process side control information from the network. Side control information may allow an NCR to perform amplify-and-forward operation in a more efficient manner. Potential benefits may include mitigation of unnecessary noise amplification, transmissions and receptions with better spatial directivity, and simplified network integration.

[019] An NCR may be regarded as a stepping stone of Reconfigurable Intelligent Surfaces (RIS), an RIS node may adjust the phase and amplitude of a received signal to improve the coverage. In accordance with the present subject matter, such kinds of network nodes,

including but not limited to NCRs, smart repeaters, RISes, and IABs are denoted as smart nodes for simplicity in facilitating the following discussion.

[020] Fig. 1 shows a diagram of an example wireless communication system 100 including a plurality of communication nodes (or just nodes) that are configured to wirelessly communicate with each other. In general, the communication nodes include at least one user device 102 and at least one wireless access node 104. The example wireless communication system 100 in Fig. 1 is shown as including two user devices 102, including a first user device 102(1) and a second user device 102(2), and one wireless access nodes 104. However, various other examples of the wireless communication system 100 that include any of various combinations of one or more user devices 102 and/or one or more wireless access nodes 104 may be possible.

[021] In general, a user device as described herein, such as the user device 102, may include a single electronic device or apparatus, or multiple (e.g., a network of) electronic devices or apparatuses, capable of communicating wirelessly over a network. A user device may comprise or otherwise be referred to as a user terminal, a user terminal device, or a user equipment (UE). Additionally, a user device may be or include, but not limited to, a mobile device (such as a mobile phone, a smart phone, a smart watch, a tablet, a laptop computer, vehicle or other vessel (human, motor, or engine-powered, such as an automobile, a plane, a train, a ship, or a bicycle as non-limiting examples) or a fixed or stationary device, (such as a desktop computer or other computing device that is not ordinarily moved for long periods of time, such as appliances, other relatively heavy devices including Internet of things (IoT), or computing devices used in commercial or industrial environments, as non-limiting examples). In various embodiments, a user device 102 may include transceiver circuitry 106 coupled to an antenna 108 to effect wireless communication with the wireless access node 104. The transceiver circuitry 106 may also be coupled to a processor 110, which may also be coupled to a memory 112 or other storage device. The memory 112 may store therein instructions or code that, when read and executed by the processor 110, cause the processor 110 to implement various ones of the methods described herein.

[022] Additionally, in general, a wireless access node as described herein, such as the wireless

access node 104, may include a single electronic device or apparatus, or multiple (e.g., a network of) electronic devices or apparatuses, and may comprise one or more base stations or other wireless network access points capable of communicating wirelessly over a network with one or more user devices and/or with one or more other wireless access nodes 104. For example, the wireless access node 104 may comprise a 4G LTE base station, a 5G NR base station, a 5G central-unit base station, a 5G distributed-unit base station, a next generation Node B (gNB), an enhanced Node B (eNB), or other similar or next-generation (e.g., 6G) base stations, in various embodiments. A wireless access node 104 may include transceiver circuitry 114 coupled to an antenna 116, which may include an antenna tower 118 in various approaches, to effect wireless communication with the user device 102 or another wireless access node 104. The transceiver circuitry 114 may also be coupled to one or more processors 120, which may also be coupled to a memory 122 or other storage device. The memory 122 may store therein instructions or code that, when read and executed by the processor 120, cause the processor 120 to implement one or more of the methods described herein.

[023] In various embodiments, two communication nodes in the wireless communication system 100—such as a user device 102 and a wireless access node 104, two user devices 102 without a wireless access node 104, or two wireless access nodes 104 without a user device 102—may be configured to wirelessly communicate with each other in or over a mobile network and/or a wireless access network according to one or more standards and/or specifications. In general, the standards and/or specifications may define the rules or procedures under which the communication nodes can wirelessly communicate, which, in various embodiments, may include those for communicating in millimeter (mm)-Wave bands, and/or with multi-antenna schemes and beamforming functions. In addition, or alternatively, the standards and/or specifications are those that define a radio access technology and/or a cellular technology, such as Fourth Generation (4G) Long Term Evolution (LTE), Fifth Generation (5G) New Radio (NR), or New Radio Unlicensed (NR-U), as non-limiting examples.

[024] Additionally, in the wireless communication system 100, the communication nodes are configured to wirelessly communicate signals between each other. In general, a communication in the wireless communication system 100 between two communication

nodes can be or include a transmission or a reception, and is generally both simultaneously, depending on the perspective of a particular node in the communication. For example, for a given communication between a first node and a second node where the first node is transmitting a signal to the second node and the second node is receiving the signal from the first node, the first node may be referred to as a source or transmitting node or device, the second node may be referred to as a destination or receiving node or device, and the communication may be considered a transmission for the first node and a reception for the second node. Of course, since communication nodes in a wireless communication system 100 can both send and receive signals, a single communication node may be both a transmitting/source node and a receiving/destination node simultaneously or switch between being a source/transmitting node and a destination/receiving node.

[025] Also, particular signals may be characterized or defined as either an uplink (UL) signal, a downlink (DL) signal, or a sidelink (SL) signal. An uplink signal is a signal transmitted from a user device 102 to a wireless access node 104. A downlink signal is a signal transmitted from a wireless access node 104 to a user device 102. A sidelink signal is a signal transmitted from a one user device 102 to another user device 102, or a signal transmitted from one wireless access node 104 to another wireless access node 104. Also, for sidelink transmissions, a first/source user device 102 directly transmits a sidelink signal to a second/destination user device 102 without any forwarding of the sidelink signal to a wireless access node 104.

[026] Additionally, signals communicated between communication nodes in the wireless communication system 100 may be characterized or defined as a data signal or a control signal. In general, a data signal is a signal that includes or carries data, such multimedia data (e.g., voice and/or image data), and a control signal is a signal that carries control information that configures the communication nodes in certain ways to communicate with each other, or otherwise controls how the communication nodes communicate data signals with each other. Also, certain signals may be defined or characterized by combinations of data/control and uplink/downlink/sidelink, including uplink control signals, uplink data signals, downlink control signals, downlink data signals, sidelink control signals, and sidelink data signals.

[027] For at least some specifications, such as 5G NR, data and control signals are transmitted

and/or carried on physical channels. Generally, a physical channel corresponds to a set of time-frequency resources used for transmission of a signal. Different types of physical channels may be used to transmit different types of signals. For example, physical data channels (or just data channels) are used to transmit data signals, and physical control channels (or just control channels) are used to transmit control signals. Example types of physical data channels include, but are not limited to, a physical downlink shared channel (PDSCH) used to communicate downlink data signals, a physical uplink shared channel (PUSCH) used to communicate uplink data signals, and a physical sidelink shared channel (PSSCH) used to communicate sidelink data signals. In addition, example types of physical control channels include, but are not limited to, a physical downlink control channel (PDCCH) used to communicate downlink control signals, a physical uplink control channel (PUCCH) used to communicate uplink control signals, and a physical sidelink control channel (PSCCH) used to communicate sidelink control signals. As used herein for simplicity, unless specified otherwise, a particular type of physical channel is also used to refer to a signal that is transmitted on that particular type of physical channel, and/or a transmission on that particular type of transmission. As an example illustration, a PDSCH refers to the physical downlink shared channel itself, a downlink data signal transmitted on the PDSCH, or a downlink data transmission. Accordingly, a communication node transmitting or receiving a PDSCH means that the communication node is transmitting or receiving a signal on a PDSCH.

[028] Additionally, for at least some specifications, such as 5G NR, and/or for at least some types of control signals, a control signal that a communication node transmits may include control information comprising the information necessary to enable transmission of one or more data signals between communication nodes, and/or to schedule one or more data channels (or one or more transmissions on data channels). For example, such control information may include the information necessary for proper reception, decoding, and demodulation of a data signals received on physical data channels during a data transmission, and/or for uplink scheduling grants that inform the user device about the resources and transport format to use for uplink data transmissions. In some embodiments, the control information includes downlink control information (DCI) that is transmitted in the downlink direction from a wireless access node 104 to a user device 102. In other embodiments, the

control information includes uplink control information (UCI) that is transmitted in the uplink direction from a user device 102 to a wireless access node 104, or sidelink control information (SCI) that is transmitted in the sidelink direction from one user device 102(1) to another user device 102(2).

[029] Additionally, in the wireless communication system 100, a slot format for a plurality of slots or frames may be configured by the wireless access node 104 or specified by a protocol. In some examples, a slot may be indicated or specified as a downlink slot, a flexible slot, or an uplink slot. Also, an orthogonal frequency divisional multiplexing (OFDM) symbol may be indicated or specified as a downlink symbol, a flexible symbol, or an uplink symbol, in various embodiments.

[030] FIG. 2 shows an example of base station 200. The example base station 200 may include radio transmitting/receiving (Tx/Rx) circuitry 208 to transmit/receive communication with UEs and/or other base stations. The base station 200 may also include network interface circuitry 209 to communicate the base station with other base stations and/or a core network, e.g., optical or wireline interconnects, Ethernet, and/or other data transmission mediums/protocols. The base station 200 may optionally include an input/output (I/O) interface 206 to communicate with an operator or the like.

[031] The base station 200 may also include system circuitry 204. System circuitry 204 may include processor(s) 221 and/or memory 222. Memory 222 may include an operating system 224, instructions 226, and parameters 228. Instructions 226 may be configured for the one or more of the processors 124 to perform the functions of the base station. The parameters 228 may include parameters to support execution of the instructions 226. For example, parameters may include network protocol settings, bandwidth parameters, radio frequency mapping assignments, and/or other parameters.

[032] FIG. 3 shows an example of an electronic device to implement a terminal device 300 (for example, user equipment (UE)). The UE 300 may be a mobile device, for example, a smart phone or a mobile communication module disposed in a vehicle. The UE 300 may include communication interfaces 302, a system circuitry 304, an input/output interfaces (I/O) 306, a display circuitry 308, and a storage 309. The display circuitry may include a user

interface 310. The system circuitry 304 may include any combination of hardware, software, firmware, or other logic/circuitry. The system circuitry 304 may be implemented, for example, with one or more systems on a chip (SoC), application specific integrated circuits (ASIC), discrete analog and digital circuits, and other circuitry. The system circuitry 304 may be a part of the implementation of any desired functionality in the UE 300. In that regard, the system circuitry 304 may include logic that facilitates, as examples, decoding and playing music and video, e.g., MP3, MP4, MPEG, AVI, FLAC, AC3, or WAV decoding and playback; running applications; accepting user inputs; saving and retrieving application data; establishing, maintaining, and terminating cellular phone calls or data connections for, as one example, internet connectivity; establishing, maintaining, and terminating wireless network connections, Bluetooth connections, or other connections; and displaying relevant information on the user interface 310. The user interface 310 and the inputs/output (I/O) interfaces 306 may include a graphical user interface, touch sensitive display, haptic feedback or other haptic output, voice or facial recognition inputs, buttons, switches, speakers, and other user interface elements. Additional examples of the I/O interfaces 306 may include microphones, video and still image cameras, temperature sensors, vibration sensors, rotation and orientation sensors, headset and microphone input / output jacks, Universal Serial Bus (USB) connectors, memory card slots, radiation sensors (e.g., IR sensors), and other types of inputs.

[033] The communication interfaces 302 may include a Radio Frequency (RF) transmit (Tx) and receive (Rx) circuitry 316 which handles transmission and reception of signals through one or more antennas 314. The communication interface 302 may include one or more transceivers. The transceivers may be wireless transceivers that include modulation / demodulation circuitry, digital to analog converters (DACs), shaping tables, analog to digital converters (ADCs), filters, waveform shapers, filters, pre-amplifiers, power amplifiers and/or other logic for transmitting and receiving through one or more antennas, or (for some devices) through a physical (e.g., wireline) medium. The transmitted and received signals may adhere to any of a diverse array of formats, protocols, modulations (e.g., QPSK, 16-QAM, 64-QAM, or 256-QAM), frequency channels, bit rates, and encodings. As one specific example, the communication interfaces 302 may include transceivers that support transmission and

reception under the 2G, 3G, BT, WiFi, Universal Mobile Telecommunications System (UMTS), High Speed Packet Access (HSPA)+, 4G / Long Term Evolution (LTE), and 5G standards. The techniques described below, however, are applicable to other wireless communications technologies whether arising from the 3rd Generation Partnership Project (3GPP), GSM Association, 3GPP2, IEEE, or other partnerships or standards bodies.

[034] The system circuitry 304 may include one or more processors 321 and memories 322. The memory 322 stores, for example, an operating system 324, instructions 326, and parameters 328. The processor 321 is configured to execute the instructions 326 to carry out desired functionality for the UE 300. The parameters 328 may provide and specify configuration and operating options for the instructions 326. The memory 322 may also store any BT, WiFi, 3G, 4G, 5G or other data that the UE 300 will send, or has received, through the communication interfaces 302. In various implementations, a system power for the UE 300 may be supplied by a power storage device, such as a battery or a transformer.

[035] FIG. 4 illustrates an example wireless communication system including a smart node 405, base station 200, and UE 300. The smart node 405 may be include a forwarding part 410 and a mobile-termination part 415. A radio link between the base station 200 and forwarding part 410 may be a backhaul link 420. A radio link between the base station 200 and the mobile-termination part 415 may be a control link 425. A radio link between smart node 405 and the UE 300 may be an access link 430. Each of the backhaul link 420, control link 425, and access link 430 may further include a downlink and uplink as shown in FIG. 4.

[036] In the downlink of backhaul link 420, the forwarding part 410 may receive the radio signal transmitted from the base station 200 and forward radio signals to the UE 300 via the access link 430. In the uplink of backhaul link 420, the forwarding part 410 may forward radio signals received from UE 300 to the base station 200. The forwarding part 410 may process the radio signals and/or merely amplify-and-forward radio signals.

[037] The mobile-termination part 415 may connect to the base station 200 as a normal mobile device (e.g., UE 300) and may receive side control information 435 via a downlink of the control link 425 from base station 200. The side control information 435 may be used to control the forwarding behavior of the forwarding part 410, and for this reason, the side

control information 435 may also be referred to as the forwarding configuration or beam indication.

[038] The side control information 435 may be of the following types: periodic side control information, semi-persistent side control information, or aperiodic side control information. Periodic side control information may be configured via a radio resource control (RRC) message transmitted from the base station 200 to the smart node 405. The smart node 405 may apply the periodic side control information when it receives the RRC message such that the periodic side control information is used to perform forwarding of the radio signals. The periodic side control information may include a list of periodic time resources and corresponding beam information. The smart node 405 may forward radio signals over access link 430 according to the configured time resource and the corresponding beam information.

[039] The semi-persistent side control information may be configured via an RRC message transmitted from the base station 200 to the smart node 405. The semi-persistent side control information may include a list of periodic time resources and corresponding beam information. The smart node 405 may apply the semi-persistent side control information when it receives a MAC control element (MAC CE) from the base station 200. The MAC CE may be used to activate the semi-persistent side control information. The smart node 405 may stop applying the semi-persistent side control information when it receives a MAC CE that is used to deactivate the semi-persistent side control information.

[040] The aperiodic side control information may include an aperiodic time resource that may be configured via an RRC message and a DCI. The DCI may include aperiodic time resource information, which refers to the aperiodic time resource configured by the RRC message, and corresponding beam information. The smart node 405 may forward radio signals over access link 430 according to the aperiodic time resource information and corresponding beam information included in the DCI.

[041] FIG. 5 illustrates an example overall architecture of a Centralized Unit (CU)/Distributed Unit (DU) split of a base station 200. The gNB 505 may include a gNB Centralized Unit (gNB-CU 510) and one or more gNB Distributed Units (gNB-DU 515). A gNB-CU 510 and a gNB-DU 515 may be connected via an F1 interface 520. The gNB-CU 510 may be defined

as a logical node hosting radio resource control (RRC), SDAP and packet data convergence protocols (PDCP) of the gNB 505, or RRC and PDCP protocols of the en-gNB, that control the operation of the one or more gNB-DUs 515. The gNB-DU 515 may be defined as a logical node hosting RLC, MAC, and PHY layers of the gNB 505 or en-gNB, and the operation of the gNB-DU 515 may be partly controlled by the gNB-CU 510. One gNB-DU 515 may support one or more cells. One cell may be supported by only one gNB-DU 515.

[042] According to progress of the current 3GPP RAN2 technical specification group, a smart node 405 may be operating in ON or OFF according to the last configuration of side control information 435 before the smart node 405 is released to RRC_IDLE mode or RRC_INACTIVE states. In other words, in order to keep an NCR in an OFF mode where the NCR performs no forwarding, the network may need to remove all configured side control information 435 before the smart node 405 is released to the RRC_IDLE or RRC_INACTIVE states.

[043] In a CU/DU split architecture as shown in FIG. 5, side control information 435 may be generated by the gNB-DU 515 while the decision to release the smart node 405 to the RRC_IDLE or RRC_INACTIVE states is made in the gNB-CU 510. Accordingly, the techniques of the present subject matter are needed to configure side control information 435 that is applied by the smart node 405 when in the RRC_IDLE or RRC_INACTIVE states.

[044] FIG. 6 illustrates an example swim lane diagram of an example communication 600 between a base station having a centralized unit/distributed unit and smart node 405 to configure side control information 435 that is applied by the smart node 405 when in the RRC_IDLE or RRC_INACTIVE states. A first message 610 may be transmitted from the gNB-CU 510 to the gNB-DU 515. The first message 610 may be, for example, a UE context modification request message or a UE context setup request message and may include one or more of the following indications for the smart node 405. In a first example, the first message 610 may indicate to the gNB-DU 515 that the smart node 405 will be released to the RRC_IDLE or RRC_INACTIVE states. Alternatively, or in addition, in a second example, the first message 610 may instruct the gNB-DU 515 to generate side control information 435 for the smart node 405 and indicate, e.g., by including an indicator, that the side control

information 435 may be applied when the smart node 405 is in the RRC_IDLE, RRC_INACTIVE, or RRC_CONNECTED states. Alternatively, or in addition, in a third example, the first message 610 may instruct the gNB-DU 515 to remove at least some or all the configured side control information 435 of the smart node 405, including periodic side control information, semi-persistent side control information, or aperiodic side control information from the current configured side control information 435 of the smart node 405. Alternatively, or in addition, in a fourth example, the first message 610 may indicate that the value of a wake-up timer is needed or requested. The wake-up timer may be started in the smart node 405 when the smart node 405 is released to the RRC_IDLE or RRC_INACTIVE states. When the wake-up timer expires, the smart node 405 may stop forwarding, or initiate an RRC connection setup or an RRC connection resume procedure. The gNB-DU 515 may include the value of the wake-up timer in a second message 615 sent from the gNB-DU 515 to the gNB-CU 510. Alternatively, or in addition, in a fifth example, the first message 610 may indicate that beam information for the backhaul link 420 of the smart node 405 is needed or requested. The beam information may be applied for transmission and/or reception in the backhaul link 420 of the smart node 405 when the smart node 405 is in the RRC_IDLE or RRC_INACTIVE states.

[045] Upon receiving the first message 610 from the gNB-CU 510, the gNB-DU 515 may perform one or more of the following actions in response. In a first example, the gNB-DU 515 may generate side control information 435 for the smart node 405 based on the first message 610. The side control information 435 may be applied when the smart node 405 is in the RRC_IDLE, RRC_INACTIVE, or RRC_CONNECTED states. The gNB-DU 515 may include the side control information 435 in the second message 615. The second message 615 may be, for example, a UE context modification response message or a UE context setup response message. Alternatively, or in addition, in a second example, the gNB-DU 515 may include, in the second message 615, an ON/OFF indicator or instructions that may be used to release existing side control information 435 configured for the smart node 405. The "OFF" indicator of the ON/OFF indicator may indicate that the forwarding part 410 of the smart node 405 is not performing forwarding. The "ON" indicator of the ON/OFF indicator may indicate that the forwarding part 410 of the smart node 405 is performing forwarding

according to side control information 435. Alternatively, or in addition, in a third example, the gNB-DU 515 may determine whether beam information is needed for the backhaul link 420 of the smart node 405 when the smart node 405 is in the RRC_IDLE or RRC_INACTIVE states. More specifically, the beam used for the backhaul link 420 when the smart node 405 is in the RRC_IDLE or RRC_INACTIVE states may be different from the beam currently configured for the backhaul link, or the beam for the backhaul link 420 may not be configured at all. In these circumstances, the gNB-DU 515 may make the determination as to whether the beam information is needed. The gNB-DU 515 may include the beam information for the backhaul link 420 in the second message 615. Alternatively, or in addition, in a fourth example, the gNB-DU 515 may determine whether a wake-up timer is needed for the smart node 405 in the RRC_IDLE or RRC_INACTIVE states. The gNB-DU 515 may determine whether the wake-up timer is needed according to the first message 610, which may indicate that the value of a wake-up timer is needed or requested as previously described. The gNB-DU 515 may determine the value of the wake-up timer. The wake-up timer may be started in the smart node 405 when the smart node 405 is released to the RRC_IDLE or RRC_INACTIVE states. Upon expiration of the wake-up timer, the smart node 405 may stop forwarding, and/or initiate an RRC connection setup or an RRC connection resume procedure. The gNB-DU 515 may include the value of the wake-up timer in the second message 615. The gNB-DU 515 may generate the second message 615 and transmit the second message 615 to the gNB-CU 510.

[046] Upon receiving the second message 615 from the gNB-DU 515, the gNB-CU 510 may perform one or more of the following actions in response. In an example, the gNB-CU 510 may generate a third message 620 that includes at least one of the side control information 435, the ON/OFF indicator, the beam information used for the backhaul link 420 of the smart node 405, or the value of the wake-up timer. The third message 620 may be, for example, an RRC reconfiguration message. The third message 620 may be sent from the gNB-CU 510 to the smart node 405. In this example, the smart node 405 may be an NCR 605, a smart repeater, an RIS, and/or an IAB as previously described.

[047] The smart node 405 may respond to the third message 620 by generating a fourth message 625 and transmitting the fourth message 625 to the gNB-CU 510. The fourth

message 625 may be, for example, an RRC reconfiguration complete message. In response to receiving the fourth message 625, the gNB-CU 510 may generate and send a fifth message 630 to release and/or transition the smart node 405 to the RRC_IDLE or RRC_INACTIVE states. The fifth message 630 may be, for example, an RRC release message. The fifth message 630 may include at least one of: the side control information 435, the ON/OFF indicator, the beam information used for the backhaul link 420 of the smart node 405, or the value of the wake-up timer depending on whether any of these items of information are included in the third message 620.

[048] The smart node 405, upon receiving the fifth message 630, may enter the RRC_INACTIVE or RRC_IDLE state and apply the configuration, which may include one or more of the following in either the third message 620 or fifth message 630: the side control information 435, the ON/OFF indicator, the beam information used for the backhaul link 420 of the smart node 405, or the value of the wake-up timer.

[049] The description and accompanying drawings above provide specific example embodiments and implementations. The described subject matter may, however, be embodied in a variety of different forms and, therefore, covered or claimed subject matter is intended to be construed as not being limited to any example embodiments set forth herein. A reasonably broad scope for claimed or covered subject matter is intended. Among other things, for example, subject matter may be embodied as methods, devices, components, systems, or non-transitory computer-readable media for storing computer codes. Accordingly, embodiments may, for example, take the form of hardware, software, firmware, storage media or any combination thereof. For example, the method embodiments described above may be implemented by components, devices, or systems including memory and processors by executing computer codes stored in the memory.

[050] Throughout the specification and claims, terms may have nuanced meanings suggested or implied in context beyond an explicitly stated meaning. Likewise, the phrase "in one embodiment/implementation" as used herein does not necessarily refer to the same embodiment and the phrase "in another embodiment/implementation" as used herein does not necessarily refer to a different embodiment. It is intended, for example, that claimed

subject matter includes combinations of example embodiments in whole or in part.

[051] In general, terminology may be understood at least in part from usage in context. For example, terms, such as "and", "or", or "and/or," as used herein may include a variety of meanings that may depend at least in part on the context in which such terms are used. Typically, "or" if used to associate a list, such as A, B or C, is intended to mean A, B, and C, here used in the inclusive sense, as well as A, B or C, here used in the exclusive sense. In addition, the term "one or more" as used herein, depending at least in part upon context, may be used to describe any feature, structure, or characteristic in a singular sense or may be used to describe combinations of features, structures, or characteristics in a plural sense. Similarly, terms, such as "a," "an," or "the," may be understood to convey a singular usage or to convey a plural usage, depending at least in part upon context. In addition, the term "based on" may be understood as not necessarily intended to convey an exclusive set of factors and may, instead, allow for the existence of additional factors not necessarily expressly described, again, depending at least in part on context.

[052] Reference throughout this specification to features, advantages, or similar language does not imply that all of the features and advantages that may be realized with the present solution should be or are included in any single implementation thereof. Rather, language referring to the features and advantages is understood to mean that a specific feature, advantage, or characteristic described in connection with an embodiment is included in at least one embodiment of the present solution. Thus, discussions of the features and advantages, and similar language, throughout the specification may, but do not necessarily, refer to the same embodiment.

[053] Furthermore, the described features, advantages and characteristics of the present solution may be combined in any suitable manner in one or more embodiments. One of ordinary skill in the relevant art will recognize, in light of the description herein, that the present solution may be practiced without one or more of the specific features or advantages of a particular embodiment. In other instances, additional features and advantages may be recognized in certain embodiments that may not be present in all embodiments of the present solution.

[054] The subject matter of the disclosure may also relate to or include, among others, the following aspects:

[055] A first aspect includes a method for configuring side control information for a smart node in a wireless communication system, including: transferring a first message from a centralized unit of a base station to a distributed unit of the base station, wherein the first message instructs the distributed unit to generate the side control information; receiving, at the centralized unit, a second message from the distributed unit, wherein the second message includes the side control information; and transferring a third message from the centralized unit to the smart node, wherein the third message comprises the side control information.

[056] A second aspect includes the method of the first aspect, wherein the first message is a UE context modification request.

[057] A third aspect includes the method of the first or second aspects, wherein

[058] the second message is a UE context modification response.

[059] A fourth aspect includes the method of any preceding aspect, wherein the third message is a radio resource control (RRC) reconfiguration message.

[060] A fifth aspect includes the method of any preceding aspect, wherein the third message is an RRC release message configured to cause the smart node to transition to an RRC_INACTIVE or an RRC_IDLE state.

[061] A sixth aspect includes the method of any preceding aspect, wherein the first message further comprises an indication that the side control information is to be applied when the smart node is in an RRC_IDLE, RRC_INACTIVE, or RRC_CONNECTED state.

[062] A seventh aspect includes the method of any preceding aspect, wherein the first message further comprises an instruction to remove at least some configured side control information of the smart node.

[063] An eighth aspect includes the method of any preceding aspect, wherein the at least some configuration side control information comprises one or more of: periodic side control information, semi-persistent side control information, or aperiodic side control information.

[064] A ninth aspect includes the method of any preceding aspect, wherein the first message further comprises an indication or request for a value of a wake-up timer.

[065] A tenth aspect includes the method of any preceding aspect, wherein the second message further comprises the value of the wake-up timer.

[066] An eleventh aspect includes the method of any preceding aspect, wherein the first message further comprises an indication or request for beam information for a backhaul link of the smart node.

[067] A twelfth aspect includes the method of any preceding aspect, wherein the second message further comprises an ON/OFF indicator.

[068] A thirteenth aspect includes the method of any preceding aspect, wherein the second message further comprises an instruction to release existing side control information configured for the smart node.

[069] A fourteenth aspect includes the method of any preceding aspect, wherein the second message further comprises the beam information.

[070] A fifteenth aspect includes the method of any preceding aspect, wherein the third message further comprises an ON/OFF indicator.

[071] A sixteenth aspect includes the method of any preceding aspect, wherein the third message further comprises beam information for a backhaul link of the smart node.

[072] A seventeenth aspect includes the method of any preceding aspect, wherein the third message further comprises the value of the wake-up timer.

[073] An eighteenth aspect includes the method of any preceding aspect, further including receiving an RRC reconfiguration complete message from the smart node.

[074] A nineteenth aspect includes a device for wireless communication including a processor; and a memory in communication with the processor, the memory storing a plurality of instructions executable by the processor to cause the device to implement the method of any preceding aspect.

[075] A twentieth aspect includes a non-transitory computer-readable medium including instructions operable, when executed by one or more processors, to implement the method of any preceding aspect.

CLAIMS

1. A method for configuring side control information for a smart node in a wireless communication system, comprising:

transferring a first message from a centralized unit of a base station to a distributed unit of the base station, wherein the first message instructs the distributed unit to generate the side control information;

receiving, at the centralized unit, a second message from the distributed unit, wherein the second message comprises the side control information; and

transferring a third message from the centralized unit to the smart node, wherein the third message comprises the side control information.

2. The method of claim 1, wherein

the first message is a UE context modification request.

3. The method of claim 1, wherein

the second message is a UE context modification response.

4. The method of claim 1, wherein

the third message is a radio resource control (RRC) reconfiguration message.

5. The method of claim 1, wherein

the third message is an RRC release message configured to cause the smart node to transition to an RRC_INACTIVE or an RRC_IDLE state.

6. The method of claim 1, wherein

the first message further comprises an indication that the side control information is to be applied to perform forwarding at the smart node when the smart node is in an RRC_IDLE, RRC_INACTIVE, or RRC_CONNECTED state.

7. The method of claim 1, wherein

the first message further comprises an instruction to remove at least some configured side control information of the smart node.

8. The method of claim 7, wherein

the at least some configuration side control information comprises one or more of:

periodic side control information,

semi-persistent side control information, or

aperiodic side control information.

9. The method of claim 1, wherein

the first message further comprises an indication or request for a value of a wake-up timer.

10. The method of claim 9, wherein

the second message further comprises the value of the wake-up timer.

11. The method of claim 1, wherein

the first message further comprises an indication or request for beam information for a backhaul link of the smart node.

12. The method of claim 1, wherein

the second message further comprises an ON/OFF indicator.

13. The method of claim 1, wherein

the second message further comprises an instruction to release existing side control information configured for the smart node.

14. The method of claim 11, wherein

the second message further comprises the beam information.

15. The method of claim 1, wherein

the third message further comprises an ON/OFF indicator.

16. The method of claim 1, wherein

the third message further comprises beam information for a backhaul link of the smart node.

17. The method of claim 9, wherein

the third message further comprises the value of the wake-up timer.

18. The method of claim 1, further comprising:

receiving an RRC reconfiguration complete message from the smart node.

19. A device for wireless communication comprising:

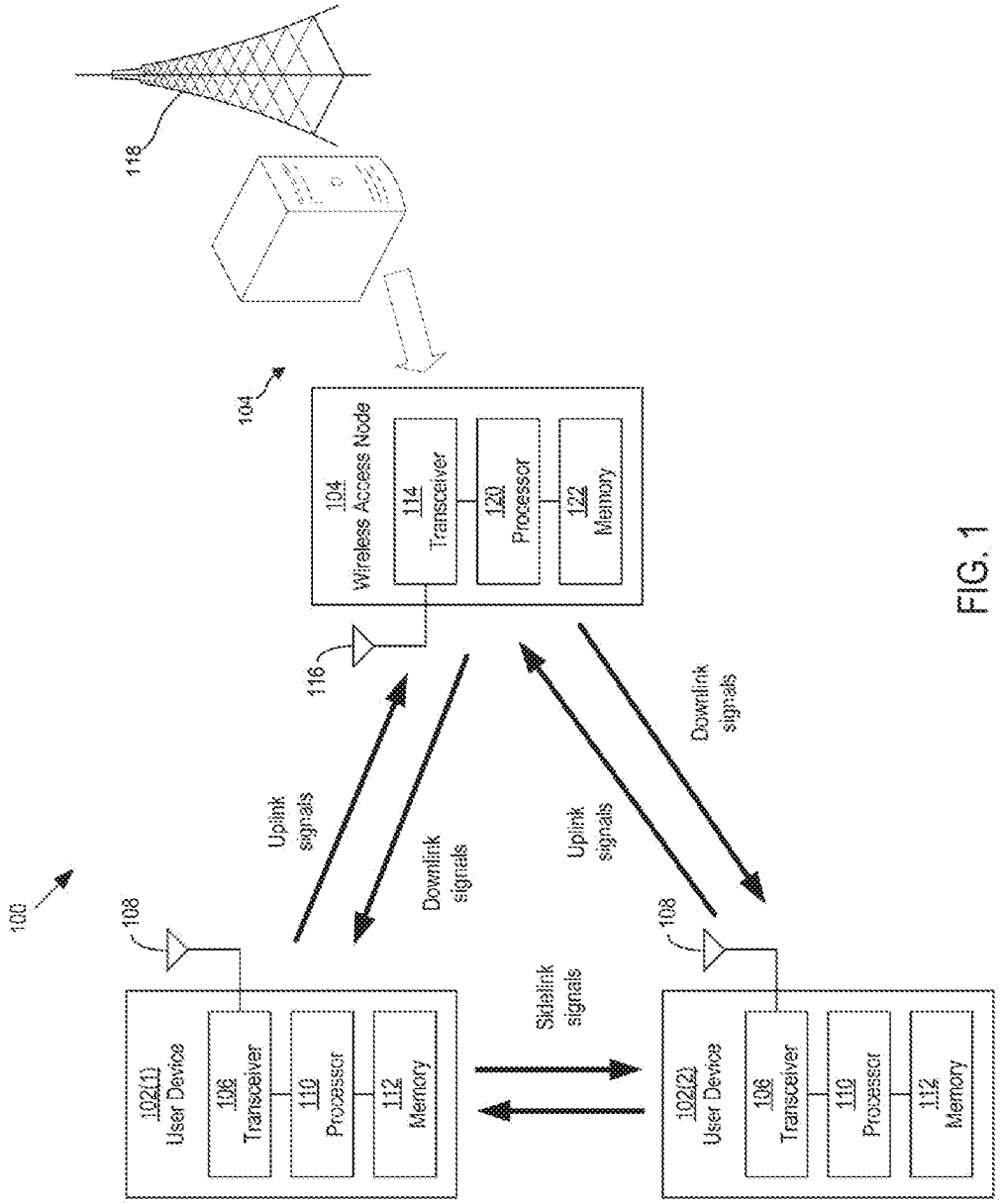
a processor; and

a memory in communication with the processor, the memory storing a plurality of instructions executable by the processor to cause the device to:

implement the method of claim 1.

20. A non-transitory computer-readable medium comprising instructions operable, when executed by one or more processors, to:

implement the method of claim 1.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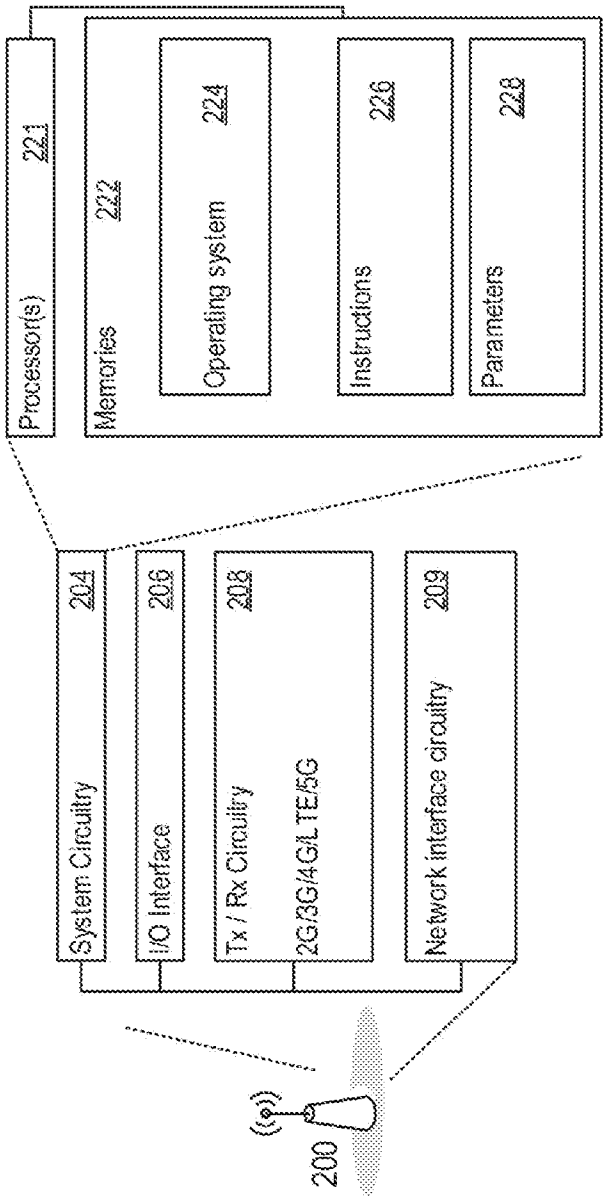
104
104 Wireless Access Node
114 Transceiver
120 Processor
122 Memory
116
Uplink signals
Downlink signals
Uplink signals
Downlink signals
100
108
108
Sidelink signals
102(1) User Device
106 Transceiver
110 Processor
112 Memory
102(2) User Device
106 Transceiver
110 Processor
112 Memory

FIG. 1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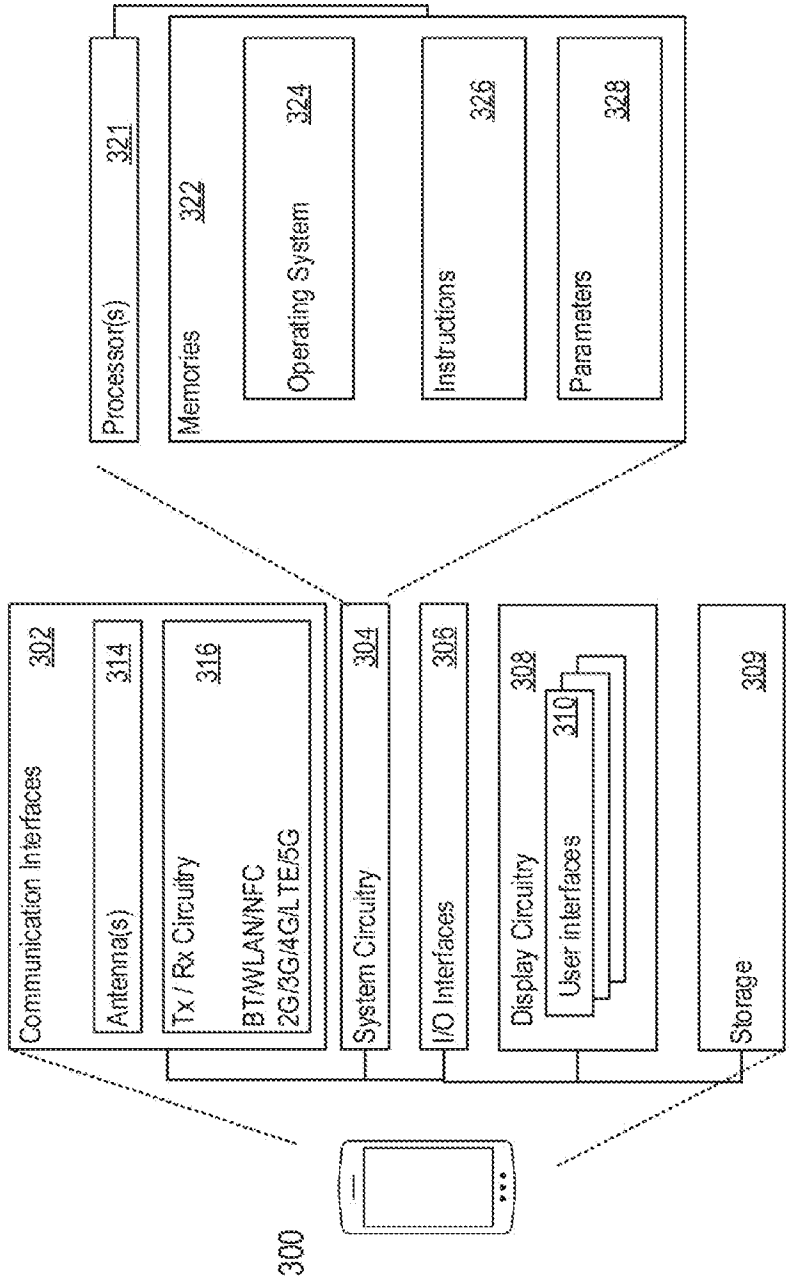
Memories 222
Operating system 224
Instructions 226
Parameters 228
System Circuitry 204
I/O Interface 206
Tx / Rx Circuitry 208
2G/3G/4G/LTE/5G
Network interface circuitry 209
200

FIG. 2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Memories 322
Operating System 324
Instructions 326
Parameters 328
Communication Interfaces 302
Antenna(s) 314
Tx / Rx Circuitry 316
BT/WLAN/NFC
2G/3G/4G/LTE/5G
System Circuitry 304
I/O Interfaces 306
Display Circuitry 308
User interfaces 310
Storage 309
300

FIG. 3

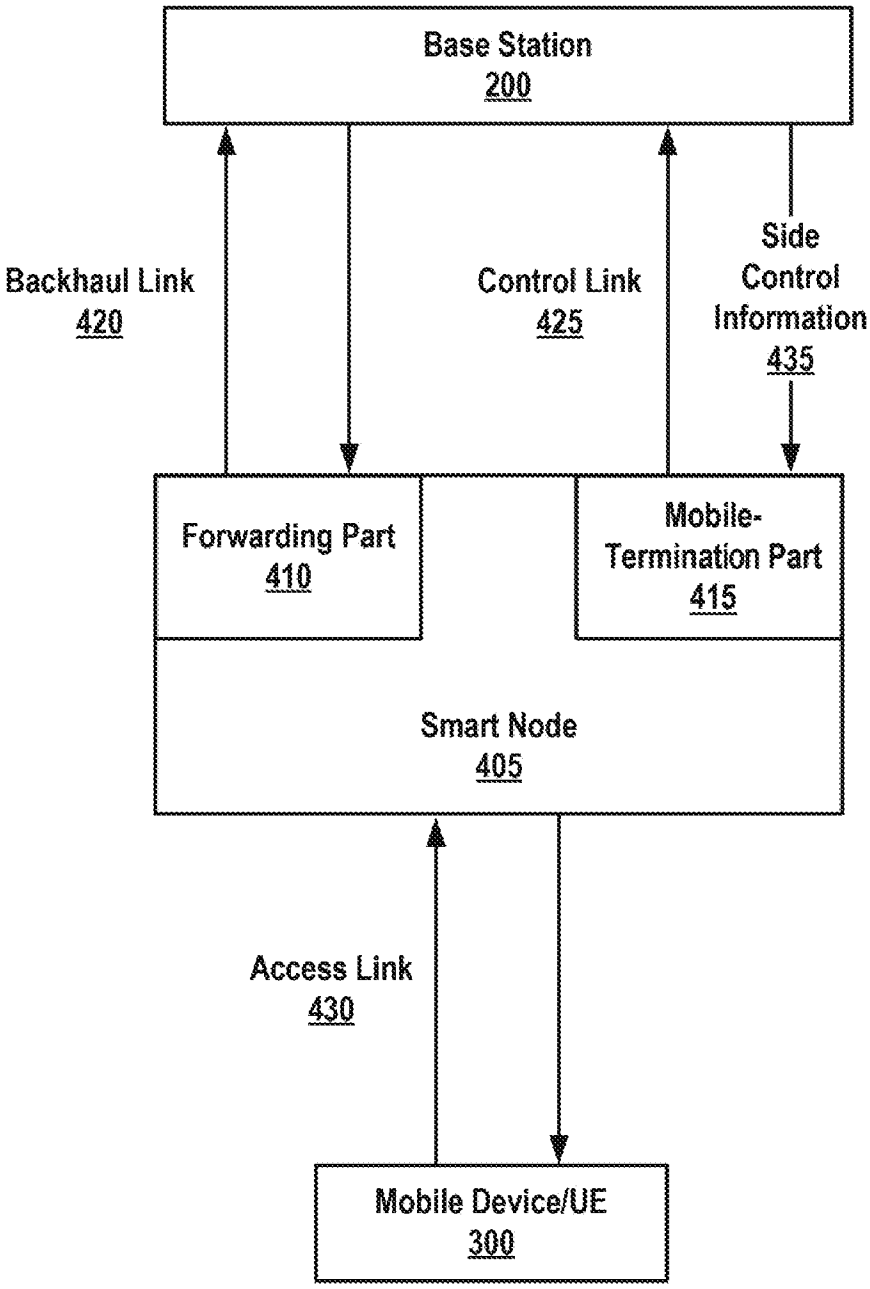
Base Station
200
Backhaul Link
420
Control Link
425
Side
Control
Information
435
Forwarding Part
410
Mobile-
Termination Part
415
Smart Node
405
Access Link
430
Mobile Device/UE
300

FIG. 4

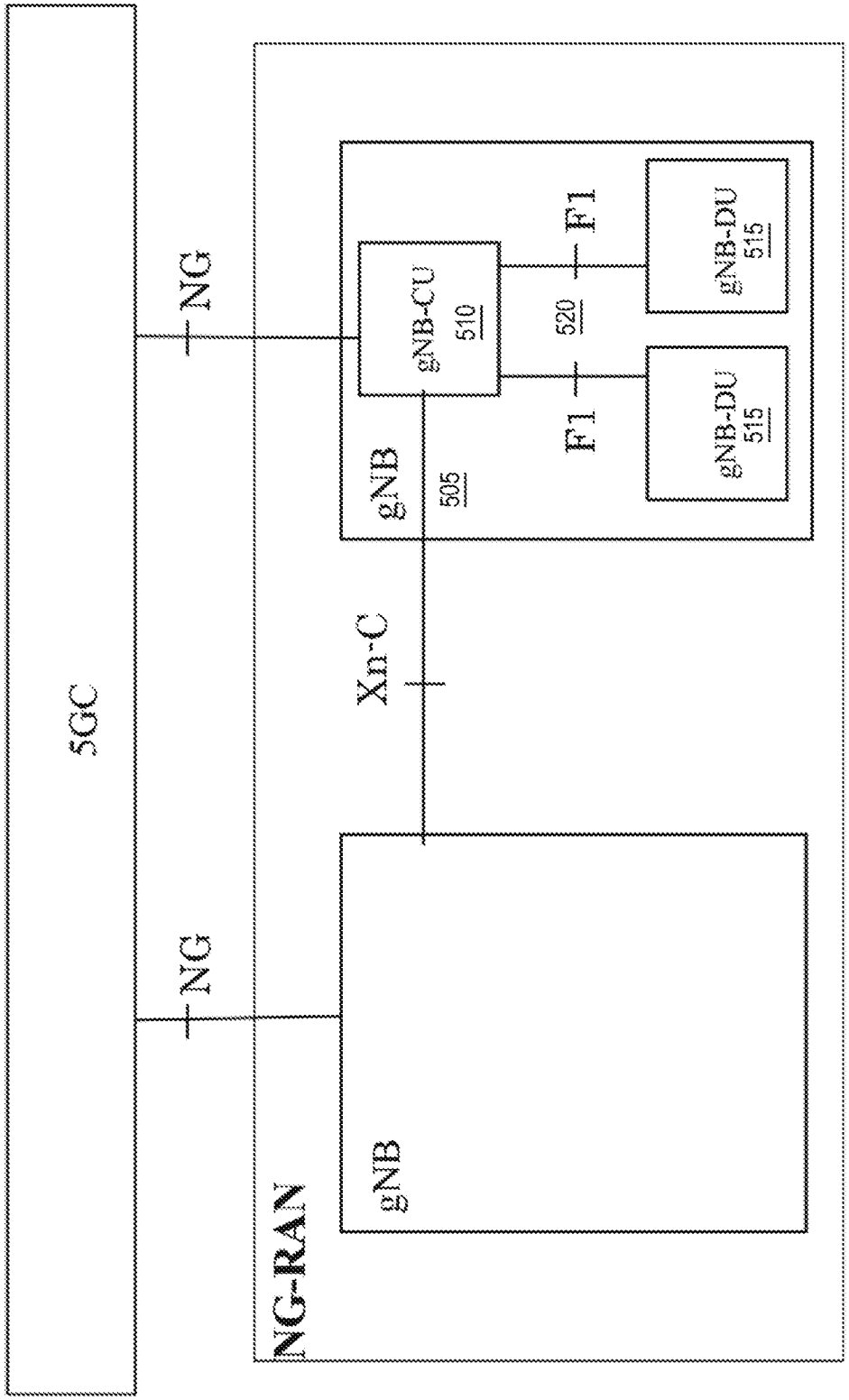
5GC
NG
NG
NG-RAN
gNB
gNB
505
gNB-CU
510
F1
520
F1
gNB-DU
515
gNB-DU
515
Xn-C

FIG. 5

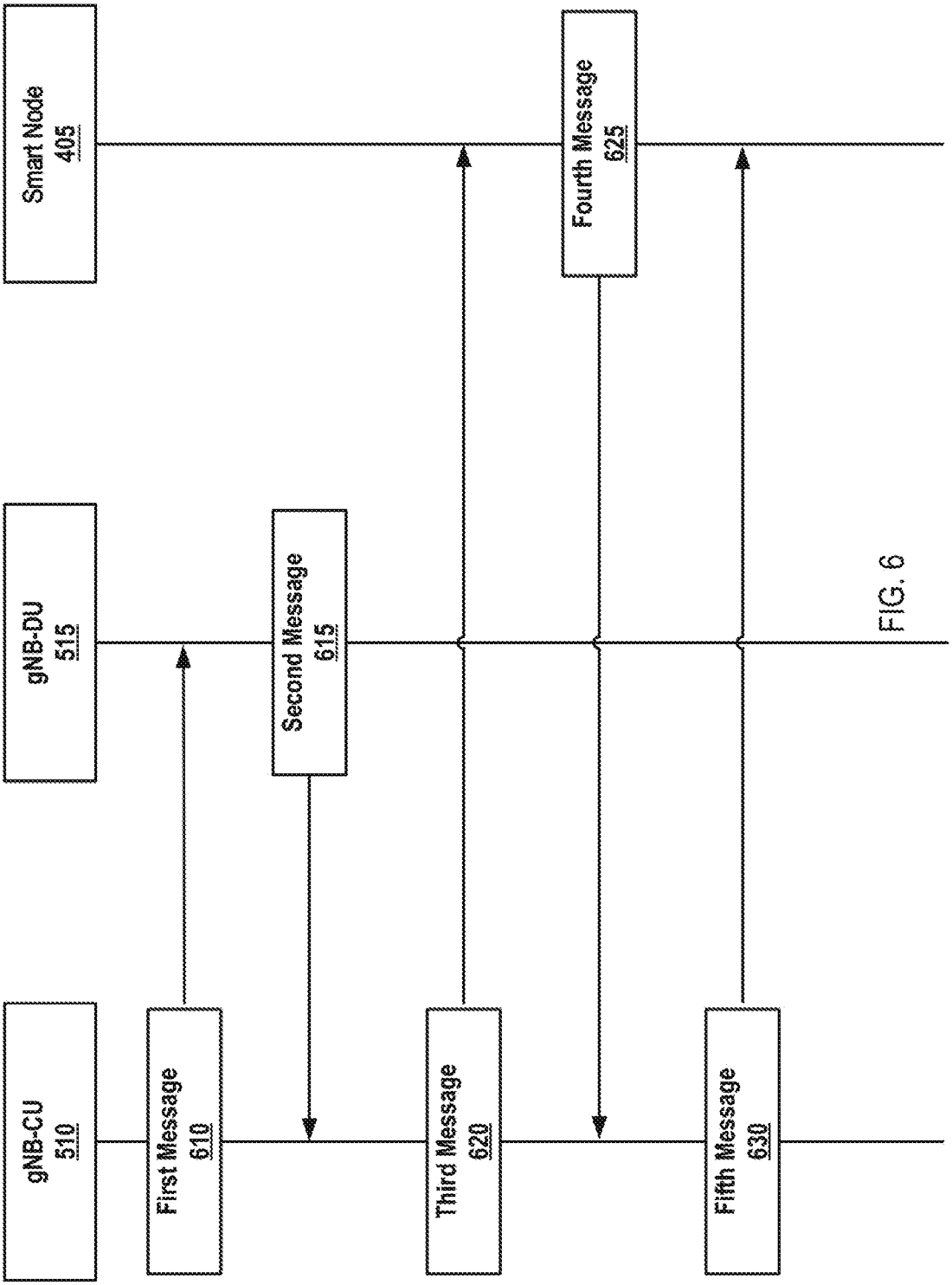
Smart Node
405
gNB-DU
515
gNB-CU
510
First Message
610
Second Message
615
Third Message
620
Fourth Message
625
Fifth Message
630

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/085733

A. CLASSIFICATION OF SUBJECT MATTER

H04L5/00(2006.01)i; H04W76/27(2018.01)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:H04L 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)

CNTXT, ENTXT, ENTXTC, WPABS, 3GPP, CNKI: network-controlled repeater, ncr, iab, ris, smart repeater, SCI, side control, config, generate, decision, decide, CU, centralized unit, gNB-CU, DU, distributed unit, gNB-DU, RRC Reconfiguration, RRCReconfiguration, RRC Release, RRCRelease, idle, inactive

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	NOKIA et al. "R2-2302155, [AT121][706][NCR] Access Link (Nokia)" *3GPP TSG-RAN WG2 Meeting #121*, 03 March 2023 (2023-03-03), sections 3.1,3.4-3.5	1-20
Y	CHINA TELECOM. "R3-230644,Further Discussion on NCR Management" *3GPP TSG-RAN WG3 #119*, 03 March 2023 (2023-03-03), section 2	1-20
A	QUALCOMM INCORPORATED. "R3-230231,Management of NCR" *3GPP TSG-RAN WG3 Meeting #119*, 03 March 2023 (2023-03-03), the whole document	1-20
A	ERICSSON. "R3-190354,IAB Node Integration Procedure" *3GPP TSG-RAN WG3 Meeting #103*, 01 March 2019 (2019-03-01), the whole document	1-20
A	CN 115606221 A (BEIJING XIAOMI MOBILE SOFTWARE CO LTD) 13 January 2023 (2023-01-13) 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	Date of mailing of the international search report
15 November 2023	**22 November 2023**

Name and mailing address of the ISA/CN	Authorized officer
CHINA NATIONAL INTELLECTUAL PROPERTY ADMINISTRATION **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	**XUE,YongXu** Telephone No. **(+86) 010-53961657**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/085733

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2022046757 A1 (QUALCOMM INCORPORATED) 03 March 2022 (2022-03-03) the whole document	1-20

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/085733

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 115606221 A	13 January 2023	None	
WO 2022046757 A1	03 March 2022	EP 4205450 A1	05 July 2023
		US 2022069893 A1	03 March 2022
		CN 115956380 A	11 April 2023