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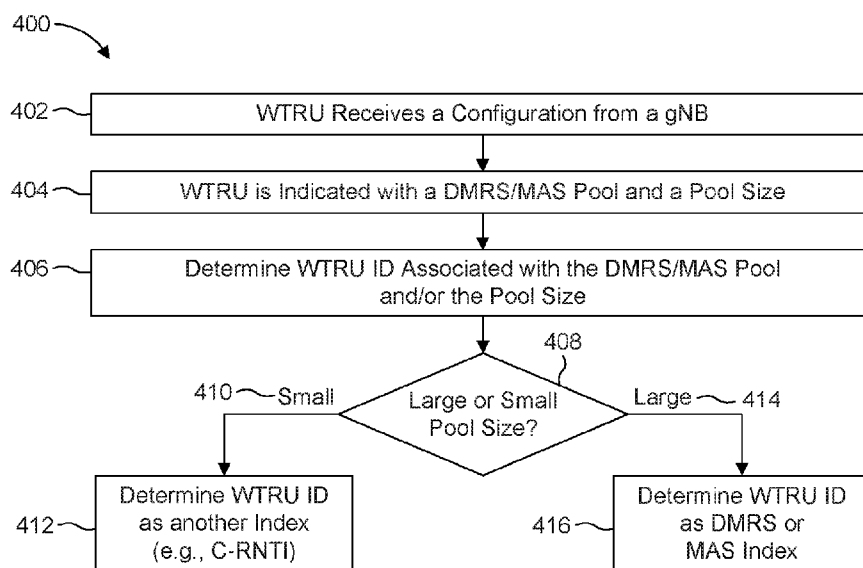


FIG. 4

(57) **Abstract:** A method performed by a WTRU may comprise receiving a common feedback transmission, in response to a transmission of the WTRU. The common feedback transmission may convey one or both of a preamble and a DMRS to indicate an identifier of the WTRU. The WTRU may determine whether a preamble-to-DMRS association is configured. If the preamble-to-DMRS association is not configured, the WTRU may determine to use both the preamble and the DMRS as the identifier of the WTRU. If the preamble-to-DMRS association is configured, the WTRU may determine whether to use one of the preamble or the DMRS as the identifier of the WTRU, based on the preamble-to-DMRS association.



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METHODS AND PROCEDURES OF WTRU IDENTIFICATION AND FEEDBACK FOR NOMA**CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims the benefit of U.S. Provisional Application Serial No. 62/716,096 filed on August 8, 2018, the contents of which are hereby incorporated by reference herein.

SUMMARY

[0002] A method performed by a wireless transmit / receive unit (WTRU) may comprise receiving a common feedback transmission, in response to a transmission of the WTRU. The common feedback transmission may convey one or both of a preamble and a demodulation reference signal (DMRS) to indicate an identifier of the WTRU. The WTRU may determine whether a preamble-to-DMRS association is configured. If the preamble-to-DMRS association is not configured, the WTRU may determine to use both the preamble and the DMRS as the identifier of the WTRU. If the preamble-to-DMRS association is configured, the WTRU may determine whether to use one of the preamble or the DMRS as the identifier of the WTRU, based on the preamble-to-DMRS association.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] A more detailed understanding may be had from the following description, given by way of example in conjunction with the accompanying drawings, wherein like reference numerals in the figures indicate like elements, and wherein:

[0004] FIG. 1A is a system diagram illustrating an example communications system in which one or more disclosed embodiments may be implemented;

[0005] FIG. 1B is a system diagram illustrating an example wireless transmit/receive unit (WTRU) that may be used within the communications system illustrated in FIG. 1A according to an embodiment;

[0006] FIG. 1C is a system diagram illustrating an example radio access network (RAN) and an example core network (CN) that may be used within the communications system illustrated in FIG. 1A according to an embodiment;

[0007] FIG. 1D is a system diagram illustrating a further example RAN and a further example CN that may be used within the communications system illustrated in FIG. 1A according to an embodiment;

[0008] FIG. 2 is a high level block diagram of a transmitter for a code-domain based non-orthogonal multiple access (NOMA) scheme;

- [0009] FIG. 3 is a flowchart which illustrates exemplary WTRU identification methods;
- [0010] FIG. 4 is a flowchart which illustrates demodulation reference signal (DMRS) / multiple access signature (MAS) (DMRS/MAS) pool-based WTRU identification methods;
- [0011] FIG. 5 is a flowchart which illustrates a DMRS-MAS association on/off-based WTRU identification method;
- [0012] FIG. 6 is a flowchart which illustrates a DMRS-MAS overlap indication-based WTRU identification method;
- [0013] FIG. 7 is a flowchart which illustrates WTRU identification methods under a one-to-one association;
- [0014] FIG. 8 is a flowchart which illustrates WTRU identification methods under a one-to-many association;
- [0015] FIG. 9 is a flowchart which illustrates identification methods under a many-to-one association;
- [0016] FIG. 10 is a flowchart which illustrates WTRU identification methods under a many-to-one association;
- [0017] FIG. 11 is a flowchart which illustrates a full DMRS-MAS association-based WTRU identification method; and
- [0018] FIG. 12 is a flowchart which illustrates a preamble-to-DMRS association type based WTRU identification method.

DETAILED DESCRIPTION

[0019] FIG. 1A is a diagram illustrating an example communications system 100 in which one or more disclosed embodiments may be implemented. The communications system 100 may be a multiple access system that provides content, such as voice, data, video, messaging, broadcast, etc., to multiple wireless users. The communications system 100 may enable multiple wireless users to access such content through the sharing of system resources, including wireless bandwidth. For example, the communications systems 100 may employ one or more channel access methods, such as code division multiple access (CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal FDMA (OFDMA), single-carrier FDMA (SC-FDMA), zero-tail unique-word DFT-Spread OFDM (ZT UW DTS-s OFDM), unique word OFDM (UW-OFDM), resource block-filtered OFDM, filter bank multicarrier (FBMC), and the like.

[0020] As shown in FIG. 1A, the communications system 100 may include wireless transmit/receive units (WTRUs) 102a, 102b, 102c, 102d, a RAN 104/113, a CN 106/115, a public switched telephone network (PSTN) 108, the Internet 110, and other networks 112, though it will be

appreciated that the disclosed embodiments contemplate any number of WTRUs, base stations, networks, and/or network elements. Each of the WTRUs 102a, 102b, 102c, 102d may be any type of device configured to operate and/or communicate in a wireless environment. By way of example, the WTRUs 102a, 102b, 102c, 102d, any of which may be referred to as a “station” and/or a “STA”, may be configured to transmit and/or receive wireless signals and may include a user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a subscription-based unit, a pager, a cellular telephone, a personal digital assistant (PDA), a smartphone, a laptop, a netbook, a personal computer, a wireless sensor, a hotspot or Mi-Fi device, an Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device and applications (e.g., remote surgery), an industrial device and applications (e.g., a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless networks, and the like. Any of the WTRUs 102a, 102b, 102c and 102d may be interchangeably referred to as a UE.

[0021] The communications systems 100 may also include a base station 114a and/or a base station 114b. Each of the base stations 114a, 114b may be any type of device configured to wirelessly interface with at least one of the WTRUs 102a, 102b, 102c, 102d to facilitate access to one or more communication networks, such as the CN 106/115, the Internet 110, and/or the other networks 112. By way of example, the base stations 114a, 114b may be a base transceiver station (BTS), a Node-B, an eNode B, a Home Node B, a Home eNode B, a gNB, a NR NodeB, a site controller, an access point (AP), a wireless router, and the like. While the base stations 114a, 114b are each depicted as a single element, it will be appreciated that the base stations 114a, 114b may include any number of interconnected base stations and/or network elements.

[0022] The base station 114a may be part of the RAN 104/113, which may also include other base stations and/or network elements (not shown), such as a base station controller (BSC), a radio network controller (RNC), relay nodes, etc. The base station 114a and/or the base station 114b may be configured to transmit and/or receive wireless signals on one or more carrier frequencies, which may be referred to as a cell (not shown). These frequencies may be in licensed spectrum, unlicensed spectrum, or a combination of licensed and unlicensed spectrum. A cell may provide coverage for a wireless service to a specific geographical area that may be relatively fixed or that may change over time. The cell may further be divided into cell sectors. For example, the cell associated with the base station 114a may be divided into three sectors. Thus, in one embodiment, the base station 114a may include three transceivers, i.e., one for each sector of the cell. In an embodiment, the base station 114a may employ multiple-input multiple output (MIMO) technology

and may utilize multiple transceivers for each sector of the cell. For example, beamforming may be used to transmit and/or receive signals in desired spatial directions.

[0023] The base stations 114a, 114b may communicate with one or more of the WTRUs 102a, 102b, 102c, 102d over an air interface 116, which may be any suitable wireless communication link (e.g., radio frequency (RF), microwave, centimeter wave, micrometer wave, infrared (IR), ultraviolet (UV), visible light, etc.). The air interface 116 may be established using any suitable radio access technology (RAT).

[0024] More specifically, as noted above, the communications system 100 may be a multiple access system and may employ one or more channel access schemes, such as CDMA, TDMA, FDMA, OFDMA, SC-FDMA, and the like. For example, the base station 114a in the RAN 104/113 and the WTRUs 102a, 102b, 102c may implement a radio technology such as Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access (UTRA), which may establish the air interface 115/116/117 using wideband CDMA (WCDMA). WCDMA may include communication protocols such as High-Speed Packet Access (HSPA) and/or Evolved HSPA (HSPA+). HSPA may include High-Speed Downlink (DL) Packet Access (HSDPA) and/or High-Speed UL Packet Access (HSUPA).

[0025] In an embodiment, the base station 114a and the WTRUs 102a, 102b, 102c may implement a radio technology such as Evolved UMTS Terrestrial Radio Access (E-UTRA), which may establish the air interface 116 using Long Term Evolution (LTE) and/or LTE-Advanced (LTE-A) and/or LTE-Advanced Pro (LTE-A Pro).

[0026] In an embodiment, the base station 114a and the WTRUs 102a, 102b, 102c may implement a radio technology such as NR Radio Access, which may establish the air interface 116 using New Radio (NR).

[0027] In an embodiment, the base station 114a and the WTRUs 102a, 102b, 102c may implement multiple radio access technologies. For example, the base station 114a and the WTRUs 102a, 102b, 102c may implement LTE radio access and NR radio access together, for instance using dual connectivity (DC) principles. Thus, the air interface utilized by WTRUs 102a, 102b, 102c may be characterized by multiple types of radio access technologies and/or transmissions sent to/from multiple types of base stations (e.g., a eNB and a gNB).

[0028] In other embodiments, the base station 114a and the WTRUs 102a, 102b, 102c may implement radio technologies such as IEEE 802.11 (i.e., Wireless Fidelity (WiFi)), IEEE 802.16 (i.e., Worldwide Interoperability for Microwave Access (WiMAX)), CDMA2000, CDMA2000 1X, CDMA2000 EV-DO, Interim Standard 2000 (IS-2000), Interim Standard 95 (IS-95), Interim Standard

856 (IS-856), Global System for Mobile communications (GSM), Enhanced Data rates for GSM Evolution (EDGE), GSM EDGE (GERAN), and the like.

[0029] The base station 114b in FIG. 1A may be a wireless router, Home Node B, Home eNode B, or access point, for example, and may utilize any suitable RAT for facilitating wireless connectivity in a localized area, such as a place of business, a home, a vehicle, a campus, an industrial facility, an air corridor (e.g., for use by drones), a roadway, and the like. In one embodiment, the base station 114b and the WTRUs 102c, 102d may implement a radio technology such as IEEE 802.11 to establish a wireless local area network (WLAN). In an embodiment, the base station 114b and the WTRUs 102c, 102d may implement a radio technology such as IEEE 802.15 to establish a wireless personal area network (WPAN). In yet another embodiment, the base station 114b and the WTRUs 102c, 102d may utilize a cellular-based RAT (e.g., WCDMA, CDMA2000, GSM, LTE, LTE-A, LTE-A Pro, NR etc.) to establish a picocell or femtocell. As shown in FIG. 1A, the base station 114b may have a direct connection to the Internet 110. Thus, the base station 114b may not be required to access the Internet 110 via the CN 106/115.

[0030] The RAN 104/113 may be in communication with the CN 106/115, which may be any type of network configured to provide voice, data, applications, and/or voice over internet protocol (VoIP) services to one or more of the WTRUs 102a, 102b, 102c, 102d. The data may have varying quality of service (QoS) requirements, such as differing throughput requirements, latency requirements, error tolerance requirements, reliability requirements, data throughput requirements, mobility requirements, and the like. The CN 106/115 may provide call control, billing services, mobile location-based services, pre-paid calling, Internet connectivity, video distribution, etc., and/or perform high-level security functions, such as user authentication. Although not shown in FIG. 1A, it will be appreciated that the RAN 104/113 and/or the CN 106/115 may be in direct or indirect communication with other RANs that employ the same RAT as the RAN 104/113 or a different RAT. For example, in addition to being connected to the RAN 104/113, which may be utilizing a NR radio technology, the CN 106/115 may also be in communication with another RAN (not shown) employing a GSM, UMTS, CDMA 2000, WiMAX, E-UTRA, or WiFi radio technology.

[0031] The CN 106/115 may also serve as a gateway for the WTRUs 102a, 102b, 102c, 102d to access the PSTN 108, the Internet 110, and/or the other networks 112. The PSTN 108 may include circuit-switched telephone networks that provide plain old telephone service (POTS). The Internet 110 may include a global system of interconnected computer networks and devices that use common communication protocols, such as the transmission control protocol (TCP), user datagram protocol (UDP) and/or the internet protocol (IP) in the TCP/IP internet protocol suite. The networks 112 may include wired and/or wireless communications networks owned and/or operated by other

service providers. For example, the networks 112 may include another CN connected to one or more RANs, which may employ the same RAT as the RAN 104/113 or a different RAT.

[0032] Some or all of the WTRUs 102a, 102b, 102c, 102d in the communications system 100 may include multi-mode capabilities (e.g., the WTRUs 102a, 102b, 102c, 102d may include multiple transceivers for communicating with different wireless networks over different wireless links). For example, the WTRU 102c shown in FIG. 1A may be configured to communicate with the base station 114a, which may employ a cellular-based radio technology, and with the base station 114b, which may employ an IEEE 802 radio technology.

[0033] FIG. 1B is a system diagram illustrating an example WTRU 102. As shown in FIG. 1B, the WTRU 102 may include a processor 118, a transceiver 120, a transmit/receive element 122, a speaker/microphone 124, a keypad 126, a display/touchpad 128, non-removable memory 130, removable memory 132, a power source 134, a global positioning system (GPS) chipset 136, and/or other peripherals 138, among others. It will be appreciated that the WTRU 102 may include any sub-combination of the foregoing elements while remaining consistent with an embodiment.

[0034] The processor 118 may be a general purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs) circuits, any other type of integrated circuit (IC), a state machine, and the like. The processor 118 may perform signal coding, data processing, power control, input/output processing, and/or any other functionality that enables the WTRU 102 to operate in a wireless environment. The processor 118 may be coupled to the transceiver 120, which may be coupled to the transmit/receive element 122. While FIG. 1B depicts the processor 118 and the transceiver 120 as separate components, it will be appreciated that the processor 118 and the transceiver 120 may be integrated together in an electronic package or chip.

[0035] The transmit/receive element 122 may be configured to transmit signals to, or receive signals from, a base station (e.g., the base station 114a) over the air interface 116. For example, in one embodiment, the transmit/receive element 122 may be an antenna configured to transmit and/or receive RF signals. In an embodiment, the transmit/receive element 122 may be an emitter/detector configured to transmit and/or receive IR, UV, or visible light signals, for example. In yet another embodiment, the transmit/receive element 122 may be configured to transmit and/or receive both RF and light signals. It will be appreciated that the transmit/receive element 122 may be configured to transmit and/or receive any combination of wireless signals.

[0036] Although the transmit/receive element 122 is depicted in FIG. 1B as a single element, the WTRU 102 may include any number of transmit/receive elements 122. More specifically, the WTRU 102 may employ MIMO technology. Thus, in one embodiment, the WTRU 102 may include two or more transmit/receive elements 122 (e.g., multiple antennas) for transmitting and receiving wireless signals over the air interface 116.

[0037] The transceiver 120 may be configured to modulate the signals that are to be transmitted by the transmit/receive element 122 and to demodulate the signals that are received by the transmit/receive element 122. As noted above, the WTRU 102 may have multi-mode capabilities. Thus, the transceiver 120 may include multiple transceivers for enabling the WTRU 102 to communicate via multiple RATs, such as NR and IEEE 802.11, for example.

[0038] The processor 118 of the WTRU 102 may be coupled to, and may receive user input data from, the speaker/microphone 124, the keypad 126, and/or the display/touchpad 128 (e.g., a liquid crystal display (LCD) display unit or organic light-emitting diode (OLED) display unit). The processor 118 may also output user data to the speaker/microphone 124, the keypad 126, and/or the display/touchpad 128. In addition, the processor 118 may access information from, and store data in, any type of suitable memory, such as the non-removable memory 130 and/or the removable memory 132. The non-removable memory 130 may include random-access memory (RAM), read-only memory (ROM), a hard disk, or any other type of memory storage device. The removable memory 132 may include a subscriber identity module (SIM) card, a memory stick, a secure digital (SD) memory card, and the like. In other embodiments, the processor 118 may access information from, and store data in, memory that is not physically located on the WTRU 102, such as on a server or a home computer (not shown).

[0039] The processor 118 may receive power from the power source 134, and may be configured to distribute and/or control the power to the other components in the WTRU 102. The power source 134 may be any suitable device for powering the WTRU 102. For example, the power source 134 may include one or more dry cell batteries (e.g., nickel-cadmium (NiCd), nickel-zinc (NiZn), nickel metal hydride (NiMH), lithium-ion (Li-ion), etc.), solar cells, fuel cells, and the like.

[0040] The processor 118 may also be coupled to the GPS chipset 136, which may be configured to provide location information (e.g., longitude and latitude) regarding the current location of the WTRU 102. In addition to, or in lieu of, the information from the GPS chipset 136, the WTRU 102 may receive location information over the air interface 116 from a base station (e.g., base stations 114a, 114b) and/or determine its location based on the timing of the signals being received from two or more nearby base stations. It will be appreciated that the WTRU 102 may acquire

location information by way of any suitable location-determination method while remaining consistent with an embodiment.

[0041] The processor 118 may further be coupled to other peripherals 138, which may include one or more software and/or hardware modules that provide additional features, functionality and/or wired or wireless connectivity. For example, the peripherals 138 may include an accelerometer, an e-compass, a satellite transceiver, a digital camera (for photographs and/or video), a universal serial bus (USB) port, a vibration device, a television transceiver, a hands free headset, a Bluetooth® module, a frequency modulated (FM) radio unit, a digital music player, a media player, a video game player module, an Internet browser, a Virtual Reality and/or Augmented Reality (VR/AR) device, an activity tracker, and the like. The peripherals 138 may include one or more sensors, the sensors may be one or more of a gyroscope, an accelerometer, a hall effect sensor, a magnetometer, an orientation sensor, a proximity sensor, a temperature sensor, a time sensor; a geolocation sensor; an altimeter, a light sensor, a touch sensor, a magnetometer, a barometer, a gesture sensor, a biometric sensor, and/or a humidity sensor.

[0042] The WTRU 102 may include a full duplex radio for which transmission and reception of some or all of the signals (e.g., associated with particular subframes for both the UL (e.g., for transmission) and downlink (e.g., for reception) may be concurrent and/or simultaneous. The full duplex radio may include an interference management unit 139 to reduce and or substantially eliminate self-interference via either hardware (e.g., a choke) or signal processing via a processor (e.g., a separate processor (not shown) or via processor 118). In an embodiment, the WTRU 102 may include a half-duplex radio for which transmission and reception of some or all of the signals (e.g., associated with particular subframes for either the UL (e.g., for transmission) or the downlink (e.g., for reception)).

[0043] FIG. 1C is a system diagram illustrating the RAN 104 and the CN 106 according to an embodiment. As noted above, the RAN 104 may employ an E-UTRA radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 116. The RAN 104 may also be in communication with the CN 106.

[0044] The RAN 104 may include eNode-Bs 160a, 160b, 160c, though it will be appreciated that the RAN 104 may include any number of eNode-Bs while remaining consistent with an embodiment. The eNode-Bs 160a, 160b, 160c may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 116. In one embodiment, the eNode-Bs 160a, 160b, 160c may implement MIMO technology. Thus, the eNode-B 160a, for example, may use multiple antennas to transmit wireless signals to, and/or receive wireless signals from, the WTRU 102a.

[0045] Each of the eNode-Bs 160a, 160b, 160c may be associated with a particular cell (not shown) and may be configured to handle radio resource management decisions, handover decisions, scheduling of users in the UL and/or DL, and the like. As shown in FIG. 1C, the eNode-Bs 160a, 160b, 160c may communicate with one another over an X2 interface.

[0046] The CN 106 shown in FIG. 1C may include a mobility management entity (MME) 162, a serving gateway (SGW) 164, and a packet data network (PDN) gateway (or PGW) 166. While each of the foregoing elements are depicted as part of the CN 106, it will be appreciated that any of these elements may be owned and/or operated by an entity other than the CN operator.

[0047] The MME 162 may be connected to each of the eNode-Bs 162a, 162b, 162c in the RAN 104 via an S1 interface and may serve as a control node. For example, the MME 162 may be responsible for authenticating users of the WTRUs 102a, 102b, 102c, bearer activation/deactivation, selecting a particular serving gateway during an initial attach of the WTRUs 102a, 102b, 102c, and the like. The MME 162 may provide a control plane function for switching between the RAN 104 and other RANs (not shown) that employ other radio technologies, such as GSM and/or WCDMA.

[0048] The SGW 164 may be connected to each of the eNode Bs 160a, 160b, 160c in the RAN 104 via the S1 interface. The SGW 164 may generally route and forward user data packets to/from the WTRUs 102a, 102b, 102c. The SGW 164 may perform other functions, such as anchoring user planes during inter-eNode B handovers, triggering paging when DL data is available for the WTRUs 102a, 102b, 102c, managing and storing contexts of the WTRUs 102a, 102b, 102c, and the like.

[0049] The SGW 164 may be connected to the PGW 166, which may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, to facilitate communications between the WTRUs 102a, 102b, 102c and IP-enabled devices.

[0050] The CN 106 may facilitate communications with other networks. For example, the CN 106 may provide the WTRUs 102a, 102b, 102c with access to circuit-switched networks, such as the PSTN 108, to facilitate communications between the WTRUs 102a, 102b, 102c and traditional land-line communications devices. For example, the CN 106 may include, or may communicate with, an IP gateway (e.g., an IP multimedia subsystem (IMS) server) that serves as an interface between the CN 106 and the PSTN 108. In addition, the CN 106 may provide the WTRUs 102a, 102b, 102c with access to the other networks 112, which may include other wired and/or wireless networks that are owned and/or operated by other service providers.

[0051] Although the WTRU is described in FIGS. 1A-1D as a wireless terminal, it is contemplated that in certain representative embodiments that such a terminal may use (e.g., temporarily or permanently) wired communication interfaces with the communication network.

[0052] In representative embodiments, the other network 112 may be a WLAN.

[0053] A WLAN in Infrastructure Basic Service Set (BSS) mode may have an Access Point (AP) for the BSS and one or more stations (STAs) associated with the AP. The AP may have an access or an interface to a Distribution System (DS) or another type of wired/wireless network that carries traffic in to and/or out of the BSS. Traffic to STAs that originates from outside the BSS may arrive through the AP and may be delivered to the STAs. Traffic originating from STAs to destinations outside the BSS may be sent to the AP to be delivered to respective destinations. Traffic between STAs within the BSS may be sent through the AP, for example, where the source STA may send traffic to the AP and the AP may deliver the traffic to the destination STA. The traffic between STAs within a BSS may be considered and/or referred to as peer-to-peer traffic. The peer-to-peer traffic may be sent between (e.g., directly between) the source and destination STAs with a direct link setup (DLS). In certain representative embodiments, the DLS may use an 802.11e DLS or an 802.11z tunneled DLS (TDLS). A WLAN using an Independent BSS (IBSS) mode may not have an AP, and the STAs (e.g., all of the STAs) within or using the IBSS may communicate directly with each other. The IBSS mode of communication may sometimes be referred to herein as an “ad-hoc” mode of communication.

[0054] When using the 802.11ac infrastructure mode of operation or a similar mode of operations, the AP may transmit a beacon on a fixed channel, such as a primary channel. The primary channel may be a fixed width (e.g., 20 MHz wide bandwidth) or a dynamically set width via signaling. The primary channel may be the operating channel of the BSS and may be used by the STAs to establish a connection with the AP. In certain representative embodiments, Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) may be implemented, for example in 802.11 systems. For CSMA/CA, the STAs (e.g., every STA), including the AP, may sense the primary channel. If the primary channel is sensed/detected and/or determined to be busy by a particular STA, the particular STA may back off. One STA (e.g., only one station) may transmit at any given time in a given BSS.

[0055] High Throughput (HT) STAs may use a 40 MHz wide channel for communication, for example, via a combination of the primary 20 MHz channel with an adjacent or nonadjacent 20 MHz channel to form a 40 MHz wide channel.

[0056] Very High Throughput (VHT) STAs may support 20MHz, 40 MHz, 80 MHz, and/or 160 MHz wide channels. The 40 MHz, and/or 80 MHz, channels may be formed by combining contiguous 20 MHz channels. A 160 MHz channel may be formed by combining 8 contiguous 20 MHz channels, or by combining two non-contiguous 80 MHz channels, which may be referred to as an 80+80 configuration. For the 80+80 configuration, the data, after channel encoding, may be

passed through a segment parser that may divide the data into two streams. Inverse Fast Fourier Transform (IFFT) processing, and time domain processing, may be done on each stream separately. The streams may be mapped on to the two 80 MHz channels, and the data may be transmitted by a transmitting STA. At the receiver of the receiving STA, the above described operation for the 80+80 configuration may be reversed, and the combined data may be sent to the Medium Access Control (MAC).

[0057] Sub 1 GHz modes of operation are supported by 802.11af and 802.11ah. The channel operating bandwidths, and carriers, are reduced in 802.11af and 802.11ah relative to those used in 802.11n, and 802.11ac. 802.11af supports 5 MHz, 10 MHz and 20 MHz bandwidths in the TV White Space (TVWS) spectrum, and 802.11ah supports 1 MHz, 2 MHz, 4 MHz, 8 MHz, and 16 MHz bandwidths using non-TVWS spectrum. According to a representative embodiment, 802.11ah may support Meter Type Control/Machine-Type Communications, such as MTC devices in a macro coverage area. MTC devices may have certain capabilities, for example, limited capabilities including support for (e.g., only support for) certain and/or limited bandwidths. The MTC devices may include a battery with a battery life above a threshold (e.g., to maintain a very long battery life).

[0058] WLAN systems, which may support multiple channels, and channel bandwidths, such as 802.11n, 802.11ac, 802.11af, and 802.11ah, include a channel which may be designated as the primary channel. The primary channel may have a bandwidth equal to the largest common operating bandwidth supported by all STAs in the BSS. The bandwidth of the primary channel may be set and/or limited by a STA, from among all STAs in operating in a BSS, which supports the smallest bandwidth operating mode. In the example of 802.11ah, the primary channel may be 1 MHz wide for STAs (e.g., MTC type devices) that support (e.g., only support) a 1 MHz mode, even if the AP, and other STAs in the BSS support 2 MHz, 4 MHz, 8 MHz, 16 MHz, and/or other channel bandwidth operating modes. Carrier sensing and/or Network Allocation Vector (NAV) settings may depend on the status of the primary channel. If the primary channel is busy, for example, due to a STA (which supports only a 1 MHz operating mode), transmitting to the AP, the entire available frequency bands may be considered busy even though a majority of the frequency bands remains idle and may be available.

[0059] In the United States, the available frequency bands, which may be used by 802.11ah, are from 902 MHz to 928 MHz. In Korea, the available frequency bands are from 917.5 MHz to 923.5 MHz. In Japan, the available frequency bands are from 916.5 MHz to 927.5 MHz. The total bandwidth available for 802.11ah is 6 MHz to 26 MHz depending on the country code.

[0060] FIG. 1D is a system diagram illustrating the RAN 113 and the CN 115 according to an embodiment. As noted above, the RAN 113 may employ an NR radio technology to

communicate with the WTRUs 102a, 102b, 102c over the air interface 116. The RAN 113 may also be in communication with the CN 115.

[0061] The RAN 113 may include gNBs 180a, 180b, 180c, though it will be appreciated that the RAN 113 may include any number of gNBs while remaining consistent with an embodiment. The gNBs 180a, 180b, 180c may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 116. In one embodiment, the gNBs 180a, 180b, 180c may implement MIMO technology. For example, gNBs 180a, 180b may utilize beamforming to transmit signals to and/or receive signals from the gNBs 180a, 180b, 180c. Thus, the gNB 180a, for example, may use multiple antennas to transmit wireless signals to, and/or receive wireless signals from, the WTRU 102a. In an embodiment, the gNBs 180a, 180b, 180c may implement carrier aggregation technology. For example, the gNB 180a may transmit multiple component carriers to the WTRU 102a (not shown). A subset of these component carriers may be on unlicensed spectrum while the remaining component carriers may be on licensed spectrum. In an embodiment, the gNBs 180a, 180b, 180c may implement Coordinated Multi-Point (CoMP) technology. For example, WTRU 102a may receive coordinated transmissions from gNB 180a and gNB 180b (and/or gNB 180c).

[0062] The WTRUs 102a, 102b, 102c may communicate with gNBs 180a, 180b, 180c using transmissions associated with a scalable numerology. For example, the OFDM symbol spacing and/or OFDM subcarrier spacing may vary for different transmissions, different cells, and/or different portions of the wireless transmission spectrum. The WTRUs 102a, 102b, 102c may communicate with gNBs 180a, 180b, 180c using subframe or transmission time intervals (TTIs) of various or scalable lengths (e.g., containing varying number of OFDM symbols and/or lasting varying lengths of absolute time).

[0063] The gNBs 180a, 180b, 180c may be configured to communicate with the WTRUs 102a, 102b, 102c in a standalone configuration and/or a non-standalone configuration. In the standalone configuration, WTRUs 102a, 102b, 102c may communicate with gNBs 180a, 180b, 180c without also accessing other RANs (e.g., such as eNode-Bs 160a, 160b, 160c). In the standalone configuration, WTRUs 102a, 102b, 102c may utilize one or more of gNBs 180a, 180b, 180c as a mobility anchor point. In the standalone configuration, WTRUs 102a, 102b, 102c may communicate with gNBs 180a, 180b, 180c using signals in an unlicensed band. In a non-standalone configuration WTRUs 102a, 102b, 102c may communicate with/connect to gNBs 180a, 180b, 180c while also communicating with/connecting to another RAN such as eNode-Bs 160a, 160b, 160c. For example, WTRUs 102a, 102b, 102c may implement DC principles to communicate with one or more gNBs 180a, 180b, 180c and one or more eNode-Bs 160a, 160b, 160c substantially simultaneously. In the non-standalone configuration, eNode-Bs 160a, 160b, 160c may serve as a mobility anchor for

WTRUs 102a, 102b, 102c and gNBs 180a, 180b, 180c may provide additional coverage and/or throughput for servicing WTRUs 102a, 102b, 102c.

[0064] Each of the gNBs 180a, 180b, 180c may be associated with a particular cell (not shown) and may be configured to handle radio resource management decisions, handover decisions, scheduling of users in the UL and/or DL, support of network slicing, dual connectivity, interworking between NR and E-UTRA, routing of user plane data towards User Plane Function (UPF) 184a, 184b, routing of control plane information towards Access and Mobility Management Function (AMF) 182a, 182b and the like. As shown in FIG. 1D, the gNBs 180a, 180b, 180c may communicate with one another over an Xn interface.

[0065] The CN 115 shown in FIG. 1D may include at least one AMF 182a, 182b, at least one UPF 184a, 184b, at least one Session Management Function (SMF) 183a, 183b, and possibly a Data Network (DN) 185a, 185b. While each of the foregoing elements are depicted as part of the CN 115, it will be appreciated that any of these elements may be owned and/or operated by an entity other than the CN operator.

[0066] The AMF 182a, 182b may be connected to one or more of the gNBs 180a, 180b, 180c in the RAN 113 via an N2 interface and may serve as a control node. For example, the AMF 182a, 182b may be responsible for authenticating users of the WTRUs 102a, 102b, 102c, support for network slicing (e.g., handling of different PDU sessions with different requirements), selecting a particular SMF 183a, 183b, management of the registration area, termination of NAS signaling, mobility management, and the like. Network slicing may be used by the AMF 182a, 182b in order to customize CN support for WTRUs 102a, 102b, 102c based on the types of services being utilized WTRUs 102a, 102b, 102c. For example, different network slices may be established for different use cases such as services relying on ultra-reliable low latency (URLLC) access, services relying on enhanced massive mobile broadband (eMBB) access, services for machine type communication (MTC) access, and/or the like. The AMF 162 may provide a control plane function for switching between the RAN 113 and other RANs (not shown) that employ other radio technologies, for example, 3rd Generation Partnership Project (3GPP) technologies including LTE, LTE-A, LTE-A Pro, and/or non-3GPP access technologies such as WiFi.

[0067] The SMF 183a, 183b may be connected to an AMF 182a, 182b in the CN 115 via an N11 interface. The SMF 183a, 183b may also be connected to a UPF 184a, 184b in the CN 115 via an N4 interface. The SMF 183a, 183b may select and control the UPF 184a, 184b and configure the routing of traffic through the UPF 184a, 184b. The SMF 183a, 183b may perform other functions, such as managing and allocating UE IP address, managing PDU sessions, controlling

policy enforcement and QoS, providing downlink data notifications, and the like. A PDU session type may be IP-based, non-IP based, Ethernet-based, and the like.

[0068] The UPF 184a, 184b may be connected to one or more of the gNBs 180a, 180b, 180c in the RAN 113 via an N3 interface, which may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, to facilitate communications between the WTRUs 102a, 102b, 102c and IP-enabled devices. The UPF 184a, 184b may perform other functions, such as routing and forwarding packets, enforcing user plane policies, supporting multi-homed PDU sessions, handling user plane QoS, buffering downlink packets, providing mobility anchoring, and the like.

[0069] The CN 115 may facilitate communications with other networks. For example, the CN 115 may include, or may communicate with, an IP gateway (e.g., an IP multimedia subsystem (IMS) server) that serves as an interface between the CN 115 and the PSTN 108. In addition, the CN 115 may provide the WTRUs 102a, 102b, 102c with access to the other networks 112, which may include other wired and/or wireless networks that are owned and/or operated by other service providers. In one embodiment, the WTRUs 102a, 102b, 102c may be connected to a local Data Network (DN) 185a, 185b through the UPF 184a, 184b via the N3 interface to the UPF 184a, 184b and an N6 interface between the UPF 184a, 184b and the DN 185a, 185b.

[0070] In view of Figures 1A-1D, and the corresponding description of Figures 1A-1D, one or more, or all, of the functions described herein with regard to one or more of: WTRU 102a-d, Base Station 114a-b, eNode-B 160a-c, MME 162, SGW 164, PGW 166, gNB 180a-c, AMF 182a-ab, UPF 184a-b, SMF 183a-b, DN 185a-b, and/or any other device(s) described herein, may be performed by one or more emulation devices (not shown). The emulation devices may be one or more devices configured to emulate one or more, or all, of the functions described herein. For example, the emulation devices may be used to test other devices and/or to simulate network and/or WTRU functions.

[0071] The emulation devices may be designed to implement one or more tests of other devices in a lab environment and/or in an operator network environment. For example, the one or more emulation devices may perform the one or more, or all, functions while being fully or partially implemented and/or deployed as part of a wired and/or wireless communication network in order to test other devices within the communication network. The one or more emulation devices may perform the one or more, or all, functions while being temporarily implemented/deployed as part of a wired and/or wireless communication network. The emulation device may be directly coupled to another device for purposes of testing and/or may performing testing using over-the-air wireless communications.

[0072] The one or more emulation devices may perform the one or more, including all, functions while not being implemented/deployed as part of a wired and/or wireless communication network. For example, the emulation devices may be utilized in a testing scenario in a testing laboratory and/or a non-deployed (e.g., testing) wired and/or wireless communication network in order to implement testing of one or more components. The one or more emulation devices may be test equipment. Direct RF coupling and/or wireless communications via RF circuitry (e.g., which may include one or more antennas) may be used by the emulation devices to transmit and/or receive data.

[0073] General requirements set out by the International Telecommunication Union Radiocommunication Sector (ITU-R), Next Generation Mobile Networks (NGMN) Alliance and 3GPP, broadly classify use cases for emerging 5G systems as follows: Enhanced Mobile Broadband (eMBB), Massive Machine Type Communications (mMTC) and URLLC. Different use cases may focus on different requirements such as higher data rate, higher spectrum efficiency, low power and higher energy efficiency, and/or lower latency and higher reliability. A wide range of spectrum bands ranging from 700 MHz to 80 GHz are being considered for a variety of deployment scenarios.

[0074] It is well known that as the carrier frequency increases, path loss becomes a crucial limitation to guarantee a sufficient coverage area. Transmission in millimeter wave systems may suffer from non-line-of-sight losses, e.g., diffraction loss, penetration loss, oxygen absorption loss, foliage loss, etc. During initial access, a base station and WTRU may need to overcome these high path losses and discover each other. Utilizing dozens or even hundreds of antenna elements to generate a beam formed signal is an effective way to compensate the severe path loss by providing significant beam forming gain. Beamforming techniques may include digital, analog and hybrid beamforming.

[0075] Similar to LTE, the basic multiple access scheme for NR is orthogonal for both downlink and uplink data transmissions, meaning that time and frequency physical resources of different users are not overlapped. On the other hand, non-orthogonal multiple-access (NOMA) schemes recently gained wide interest, prompting a Rel-13 Study Item on downlink multi-user superposition transmission (MUST) and some initial study in Rel-14 Study Item on NR.

[0076] Many non-orthogonal multiple-access schemes are evaluated in the Rel-14 NR Study Item. For the evaluated scenarios the results show significant benefit of non-orthogonal multiple access in terms of UL link-level sum throughput and overloading capability, as well as system capacity enhancement in terms of supported packet arrival rate at a given system outage.

The Rel-14 Study Item further identified that NR should at least target UL non-orthogonal multiple access at least for mMTC.

[0077] For non-orthogonal multiple access, there may be interference between transmissions using overlapping resources. As the system load increases, this non-orthogonal characteristic is more pronounced. To combat the interference between non-orthogonal transmissions, transmitter side schemes such as spreading (linear or non-linear, with or without sparseness) and interleaving are normally employed to improve the performance and ease the burden of advanced receivers.

[0078] Non-orthogonal transmission may be applied to both grant-based and grant-free transmissions. The benefits of non-orthogonal multiple access, particularly when enabling grant-free transmission, may encompass a variety of use cases or deployment scenarios, including eMBB, URLLC, mMTC etc.

[0079] With new applications emerging for cellular technology, the importance of supporting higher data rates, lower latency, and massive connectivity continues to increase. For example, support for eMBB communications, URLLC and mMTC has been recommended by the ITU, along with example usage scenarios and desirable radio access capabilities. With a broad range of applications and usage scenarios, radio access capabilities may differ in importance across the range.

[0080] Traditional multiple access schemes used in wireless cellular communication systems assign time/frequency/spatial resources such that each user signal does not interfere with other users' signals. This type of access is referred to as Orthogonal Multiple Access (OMA), where multiplexing the users on orthogonal resources may be performed in the time domain (TDM), in the frequency domain (FDM) or in the spatial domain (SDM).

[0081] FIG. 2 is a high level block diagram of a transmitter 200 for code-domain based NOMA schemes. NOMA has been developed in recent years, for example to address some of the challenges of wireless communications such as high spectral efficiency and massive connectivity. A NOMA scheme may multiplex users in the code-domain. For example, different users may be assigned different spreading codes and may be multiplexed over the same time-frequency resources. For certain NOMA schemes, the spreading sequences may be short; for example, they may consist of or may be comprised of four to eight samples.

[0082] A high level block diagram of a transmitter for the code-domain based NOMA scheme is shown in FIG. 2. Referring to FIG. 2, input bits 202 are received from higher layers of a WTRU at a forward error correction (FEC) encoder 204 to produce coded bits 206. Coded bits 206 are provided to a modulation mapper or mapping circuitry 208 to produce modulation symbols 210.

Spreading 212 is performed to produce spread symbols 214. The spread symbols 214 are mapped to subcarriers 216 and an Inverse Discrete Fourier Transform (IDFT) 218 converts from time domain into the frequency domain.

[0083] NOMA may be used for one or more of URLLC, mMTC and eMBB. Different design targets may be required for different use cases and scenarios. For example, design targets for URLLC may focus on low latency and high reliability. Design targets for mMTC may focus on large connections and coverage. Design targets for eMBB may focus on spectrum efficiency and throughput enhancement.

[0084] In NOMA systems, WTRUs need to be identified correctly in order to operate NOMA successfully. Since many WTRUs may transmit data using NOMA operations, how to efficiently distinguish between different WTRUs is a relevant issue and may be a problem when NOMA systems are considered.

[0085] FIG. 3 is a flowchart 300 which illustrates exemplary WTRU identification methods. One or more WTRU identification methods may be performed under no association. A DMRS and multiple access signature (MAS) may or may not be associated with each other. When there is no association between DMRS and MAS, WTRU identification may be determined based on either a DMRS index or MAS index. If data decoding is successful, WTRU identification may be determined based on a MAS index. Otherwise, WTRU identification may be determined based on DMRS index. When decoding is successful, MAS may provide a unique identification for WTRU. When decoding is not successful, DMRS may provide a unique identification for WTRU. An example is depicted in FIG. 3.

[0086] In the example depicted in FIG. 3, a receiving device, for example, a base station, gNB or the like may detect a DMRS 302 transmitted by a WTRU. The receiving device may perform 304 NOMA data detection using a MAS and may determine 306 if the data decode is successful. The determination may be based on a cyclic redundancy check (CRC) or other means to check successful reception. If the decode is successful 308, the WTRU ID may be determined 310 as a MAS index. If the decode is not successful 312, the WTRU ID may be determined 314 as a DMRS index.

[0087] In an embodiment, the case when two WTRUs select a same DMRS or MAS, and only one of them is decoded successfully, may be supported. In an example case 1, if two WTRUs select the same DMRS but different MASs, and if one of MASs is decoded successfully, MAS may provide WTRU ID. In an example case 2, if two WTRUs select the same MAS but different DMRSs, and if the MAS is decoded successfully, DMRS may provide WTRU ID. In an example case 3, if two WTRUs select the same MAS and the same DMRS, and if the MAS is decoded successfully, neither

DMRS nor MAS may provide WTRU ID. In this case, another index other than DMRS and MAS may provide a unique WTRU ID. In an example case 4, if two WTRUs select different DMRSs and different MASs, and if one of MASs is decoded successfully, either DMRS or MAS may provide WTRU ID.

[0088] Another index other than DMRS and MAS may be a radio network temporary identifier (RNTI), a new type RNTI, a cell RNTI (C-RNTI), Network Management RNTI (NM-RNTI), IMSI or the like. Another index other than a DMRS and MAS may be a random number generated by a WTRU for identification purposes. Such another index may be implicitly or explicitly sent to the gNB. Such another index may be carried in data payload, for example, in a data channel such as PUSCH which may be transmitted with preamble, MAS and/or DMRS.

[0089] If a pool for DMRS or MAS is large, the likelihood that WTRUs select the same DMRS and the same MAS is low. Thus, such a case may be ignored given the availability of a large pool. On the other hand, if the pool for DMRS or MAS is small, the chance that WTRUs select the same DMRS and the same MAS is high, therefore another embodiment may be considered. In this case, another index other than DMRS or MAS may provide a unique WTRU ID.

[0090] FIG. 4 is a flowchart 400 which illustrates DMRS/MAS pool-based WTRU identification methods. An association between a pool or pool size for DMRS or MAS and WTRU identification may be used. For example, a pool-based WTRU identification may be used. If a WTRU is configured with a large pool for DMRS and/or MAS, either DMRS, MAS or both may provide for a unique WTRU ID. If the WTRU is configured with a small pool for DMRS and/or MAS, another index may provide for a unique WTRU ID. An embodiment is depicted in FIG. 4.

[0091] Referring to FIG. 4, a WTRU may receive 402 a configuration from a gNB. The WTRU may be provided 404 with an indication of a DMRS or MAS pool and the size of the pool. Based on the pool or the size thereof, a WTRU ID may be determined 406 accordingly. For example, a determination 408 may be made as to whether the pool size is a large or small pool. If the pool is small 410, the WTRU ID may be determined 412 by an index other than a DMRS or MAS. For example, the WTRU ID may be a cell radio network temporary identifier (C-RNTI) or a function of a C-RNTI. If the pool is sufficiently large 414, the WTRU ID may be determined 416 as a DMRS or MAS index.

[0092] In an example of a group of three WTRUs, if WTRU 1 selects DMRS#1 and MAS#1, WTRU 2 selects DMRS#2 and MAS#1 and WTRU 3 selects DMRS#2 and MAS #2, for some WTRU, say WTRU#2, neither DMRS or MAS alone may provide a unique identification for a particular WTRU. This is true because MAS#1 was selected at least twice, by WTRU 1 and WTRU 2 and because DMRS#2 was selected twice by WTRU 2 and WTRU 3. In this case, when neither

DMRS nor MAS may be used as a unique identification, another solution may be needed for identification purposes.

[0093] In one embodiment, joint DMRS/MAS indices may be used to provide a unique WTRU ID. Therefore, if there is an overlap between DMRSs and MASs that WTRUs select, then joint DMRS/MAS may provide a unique WTRU ID. Such situation may occur when association for DMRS and MAS is not present or not configured. The solution based on whether DMRS-MAS association is configured or not is depicted in FIG. 5. In the example above, each one of WTRU 1, WTRU 2 and WTRU 3 selected a different combination of DMRS and MAS and thus, each WTRU demonstrates a unique combination.

[0094] FIG. 5 is a flowchart 500 which illustrates a DMRS-MAS association based WTRU identification method. A basis for determining a WTRU ID may be in accordance with an association being configured as 'on' or 'off.' A WTRU may receive 502 a configuration from a gNB. The association configuration may indicate 504 a presence or absence of a DMRS to MAS association. For example, if a WTRU does not receive an association element, the WTRU may determine 506 that an association is configured as 'off' 514. If the WTRU does receive an association or association element, the association configuration may be determined 605 as 'on' 510. Based on whether or not the WTRU receives an association configuration 508, a WTRU ID may be determined. For example, if a DMRS to MAS association is configured 510, the WTRU ID may be determined 512 based on one of the DMRS or MAS index. This is due in part to an association providing a link between the two, thus either one may convey the same information. If an association is not configured 514, the WTRU ID may be determined 516 as a joint DMRS-MAS combination index.

[0095] FIG. 6 is a flowchart 600 which illustrates a DMRS-MAS overlap indication-based WTRU identification method. This embodiment is based on the WTRU receiving 602 an overlap indicator. In this case, the WTRU may or may not be provided 604 with the indicator of DMRS or MAS overlap. If a DMRS and MAS overlap indicator is determined 606 as 'on' 612, then a WTRU ID may be configured 614 as joint DMRS/MAS. If only DMRS overlap indicator is 'on,' then a WTRU ID may be configured as MAS. If only MAS overlap indicator is 'on,' then a WTRU ID is DMRS. If neither 608 one of the DMRS nor MAS overlap indicator is 'on,' then a WTRU ID is either 610 DMRS or MAS. A measurement based overlap indication for DMRS or MAS may be used. In an embodiment, RSRP may be used for measurement purposes. A threshold may be configured in RRC, RMSI or other system information (OSI) or the like. Such threshold may be an RSRP-based threshold or the like.

[0096] Alternatively, such ambiguity may be resolved using association for DMRS and MAS. A solution using non-overlapping association between DMRS and MAS may be used.

[0097] WTRU identification methods under association are disclosed herein. Embodiments using association between DMRS and MAS are considered. Embodiments using non-overlapping association between DMRS and MAS may be used.

[0098] FIG. 7 is a flowchart 700 which illustrates WTRU identification methods under a one-to-one association. If there is a one-to-one association, then either DMRS or MAS may provide a unique identification of a WTRU. In an embodiment, a DMRS may be detected 702. A MAS which is associated with the DMRS may be selected 704. NOMA data detection may be performed 706 using the selected MAS which is associated with the DMRS. A WTRU ID may be determined 708 as a DMRS index or MAS index.

[0099] In order to support a case in which two WTRUs select a same DMRS and thus the same MAS, and one of them is decoded successfully, another solution may be needed. For example, if two WTRUs select the same MAS and the same DMRS, and if the MAS is decoded successfully, neither DMRS or MAS may provide a WTRU ID. In this case, another index other than DMRS or MAS may provide a unique WTRU ID. In one-to-one association, two WTRUs select the same MAS but different DMRSs or the same DMRS but different MASs may not occur.

[00100] FIG. 8 is a flowchart 800 which illustrates WTRU identification methods under a one-to-many association. When there is one-to-many association, depending on the decoding outcome, the WTRU ID may be different. For example, if decoding is successful, MAS may provide a unique WTRU ID. Otherwise, DMRS may provide a unique WTRU ID.

[00101] In the embodiment depicted in FIG. 8, a DMRS may be detected 802. All MASs associated with the detected DMRS may be selected 804 and NOMA data detection may be performed 806 using all selected MASs associated with the detected DMRS. If a decode 808 of the data is successful 810, then a WTRU ID may be determined 812 as a MAS index. If the decode 808 is unsuccessful 814, then the WTRU ID may be determined 816 as a DMRS index.

[00102] The case where two WTRUs select a same DMRS or MAS, and only one of them is decoded successfully, may be supported. For example, if two WTRUs select the same DMRS but different MASs, and if one of MASs is decoded successfully, MAS may provide WTRU ID. In one-to-many association, two WTRUs select the same MAS but different DMRSs may not occur.

[00103] If two WTRUs select the same MAS and the same DMRS, and if the MAS is decoded successfully, neither DMRS or MAS may provide a WTRU ID. In this case, another index other than DMRS and MAS may provide a unique WTRU ID.

[00104] FIG. 9 is a flowchart 900 which illustrates identification methods under a many-to-one association (example 1). In an embodiment, a DMRS may be detected 902. A MAS which is associated with the DMRS may be selected 904. NOMA data detection may be performed 906 using the selected MAS. A WTRU ID may be determined 908 as a DMRS index or MAS index.

[00105] FIG. 10 is a flowchart 1000 which illustrates WTRU identification methods under a many-to-one association (Example 2). If there is many-to-one association, then a WTRU ID may be provided either by DMRS or MAS. An embodiment is depicted in FIG. 9. Alternatively, a WTRU ID may be provided by joint DMRS and MAS. An embodiment is depicted in FIG. 10.

[00106] In the embodiment shown in FIG. 10, a DMRS may be detected 1002. A MAS which is associated with the DMRS may be selected 1004. NOMA data detection may be performed 1006 using the selected MAS. A WTRU ID may be determined 1008 as a joint DMRS index and MAS index.

[00107] In order to support the case when two WTRUs select the same DMRS or MAS, and only one of them is decoded successfully, another embodiment may be relied upon. For example, if two WTRUs select the same MAS but different DMRSs, and if the MAS is decoded successfully, DMRS may provide a WTRU ID. In many-to-one association, two WTRUs select the same DMRS but different MASs may not occur.

[00108] If two WTRUs select the same MAS and thus the same DMRS, and if the MAS is decoded successfully, neither DMRS or MAS may provide WTRU ID. In this case, another index other than DMRS and MAS may provide a unique WTRU ID.

[00109] FIG. 11 is a flowchart 1100 which illustrates a full DMRS-MAS association-based WTRU identification method. WTRU identification may be based on whether there is an association or not. For example, MAS may provide a unique WTRU ID. Furthermore, WTRU identification may be based on association type. For example, if an association type is one-to-many, DMRS may provide a unique WTRU ID. If association type is many-to-one, MAS may provide a unique WTRU ID. Otherwise, either DMRS or MAS may provide a unique WTRU ID. Joint DMRS and MAS may also provide a unique WTRU ID. An embodiment is depicted in FIG. 11.

[00110] In the example shown in FIG. 11, a WTRU may receive 1102 feedback from a gNB. The feedback may be in response to a transmission made by a WTRU. A WTRU may receive 1104 an indication of an association or association type. A determination may be made 1106 as to whether a DMRS-MAS association is configured. If a DMRS-MAS association is not configured 1108, a WTRU ID may be determined 1110 as a joint DMRS/MAS index. If a DMRS-MAS association is configured 1112, the WTRU may determine 1114 an association type. The association type may be determined 1116 as a 1-to-1 association type, a 1-to-many association type

or a many-to-1 association type. If the association is 1-to-1 1118, the WTRU ID may be determined 1120 as a DMRS index or a MAS index. If the association is 1-to-many 1122, the WTRU ID may be determined 1124 as a DMRS index. If the association is many-to-1 1126, the WTRU ID may be determined 1128 as a MAS index.

[00111] A new feedback or DCI may be introduced particular to enable more efficient NOMA operation. A feedback or DCI may include: a DMRS field; a multiple access (MA) signature field; a 1-bit indicator or K-bit indicator. A 1-bit indicator may be set to: "0" if DMRS field is indicated or "1" if a MA signature field is indicated. A K-bit indicator may be set to "00" if a DMRS field is indicated or may be set to "01" if a MA signature field is indicated. The K-bit indicator may be set to "10" if a joint DMRS and MA signature field is indicated or may be set to "11" if another index is indicated or this field is reserved.

[00112] A feedback may be a control channel such as NR-PDCCH, group common control (GC-PDCCH) or WTRU-specific control channel. A feedback may be a data channel such as NR-PDSCH.

[00113] A pool-based WTRU identification method may be used. If a WTRU is configured with large pool, DMRS, MAS or both may be provided for a WTRU ID. If a WTRU is configured with small pool, another index may be provided for a WTRU ID. Another index may be RNTI, C-RNTI, IMSI or the like. In case of idle mode, IMSI or the like may be used. In case of RRC connected mode, C-RNTI may be used.

[00114] In RRC Connected Mode, one or more NOMA resource(s) may be configured in RRC signaling or the like. A WTRU ID may be determined based on DMRS, MAS and/or C-RNTI. A feedback signal containing or conveying DMRS, MAS and/or C-RNTI may be transmitted. When a WTRU receives a feedback channel or signal, the WTRU may compare the selected DMRS and/or MAS with the transmitted DMRS and/or MAS to distinguish the transmission from transmissions of other WTRUs. The WTRU may also compare the C-RNTI with the transmitted C-RNTI to distinguish a transmission from transmission(s) of other WTRUs if needed. A payload based feedback channel may be used. NR-PDCCH and/or NR-PDSCH may be used for feedback channel. A feedback signal may also be used. gNB may transmit NR-PDCCH and/or NR-PDSCH containing DMRS, MAS and/or another index, for example, a random number generated by the WTRU, an RNTI, a C-RNTI or a set of DMRSs, MASs and/or other indices, for example, random numbers generated by the WTRU, RNTIs or C-RNTIs.

[00115] Common channel based feedback may be provided to a WTRU or gNB. A feedback indicator containing a set of DMRSs, MASs and/or other indices, for example, random numbers generated by the WTRU, RNTIs or C-RNTIs) may be transmitted to a group of WTRUs

including all WTRUs in range of a gNB. A PDCCH or GC-PDCCH may be used. A NM-C-RNTI or NMGC-C-RNTI may be used for PDCCH or GC-PDCCH. Two or more options may be possible. In a first option, option 1) A PDCCH or GC-PDCCH containing a set of DMRSs, MASs and/or other indices, for example, random numbers generated by the WTRU, RNTIs or C-RNTIs may be used. In a second option, option 2) A PDCCH or GC-PDCCH scheduling a PDSCH or GC-PDSCH containing a set of DMRSs, MASs and/or other indices, for example, random numbers generated by the WTRU, RNTIs or C-RNTIs may be used. If many feedback indicators or feedback transmissions are needed, a relatively small CORESET or search space may be sufficient.

[00116] A feedback containing DMRS, MAS and/or another index, for example, a random number generated by the WTRU, an RNTI, a C-RNTI, or an IMSI may be transmitted to a specific WTRU or a group of WTRUs by a gNB. For example, a PDCCH may be used for the feedback. A C-RNTI may be used for transmission on the NR-PDCCH. A gNB may transmit NR-PDCCH masked with another index, for example, a random number generated by the WTRU, an RNTI, a C-RNTI, or an IMSI. A gNB may transmit NR-PDCCH masked with C-RNTI. If many feedback indicators or feedback transmissions are needed, a large CORESET or search space may be required.

[00117] In an Idle Mode, a NOMA resource may be configured in RMSI, OSI or the like. A WTRU ID may be determined based on DMRS, MAS and/or another index, for example, random number generated by the WTRU, RNTI or IMSI). A feedback containing DMRS, MAS and/or another index, for example, a random number generated by the WTRU, RNTI or IMSI, may be transmitted. When a WTRU receives a feedback channel or signal, the WTRU may compare the received DMRS and/or MAS and/or another index, for example, a random number generated by the WTRU, an RNTI, a C-RNTI or an IMSI, with the selected and transmitted DMRS and/or MAS and/or another index, for example, a random number generated by the WTRU, an RNTI or an IMSI, to distinguish from other WTRUs. The WTRU may also compare the received IMSI with the transmitted IMSI to distinguish itself from other WTRUs if needed. A payload based feedback channel may be used. PDCCH and/or PDSCH may be used for a feedback channel. A feedback signal with explicit or implicit method may also be used. A gNB may transmit PDCCH and/or PDSCH containing DMRS, MAS and/or another index, for example, a random number generated by the WTRU, an RNTI or an IMSI. A NM-RNTI may be used for PDCCH. A GC-PDCCH may also be used. A NMGC-RNTI may be used for GC-PDCCH. A MAS may be a spreading sequence, scrambling sequence, preamble sequence, interleaving pattern, or the like.

[00118] FIG. 12 is a flowchart 1200 which illustrates a preamble-to-DMRS association type WTRU identification method. In an embodiment, a WTRU may receive 1202 a preamble/DMRS configuration which includes a Preamble/DMRS pool configuration and a preamble-to-DMRS

association type. The WTRU may select a preamble and a DMRS and may transmit data 1204 together with the selected preamble and DMRS, for example in a msg A random access transmission. This initial transmission may be referred to as a step 1 transmission. In response to the msg A transmission, the WTRU may receive 1206 common feedback, for example, a msg B or common ACK/NACK transmission from a gNB in step 2. The common feedback received 1206 may indicate a WTRU identifier by indicating the preamble and/or DMRS.

[00119] The WTRU may determine whether a Preamble-to-DMRS association is configured 1208. If yes 1210, the WTRU may determine 1214 the preamble-to-DMRS association type, which may be for example, 1-to-1, 1-to-many or Many-to-1. If no 1212, the Preamble-to-DMRS association is not configured, the WTRU may determine 1228 to use both the preamble and the DMRS as an intended WTRU identifier. If the preamble-to-DMRS association type is 1-to-1 1216, the WTRU may determine 1222 to use either the preamble or the DMRS as the intended WTRU identifier. If the preamble-to-DMRS association type is 1-to-many 1218, the WTRU may determine to use the preamble 1224 as the intended WTRU identifier. Alternatively, if the preamble-to-DMRS association type is many-to-1 1220, the WTRU may determine to use the DMRS 1226 as the intended WTRU identifier.

[00120] Once an intended WTRU identifier is determined, the WTRU may determine 1230 whether the intended WTRU identifier transmitted in step 1 is equivalent to the intended WTRU identifier received in step 2. If the identifiers are equivalent 1234, then feedback is acknowledged, for example, the WTRU confirms 1238 that step 1 (msg A) transmission is successful. If the identifiers are not equivalent 1232, then the feedback is not acknowledged 1236, i.e. the step 1 (msg A) transmission is assumed to have failed.

[00121] In another embodiment, a WTRU may determine another index, for example, a random number generated by the WTRU, an RNTI, a C-RNTI or an IMSI, and may transmit data, for example, PUSCH together with the another index, for example in a msg A random access transmission. This initial transmission may be referred to as a step 1 transmission. In response to the msg A transmission, the WTRU may receive common feedback, for example, a msg B or common ACK/NACK transmission from a gNB in step 2. The common feedback received may indicate a WTRU identifier by indicating the another index. The WTRU may determine to use the another index as the intended WTRU identifier.

[00122] Once an intended WTRU identifier is determined, the WTRU may determine whether the intended WTRU identifier transmitted in step 1 is equivalent to the intended WTRU identifier received in step 2. If the identifiers are equivalent, then feedback is acknowledged, i.e. the WTRU confirms that step 1 (msg A) transmission is successful. If the identifiers are not equivalent,

then the feedback is not acknowledged, i.e. the step 1 (msg A) transmission is assumed to have failed.

[00123] Although features and elements are described in the preferred embodiments in particular combinations, each feature or element can be used alone without the other features and elements of the preferred embodiments or in various combinations with or without other features and elements of the present invention.

[00124] Although the solutions described herein consider LTE, LTE-A, New Radio (NR) or 5G specific protocols, it is understood that the solutions described herein are not restricted to this scenario and are applicable to other wireless systems as well.

[00125] Although features and elements are described above in particular combinations, one of ordinary skill in the art will appreciate that each feature or element can be used alone or in any combination with the other features and elements. In addition, the methods described herein may be implemented in a computer program, software, or firmware incorporated in a computer-readable medium for execution by a computer or processor. Examples of computer-readable media include electronic signals (transmitted over wired or wireless connections) and computer-readable storage media. Examples of computer-readable storage media include, but are not limited to, a read only memory (ROM), a random access memory (RAM), a register, cache memory, semiconductor memory devices, magnetic media such as internal hard disks and removable disks, magneto-optical media, and optical media such as CD-ROM disks, and digital versatile disks (DVDs). A processor in association with software may be used to implement a radio frequency transceiver for use in a WTRU, UE, terminal, base station, RNC, or any host computer.

* * *

CLAIMS

What is claimed:

1. A method performed by a wireless transmit / receive unit (WTRU), the method comprising:
 - receiving a common feedback transmission, in response to a transmission of the WTRU, wherein the common feedback transmission conveys one or both of a preamble and a demodulation reference signal (DMRS) to indicate an identifier of the WTRU;
 - determining whether a preamble-to-DMRS association is configured;
 - on a condition the preamble-to-DMRS association is not configured, determining to use both the preamble and the DMRS as the identifier of the WTRU; and
 - on a condition the preamble-to-DMRS association is configured, determining to use one of the preamble or the DMRS as the identifier of the WTRU based on the preamble-to-DMRS association.
2. The method of claim 1, wherein the transmission of the WTRU is a data transmission.
3. The method of claim 1, wherein the transmission of the WTRU is a random access transmission.
4. The method of claim 1, wherein the common feedback transmission is a non-orthogonal multiple access (NOMA) type transmission.
5. The method of claim 1, further comprising:
 - receiving an indication of the preamble-to-DMRS association.
6. The method of claim 1, wherein the preamble-to-DMRS association is based on a resource pool configuration.
7. The method of claim 1, wherein the preamble-to-DMRS association is a one-to-one, one-to-many or many-to-one type association.
8. The method of claim 1, wherein the preamble is determined as the identifier of the WTRU.
9. The method of claim 1, wherein the DMRS is determined as the identifier of the WTRU.
10. The method of claim 1, wherein a radio network temporary identifier (RNTI) is used as the identifier of the WTRU in combination with one or both of the preamble and the DMRS.
11. The method of claim 1, further comprising:

determining, based on the identifier of the WTRU and the common feedback transmission, that the transmission of the WTRU has been successfully received by a next generation Node B (gNB).

12. A method performed by a wireless transmit / receive unit (WTRU), the method comprising:

receiving a common feedback transmission, in response to a transmission of the WTRU, wherein the common feedback transmission conveys one or both of a preamble and a demodulation reference signal (DMRS) to indicate an identifier of the WTRU;

determining whether a preamble-to-DMRS association is configured;

on a condition the preamble-to-DMRS association is not configured, determining to use both the preamble and the DMRS as the identifier of the WTRU;

on a condition the preamble-to-DMRS association is configured, determining to use one of the preamble or the DMRS as the identifier of the WTRU based on the preamble-to-DMRS association; and

determining to use another identifier, in combination with one or both of the preamble and the DMRS, as the identifier of the WTRU.

13. The method of claim 12, wherein the another identifier is a radio network temporary identifier (RNTI).

14. The method of claim 13, wherein the RNTI is a cell-RNTI (C-RNTI).

15. The method of claim 13, wherein the another identifier is an NM-RNTI.

16. The method of claim 13, wherein the another identifier is a group common physical downlink control channel (GC-PDCCH) identifier.

17. The method of claim 13, wherein the another identifier is a multiple access signature.

18. The method of claim 12, wherein the another identifier is an IMSI or the another identifier is a random number generated by the WTRU.

19. The method of claim 12, further comprising:

determining, based on the identifier of the WTRU and the common feedback transmission, that the transmission of the WTRU has been successfully received by a next generation Node B (gNB).

20. A wireless transmit / receive unit (WTRU) comprising:

a receiver configured to receive a common feedback transmission, in response to a transmission of the WTRU, wherein the common feedback transmission conveys one or both of a preamble and a demodulation reference signal (DMRS) to indicate an identifier of the WTRU;

circuitry configured to determine whether a preamble-to-DMRS association is configured;

circuitry configured to, on a condition the preamble-to-DMRS association is not configured, determine to use both the preamble and the DMRS as the identifier of the WTRU;

circuitry configured to, on a condition the preamble-to-DMRS association is configured, determine to use one of the preamble or the DMRS as the identifier of the WTRU, based on the preamble-to-DMRS association; and

circuitry configured to determine to use another identifier, in combination with one or both of the preamble and the DMRS, as the identifier of the WTRU.

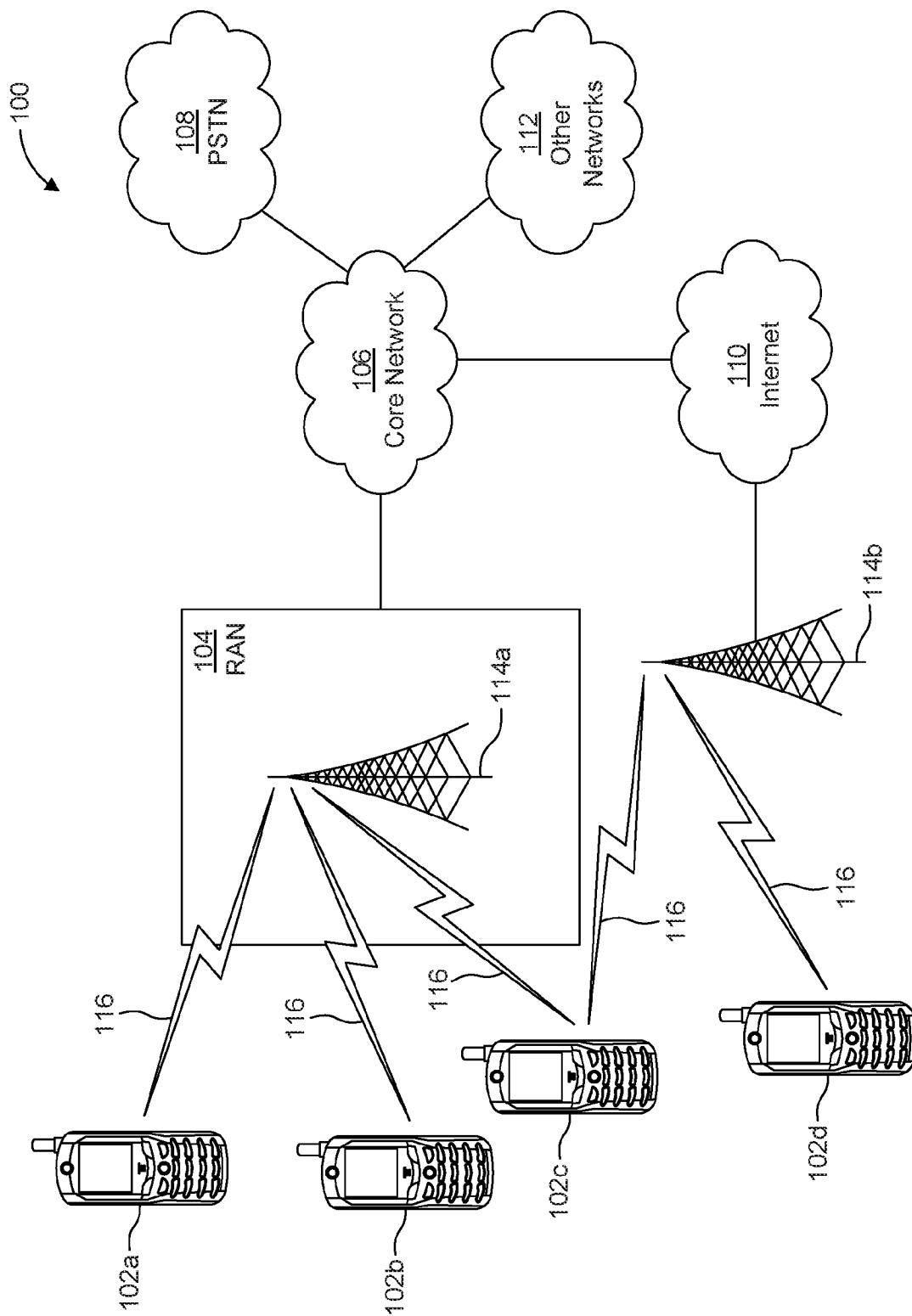


FIG. 1A

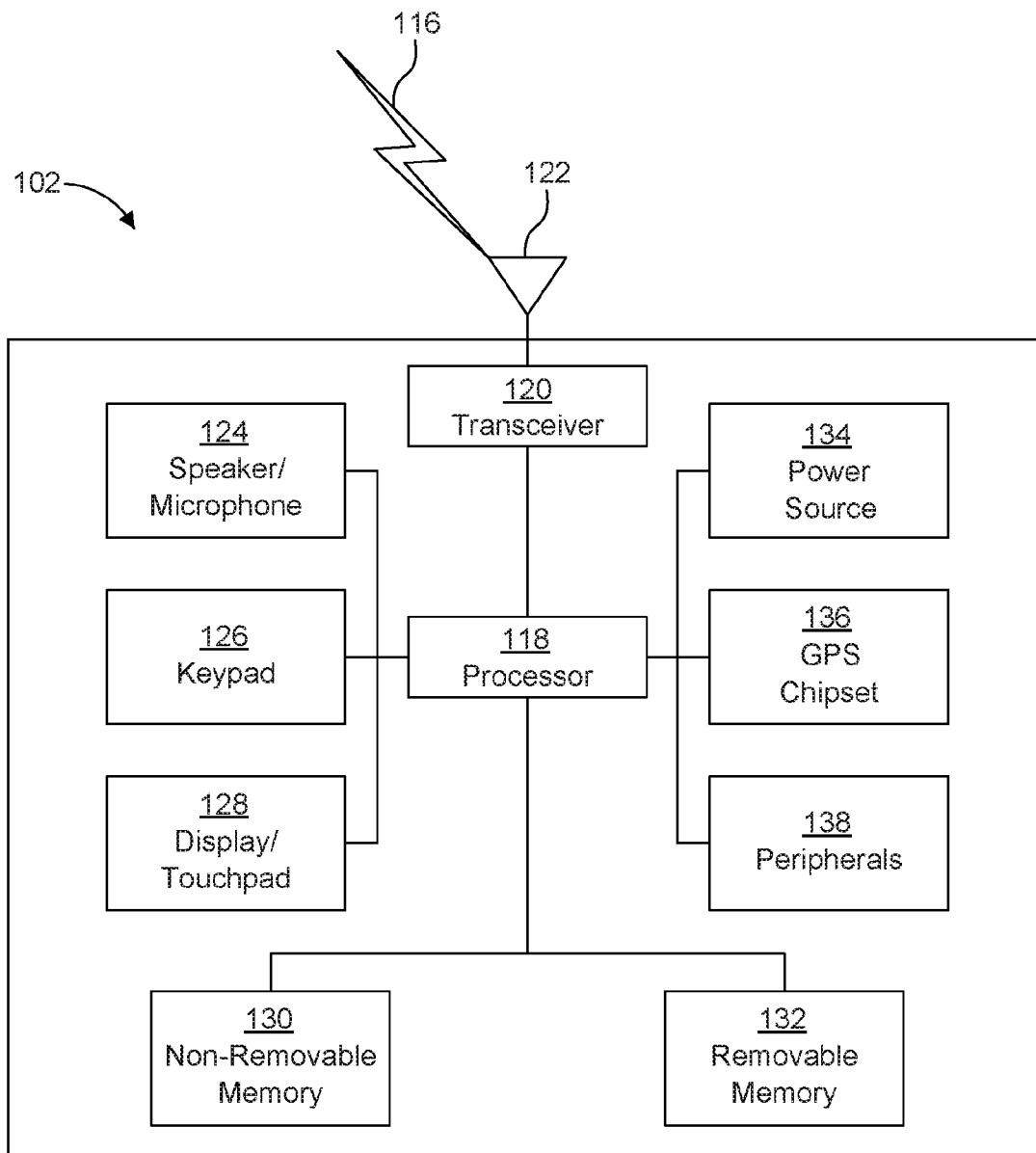


FIG. 1B

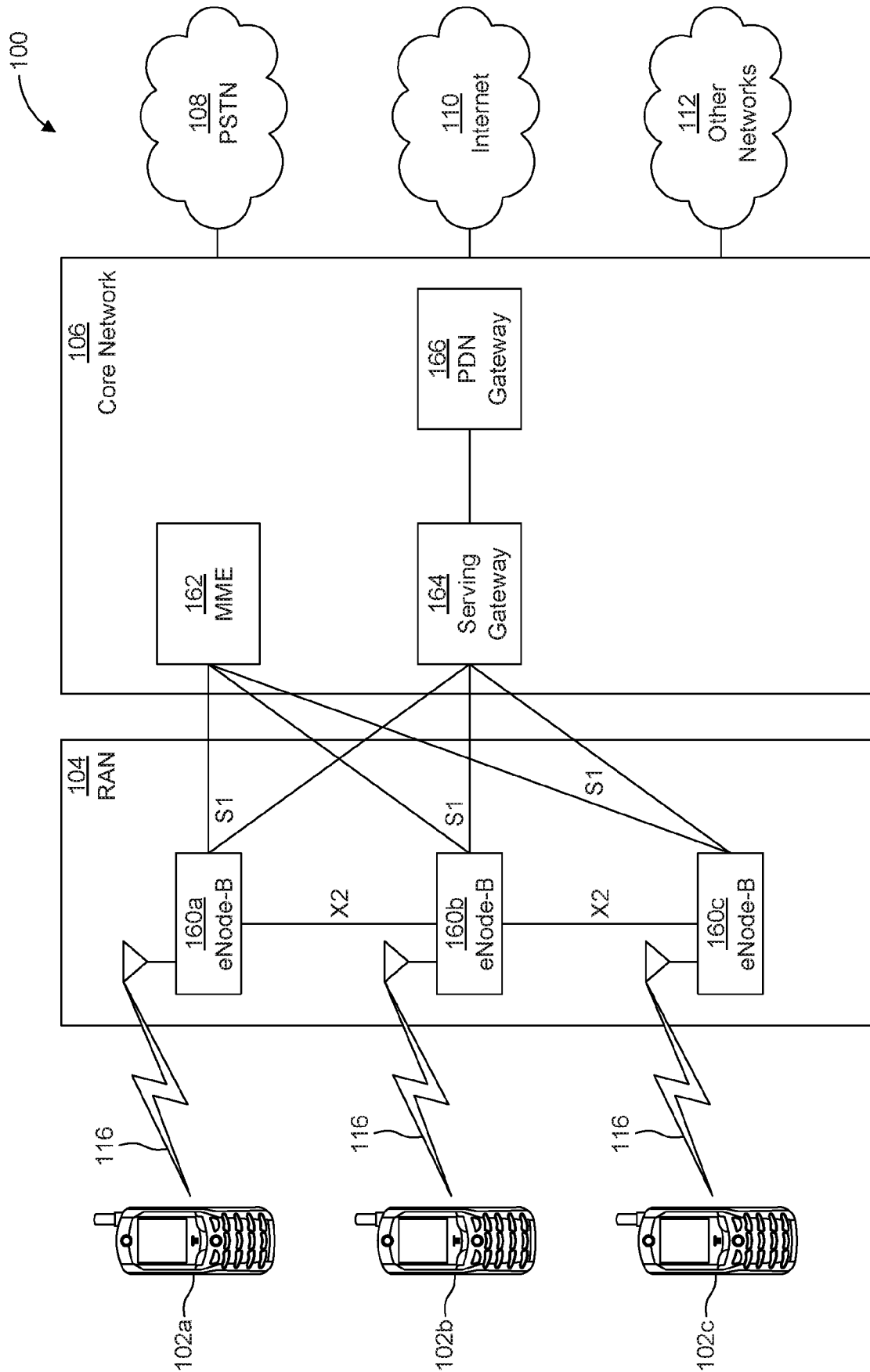


FIG. 1C

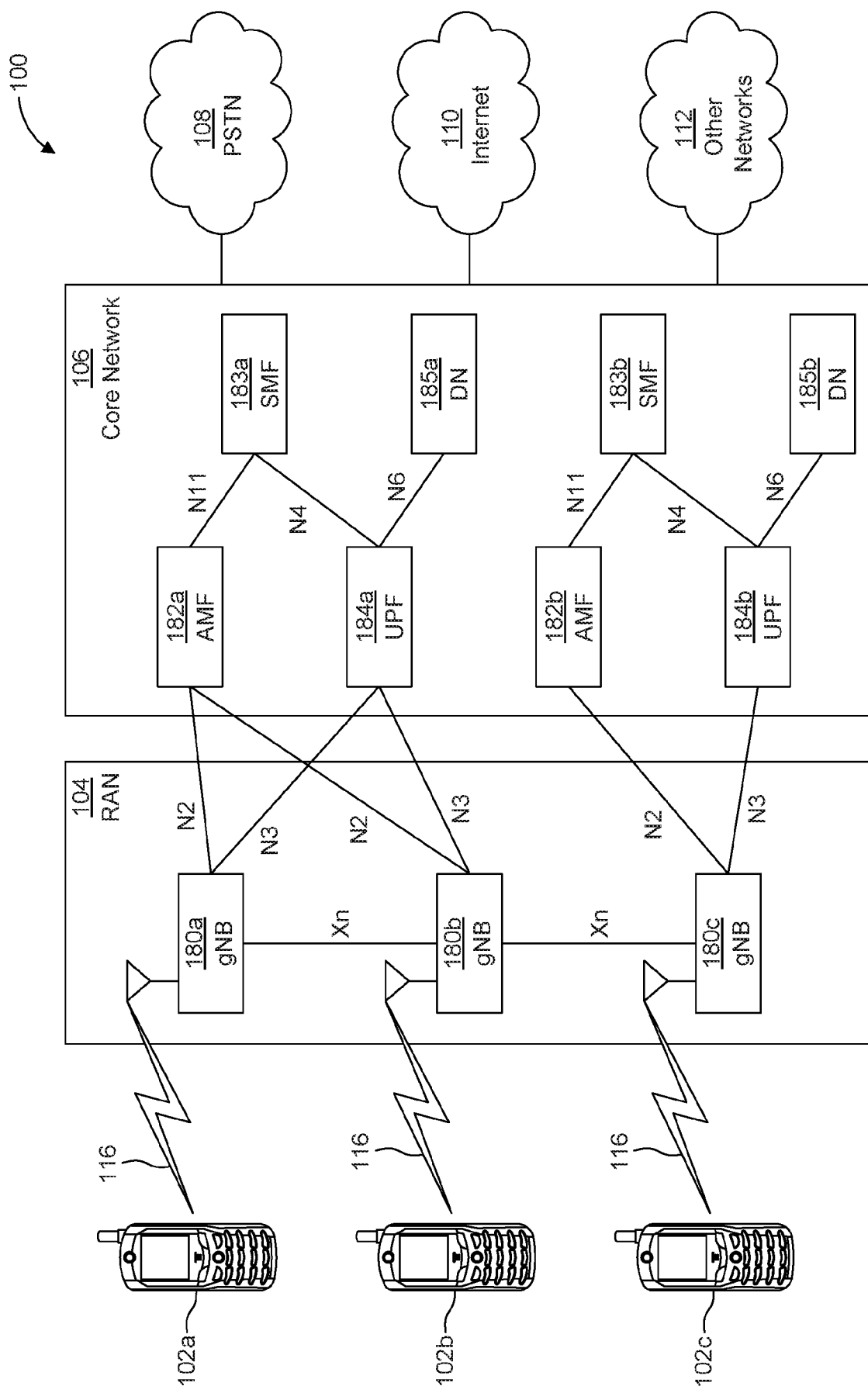


FIG. 1D

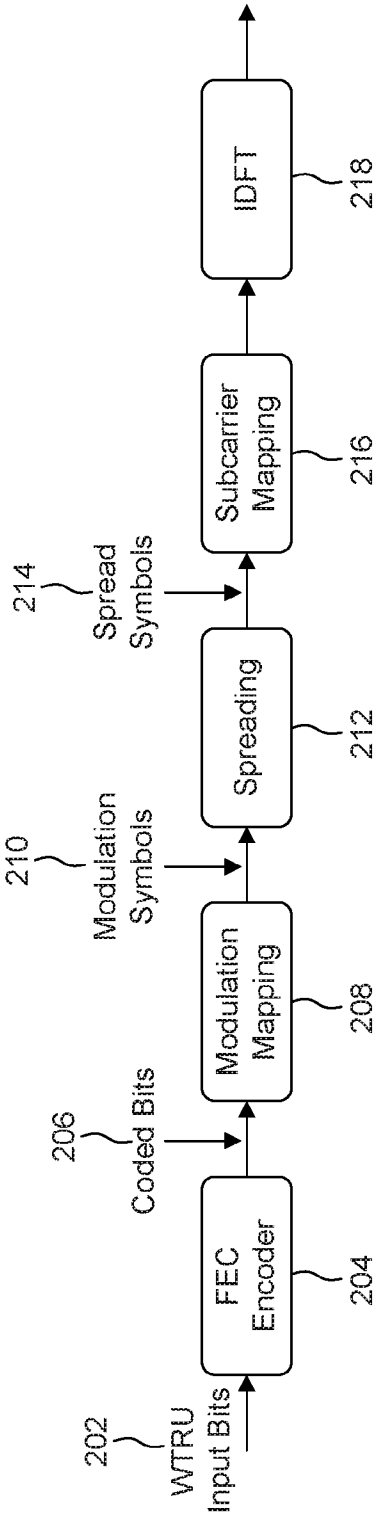


FIG. 2

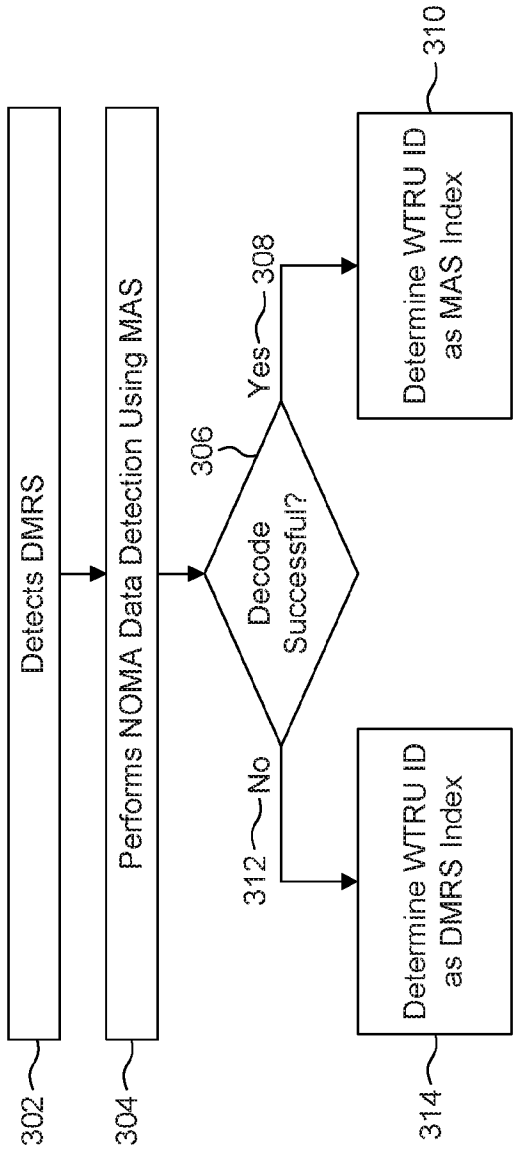


FIG. 3

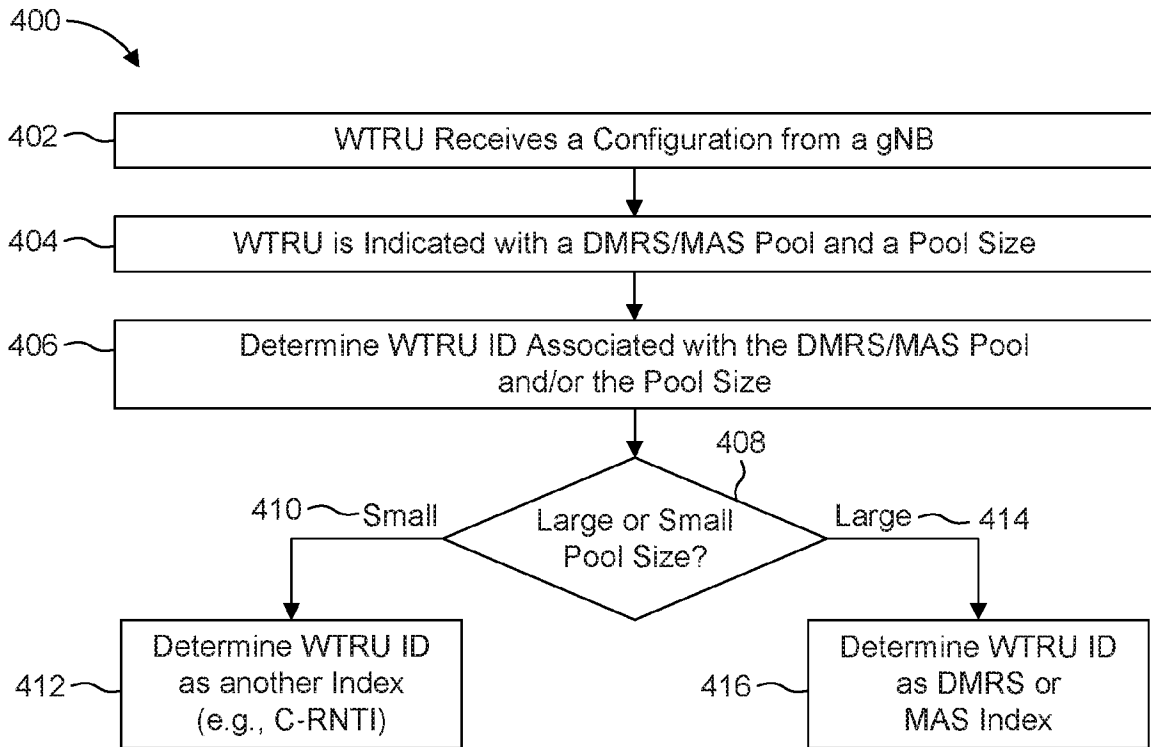


FIG. 4

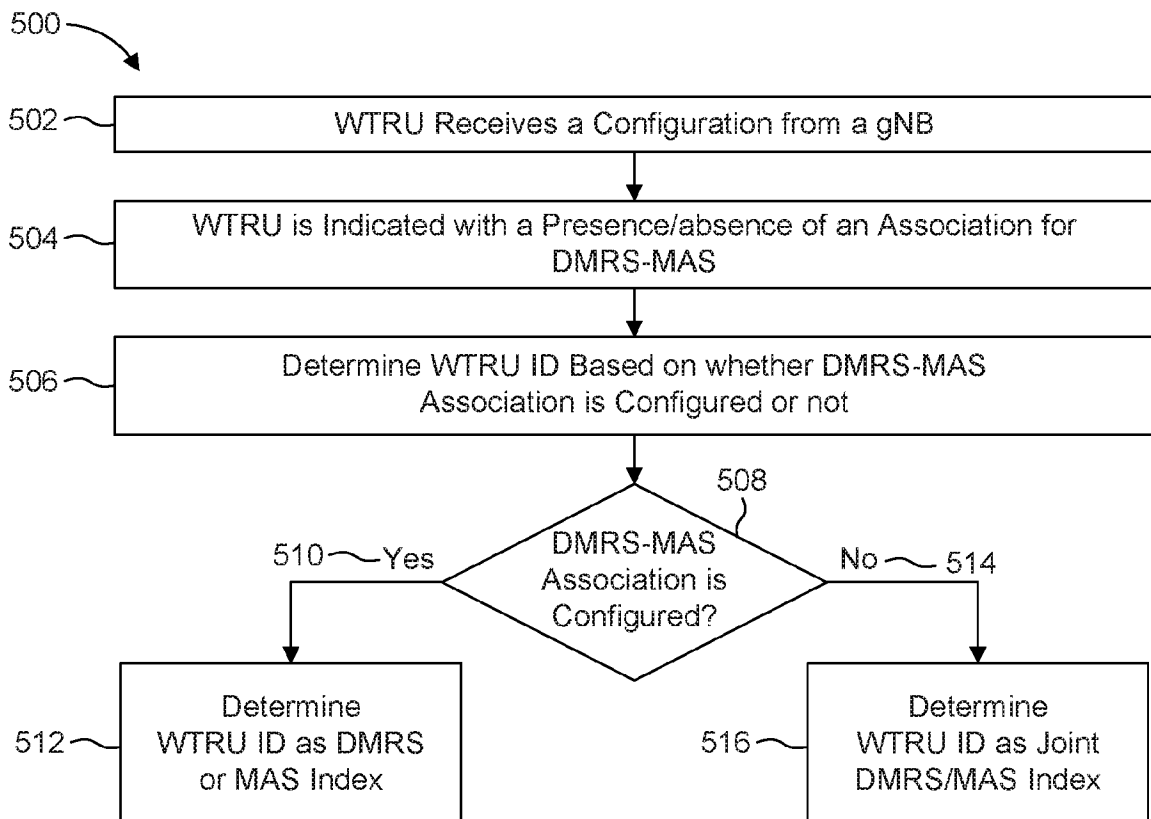


FIG. 5

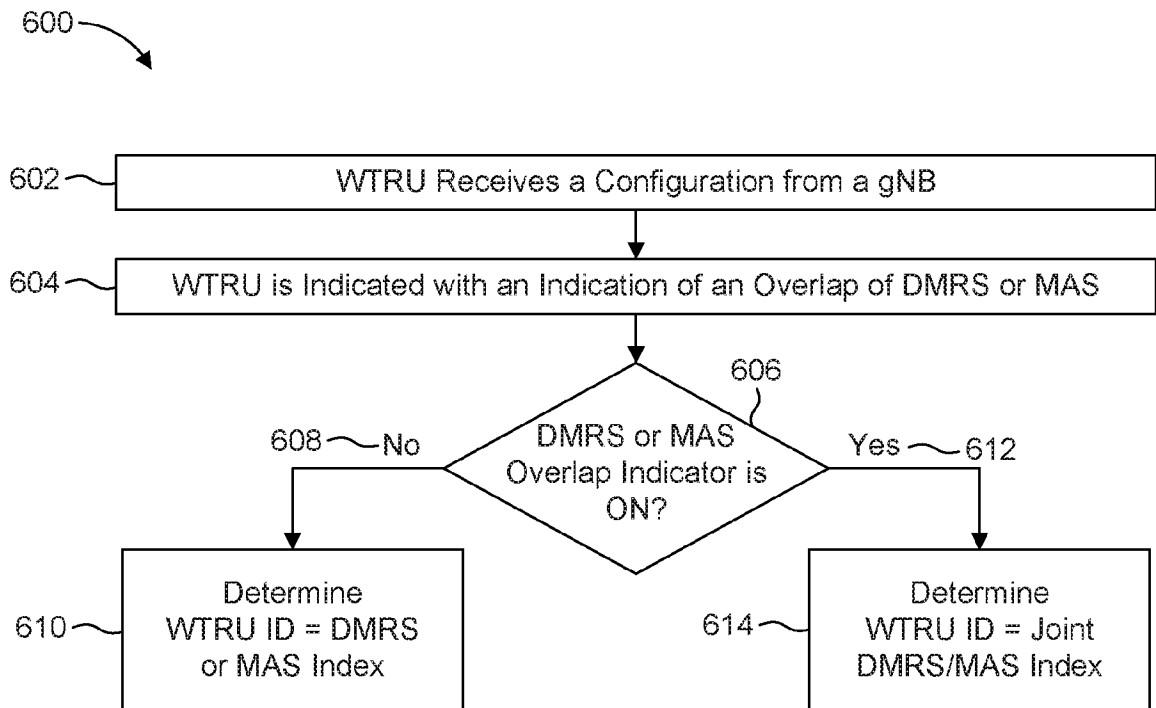


FIG. 6

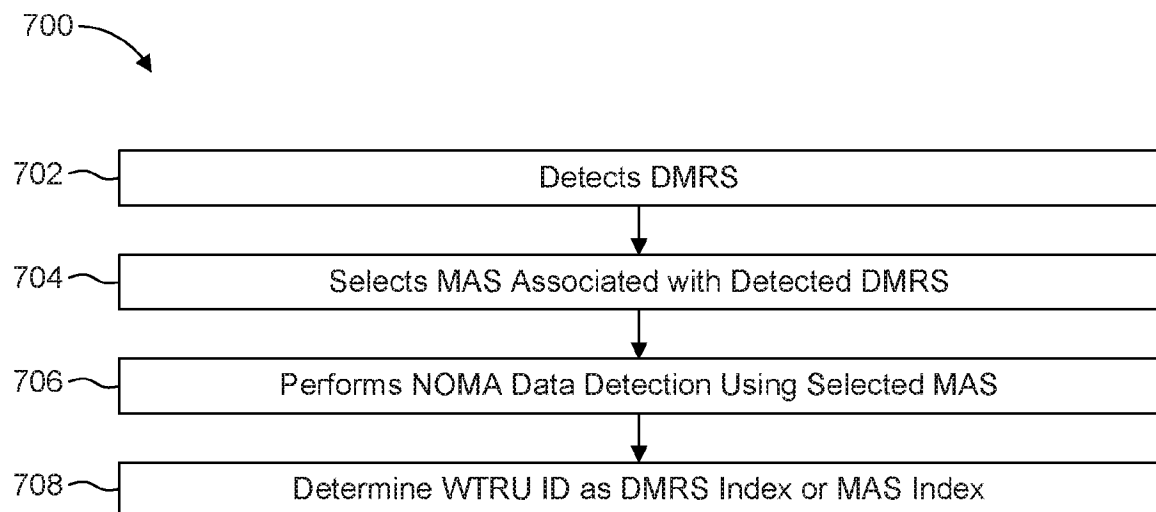


FIG. 7

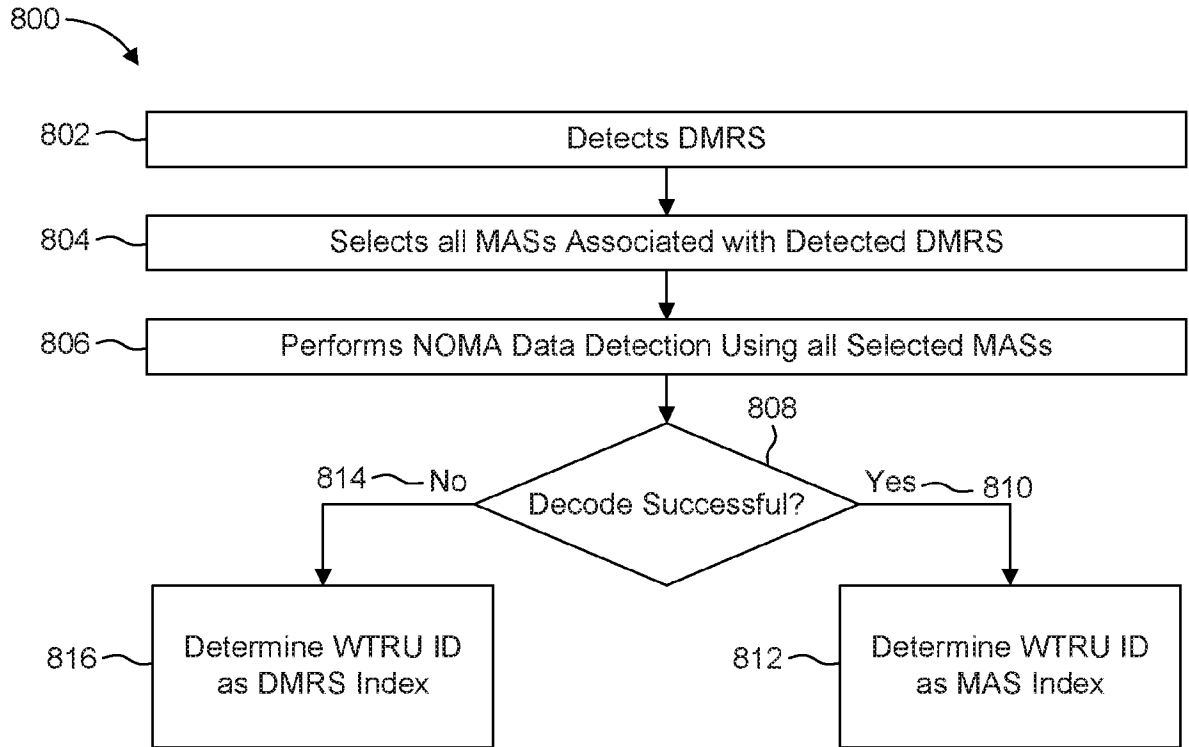


FIG. 8

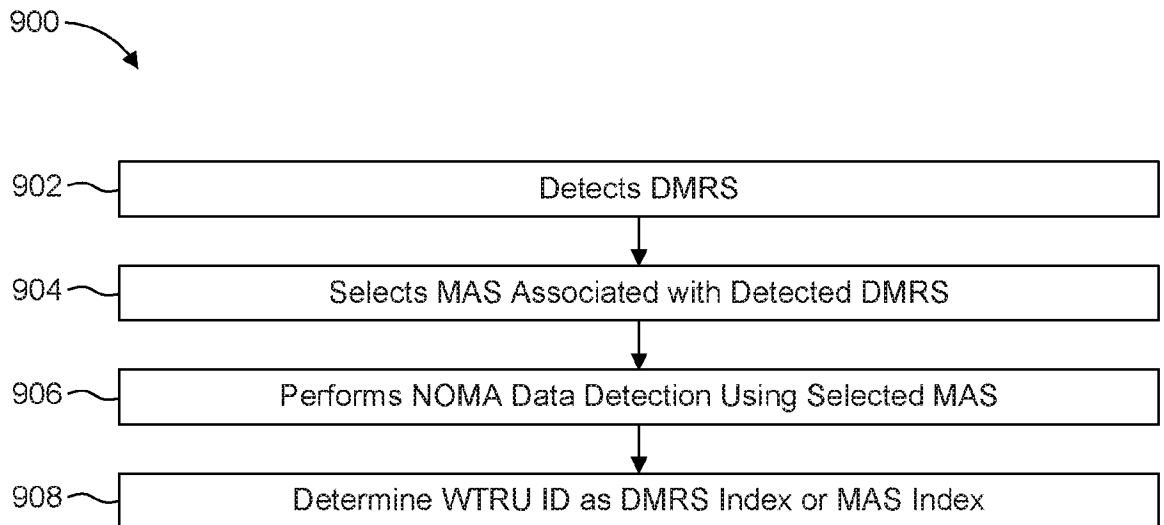


FIG. 9

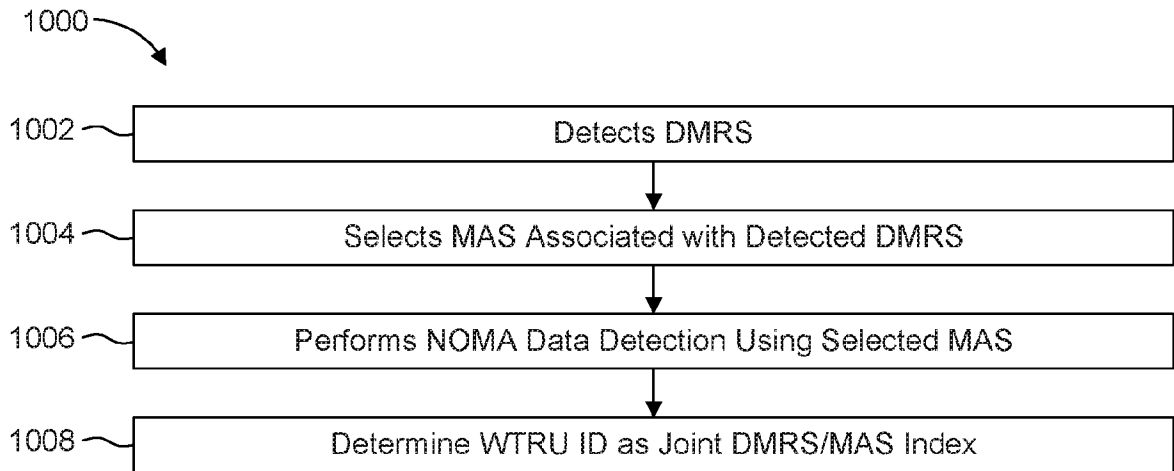


FIG. 10

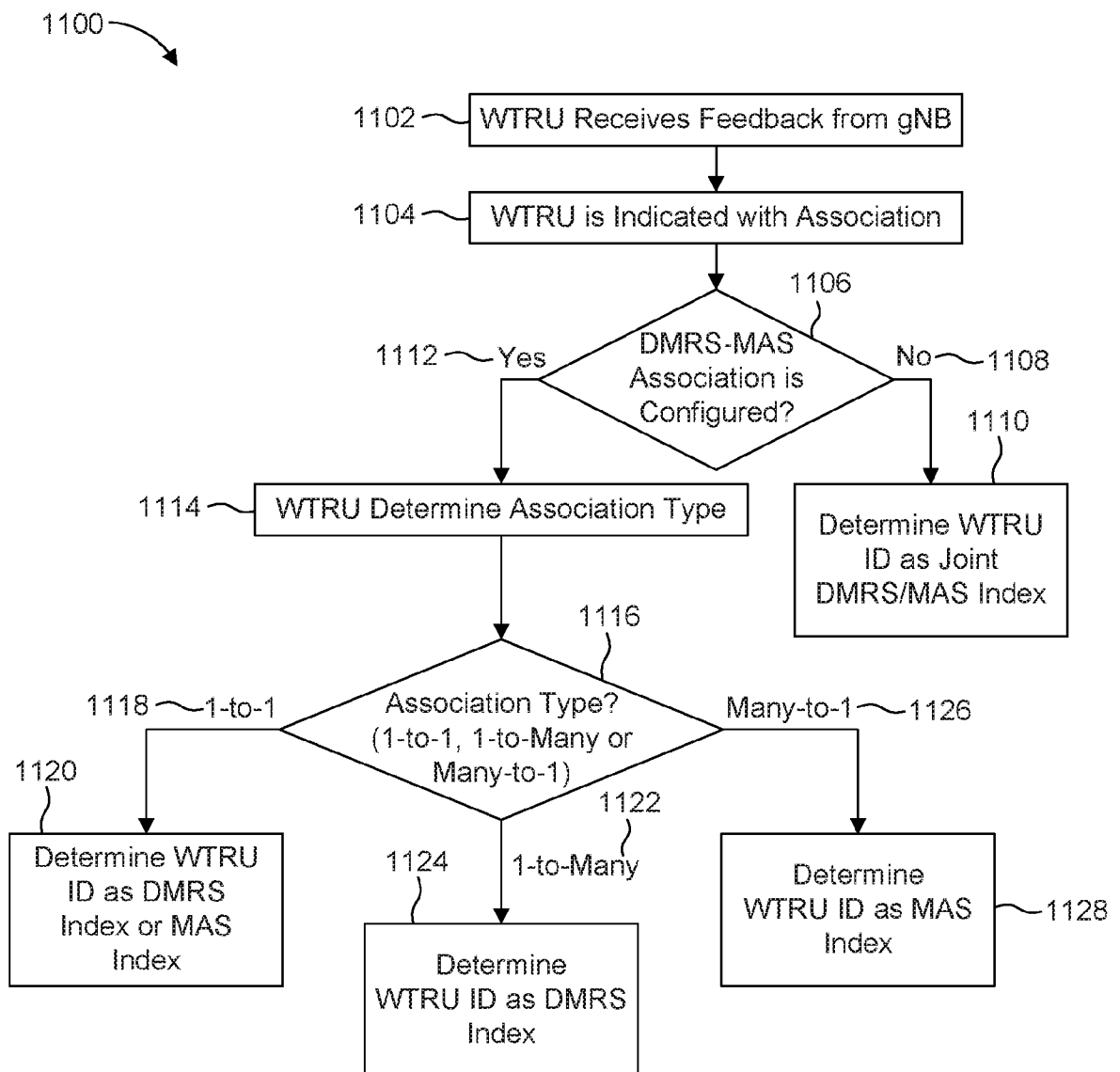


FIG. 11

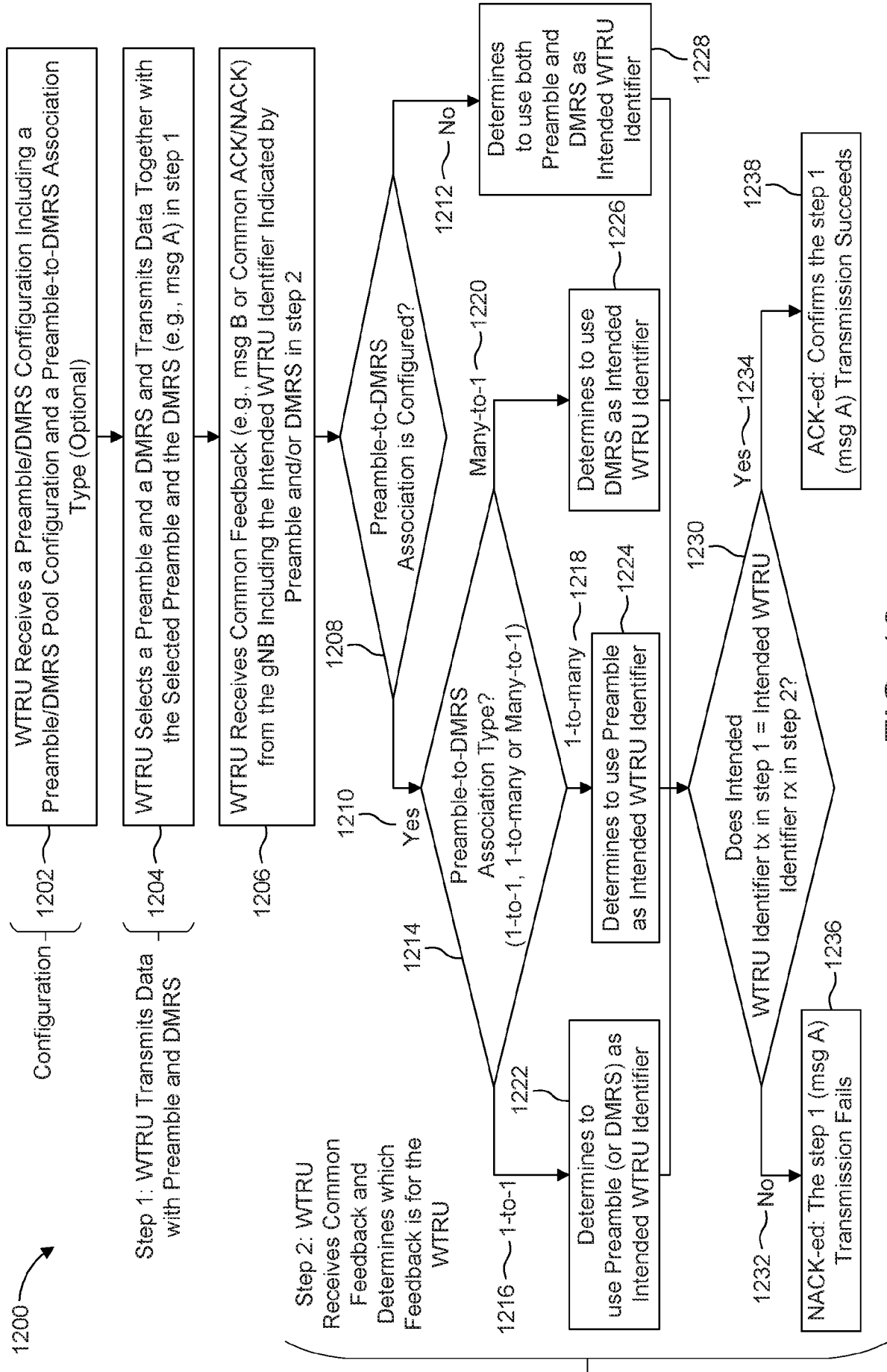


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/045079

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L5/00
ADD.

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)
H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 2017/209570 A1 (SAMSUNG ELECTRONICS CO LTD [KR]) 7 December 2017 (2017-12-07) paragraph [0120] paragraph [0129] paragraph [0027] paragraph [0122] paragraph [0168] - paragraph [0170] page 7 ----- -/--	1-9,11, 12,17, 19,20 10, 13-16,18



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

31 October 2019

Date of mailing of the international search report

20/11/2019

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Fax: (+31-70) 340-3016

Authorized officer

Tanbourgi, Ralph

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2019/045079

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	VIVO: "Discussion on NOMA Procedures", 3GPP DRAFT; R1-1803852 DISCUSSION ON NOMA PROCEDURES, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. Sanya, China; 20180216 - 20180320 15 April 2018 (2018-04-15), XP051426147, Retrieved from the Internet: URL: http://www.3gpp.org/ftp/Meetings%5F3GP P%5FSYNC/RAN1/Docs/ [retrieved on 2018-04-15]	1
A	sec.2.1; page 2 -----	2-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2019/045079

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2017209570 A1	07-12-2017	CN 107466112 A WO 2017209570 A1	12-12-2017 07-12-2017
