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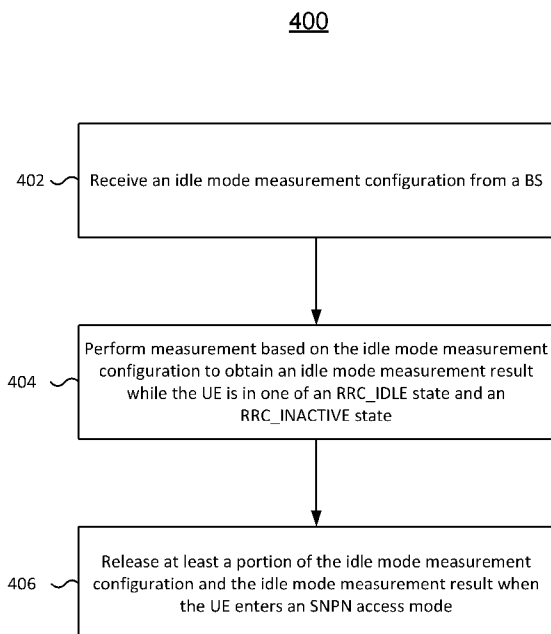


FIG. 4

(57) Abstract: A user equipment (UE) and a method for idle mode measurement are provided. The method includes receiving an idle mode measurement configuration from a base station (BS); performing measurement based on the idle mode measurement configuration to obtain an idle mode measurement result while the UE is in one of a Radio Resource Control (RRC) _IDLE state and an RRC_INACTIVE state; and releasing at least a portion of the idle mode measurement configuration and the idle mode measurement result when the UE enters a Standalone Non-Public Network (SNPN) access mode.

USER EQUIPMENT AND METHOD FOR IDLE MODE MEASUREMENT

FIELD

[0001] The present disclosure is related to wireless communication, and more particularly, to a method for idle mode measurement in cellular wireless communication networks.

BACKGROUND

[0002] The acronyms in the present application are defined as follows and unless otherwise specified, the acronyms have the following meanings:

Abbreviation	Full name
3GPP	3 rd Generation Partnership Project
5G	5 th Generation
5GC	5G Core
ARFCN	Absolute Radio-Frequency Channel Number
AS	Access Stratum
BS	Base Station
BWP	Bandwidth Part
CA	Carrier Aggregation
CAG	Closed Access Group
CN	Core Network
CU	Central Unit
DAPS	Dual Active Protocol Stack
DC	Dual Connectivity
DCI	Downlink Control Information
DL	Downlink
DU	Distributed Unit
E-UTRA(N)	Evolved Universal Terrestrial Radio Access (Network)
EN-DC	E-UTRA NR Dual Connectivity
EPC	Evolved Packet Core
FR	Frequency Range
IAB	Integrated Access and Backhaul
ID	Identifier
IE	Information Element

LAN	Local Area Network
LTE	Long Term Evolution
MAC	Medium Access Control
MAC CE	MAC Control Element
MCG	Master Cell Group
MIB	Master Information Block
MN	Master Node
MSG	Message
MT	Mobile Termination
NAS	Non-Access Stratum
NE-DC	NR - E-UTRA Dual Connectivity
NPN	Non-Public Network
NR	New Radio
NR-U	NR Unlicensed
NW	Network
PCell	Primary Cell
PCI	Physical Cell Identity
PDCCH	Physical Downlink Control Channel
PDSCH	Physical Downlink Shared Channel
PDU	Protocol Data Unit
PHY	Physical (layer)
PLMN	Public Land Mobile Network
PNI-NPN	Public Network Integrated Non-Public Network
PRACH	Physical Random Access Channel
PSCell	Primary SCG Cell / Primary Secondary Cell
PUCCH	Physical Uplink Control Channel
PUSCH	Physical Uplink Shared Channel
RA	Random Access
RAN	Radio Access Network
RAR	Random Access Response
RAT	Radio Access Technology
RF	Radio Frequency
RNTI	Radio Network Temporary Identifier

RRC	Radio Resource Control
RS	Reference Signal
RSRP	Reference Signal Received Power
SCell	Secondary Cell
SCG	Secondary Cell Group
SI	System Information
SIB	System Information Block
SL	Sidelink
SN	Secondary Node
SNPN	Stand-alone Non-Public Network
SSB	Synchronization Signal Block
TS	Technical Specification
UE	User Equipment
UL	Uplink
V2X	Vehicle-to-Everything

[0003] With the tremendous growth in the number of connected devices and the rapid increase in user/network traffic volume, various efforts have been made to improve different aspects of wireless communication for the next-generation wireless communication system, such as the fifth-generation (5G) New Radio (NR), by improving data rate, latency, reliability, and mobility. The 5G NR system is designed to provide flexibility and configurability to optimize the network services and types, accommodating various use cases, such as enhanced Mobile Broadband (eMBB), massive Machine-Type Communication (mMTC), and Ultra-Reliable and Low-Latency Communication (URLLC). However, as the demand for radio access continues to increase, there exists a need for further improvements in the art.

SUMMARY

[0004] The present disclosure is related to a method performed by a UE in cellular wireless communication network for idle mode measurement.

[0005] In a first aspect of the present application, a method for idle mode measurement performed by a UE is provided. The method includes receiving an idle mode measurement configuration from a BS; performing measurement based on the idle mode measurement configuration to obtain an idle mode measurement result while the UE is in one of an RRC_IDLE state and an RRC_INACTIVE state; and releasing at least a portion of the idle

mode measurement configuration and the idle mode measurement result when the UE enters an SNPN access mode.

[0006] In an implementation of the first aspect, the idle mode measurement configuration includes at least one of an NR idle mode measurement configuration and an E-UTRA idle mode measurement configuration; and the idle mode measurement result includes at least one of an NR idle mode measurement result and an E-UTRA idle mode measurement result.

[0007] In another implementation of the first aspect, the released portion of the idle mode measurement configuration and the idle mode measurement result includes at least one of the E-UTRA idle mode measurement configuration and the E-UTRA idle mode measurement result.

[0008] In another implementation of the first aspect, the UE has one of a registered SNPN that does not support E-UTRA and a selected SNPN that does not support E-UTRA.

[0009] Another implementation of the first aspect further comprises ignoring the E-UTRA idle mode measurement configuration upon receiving the idle mode measurement configuration while the UE operates in the SNPN access mode.

[0010] In another implementation of the first aspect, the idle mode measurement configuration is received by the UE via system information or an RRC release message.

[0011] Another implementation of the first aspect further comprises receiving an idle mode measurement request from the BS during a random access procedure; and transmitting the idle mode measurement result to the BS.

[0012] In another implementation of the first aspect, the random access procedure is one of a 2-step random access procedure and a 4-step random access procedure.

[0013] In another implementation of the first aspect, the idle mode measurement request is received via one of an RRC resume message and an RRC setup message; and the idle mode measurement result is transmitted via one of an RRC resume complete message and an RRC setup complete message corresponding to the idle mode measurement request.

[0014] In another implementation of the first aspect, the idle mode measurement request indicates at least one RAT; and the idle mode measurement result transmitted to the BS is response to the at least one RAT indicated in the idle mode measurement request.

[0015] Another implementation of the first aspect further comprises receiving a first indicator via broadcast system information from the BS, the first indicator indicating that the BS supports the UE to report a specific idle mode measurement result associated with at least one specific RAT.

[0016] Another implementation of the first aspect further comprises transmitting a second

indicator to the BS after a random access procedure associated with the BS, the second indicator indicating availability of the specific idle mode measurement result associated with the at least one specific RAT.

[0017] In another implementation of the first aspect, the idle mode measurement configuration configures a validity timer; the idle mode measurement configuration is considered valid when the validity timer is running; and the method further comprises starting the validity timer when the UE configures idle mode measurement based on the received idle mode measurement configuration.

[0018] Another implementation of the first aspect further comprises stopping the validity timer when the UE enters the SNPN access mode.

[0019] In a second aspect, a UE for idle mode measurement is provided. The UE includes one or more processors and at least one memory coupled to at least one of the one or more processors, where the at least one memory stores a computer-executable program that, when executed by the at least one of the one or more processors, causes the UE to receive an idle mode measurement configuration from a BS; perform measurement based on the idle mode measurement configuration to obtain an idle mode measurement result while the UE is in one of an RRC_IDLE state and an RRC_INACTIVE state; and release at least a portion of the idle mode measurement configuration and the idle mode measurement result when the UE enters an SNPN access mode.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Aspects of the present disclosure are best understood from the following detailed description when read with the accompanying drawings. Various features are not drawn to scale. Dimensions of various features may be arbitrarily increased or reduced for clarity of discussion.

[0021] FIG. 1 illustrates a process of idle mode measurement according to an implementation of the present disclosure.

[0022] FIG. 2 illustrates a process of idle mode measurement including a 2-step random access procedure according to an implementation of the present disclosure.

[0023] FIG. 3 illustrates a process of SNPN access mode change according to an example implementation of the present disclosure.

[0024] FIG. 4 illustrates a method performed by a UE for idle mode measurement according to an example implementation of the present disclosure.

[0025] FIG. 5 illustrates a process of idle mode measurement with a request from a BS according to an example implementation of the present disclosure.

[0026] FIG. 6 illustrates a process of idle mode measurement with a UE indicating availability of the idle mode measurement result according to an example implementation of the present disclosure.

[0027] FIG. 7 illustrates a method performed by a UE for idle mode measurement with a validity timer according to an example implementation of the present disclosure.

[0028] FIG. 8 is a block diagram illustrating a node for wireless communication according to an implementation of the present disclosure.

DESCRIPTION

[0029] The following description contains specific information related to implementations of the present disclosure. The drawings and their accompanying detailed description are merely directed to implementations. However, the present disclosure is not limited to these implementations. Other variations and implementations of the present disclosure will be obvious to those skilled in the art.

[0030] Unless noted otherwise, like or corresponding elements among the drawings may be indicated by like or corresponding reference numerals. Moreover, the drawings and illustrations in the present disclosure are generally not to scale and are not intended to correspond to actual relative dimensions.

[0031] For the purpose of consistency and ease of understanding, like features may be identified (although, in some examples, not illustrated) by the same numerals in the drawings. However, the features in different implementations may be differed in other respects and shall not be narrowly confined to what is illustrated in the drawings.

[0032] The phrases “in one implementation,” or “in some implementations,” may each refer to one or more of the same or different implementations. The term “coupled” is defined as connected whether directly or indirectly through intervening components and is not necessarily limited to physical connections. The term “comprising” means “including, but not necessarily limited to” and specifically indicates open-ended inclusion or membership in the so-described combination, group, series or equivalent. The expression “at least one of A, B and C” or “at least one of the following: A, B and C” means “only A, or only B, or only C, or any combination of A, B and C.”

[0033] The terms “system” and “network” may be used interchangeably. The term “and/or” is only an association relationship for describing associated objects and represents that three relationships may exist such that A and/or B may indicate that A exists alone, A and B exist at the same time, or B exists alone. The character “/” generally represents that the associated

objects are in an “or” relationship.

[0034] For the purposes of explanation and non-limitation, specific details such as functional entities, techniques, protocols, and standards are set forth for providing an understanding of the disclosed technology. In other examples, detailed description of well-known methods, technologies, systems, and architectures are omitted so as not to obscure the description with unnecessary details.

[0035] Persons skilled in the art will immediately recognize that any network function(s) or algorithm(s) disclosed may be implemented by hardware, software or a combination of software and hardware. Disclosed functions may correspond to modules which may be software, hardware, firmware, or any combination thereof.

[0036] A software implementation may include computer executable instructions stored on a computer readable medium such as memory or other type of storage devices. One or more microprocessors or general-purpose computers with communication processing capability may be programmed with corresponding executable instructions and perform the disclosed network function(s) or algorithm(s).

[0037] The microprocessors or general-purpose computers may include Applications Specific Integrated Circuitry (ASIC), programmable logic arrays, and/or using one or more Digital Signal Processor (DSPs). Although some of the disclosed implementations are oriented to software installed and executing on computer hardware, alternative implementations implemented as firmware or as hardware or combination of hardware and software are well within the scope of the present disclosure. The computer readable medium includes but is not limited to Random Access Memory (RAM), Read Only Memory (ROM), Erasable Programmable Read-Only Memory (EPROM), Electrically Erasable Programmable Read-Only Memory (EEPROM), flash memory, Compact Disc Read-Only Memory (CD-ROM), magnetic cassettes, magnetic tape, magnetic disk storage, or any other equivalent medium capable of storing computer-readable instructions.

[0038] A radio communication network architecture such as a Long Term Evolution (LTE) system, an LTE-Advanced (LTE-A) system, an LTE-Advanced Pro system, or a 5G NR Radio Access Network (RAN) typically includes at least one BS, at least one UE, and one or more optional network elements that provide connection within a network. The UE communicates with the network such as a Core Network (CN), an Evolved Packet Core (EPC) network, an Evolved Universal Terrestrial RAN (E-UTRA), a 5G Core (5GC), or an internet via a RAN established by one or more BSs.

[0039] A UE may include but is not limited to a mobile station, a mobile terminal or device,

or a user communication radio terminal. The UE may be portable radio equipment that includes but is not limited to a mobile phone, a tablet, a wearable device, a sensor, a vehicle, or a Personal Digital Assistant (PDA) with wireless communication capability. The UE is configured to receive and transmit signals over an air interface to one or more cells in a RAN.

[0040] A BS may be configured to provide communication services according to at least a Radio Access Technology (RAT) such as Worldwide Interoperability for Microwave Access (WiMAX), Global System for Mobile communications (GSM) that is often referred to as 2G, GSM Enhanced Data rates for GSM Evolution (EDGE) RAN (GERAN), General Packet Radio Service (GPRS), Universal Mobile Telecommunication System (UMTS) that is often referred to as 3G based on basic wideband-code division multiple access (W-CDMA), high-speed packet access (HSPA), LTE, LTE-A, evolved LTE (eLTE) that is LTE connected to 5GC, NR (often referred to as 5G), and/or LTE-A Pro. However, the scope of the present disclosure is not limited to these protocols.

[0041] A BS may include but is not limited to a node B (NB) in the UMTS, an evolved node B (eNB) in LTE or LTE-A, a radio network controller (RNC) in UMTS, a BS controller (BSC) in the GSM/GERAN, a ng-eNB in an E-UTRA BS in connection with 5GC, a next generation Node B (gNB) in the 5G-RAN, or any other apparatus capable of controlling radio communication and managing radio resources within a cell. The BS may serve one or more UEs via one or more radio interface.

[0042] The BS is operable to provide radio coverage to a specific geographical area using a plurality of cells forming the RAN. The BS supports the operations of the cells. Each cell is operable to provide services to at least one UE within its radio coverage.

[0043] Each cell (often referred to as a serving cell) provides services to serve one or more UEs within its radio coverage such that each cell schedules the downlink (DL) and optionally uplink (UL) resources to at least one UE within its radio coverage for DL and optionally UL packet transmissions. The BS can communicate with one or more UEs in the radio communication system via the plurality of cells.

[0044] A cell may allocate sidelink (SL) resources for supporting Proximity Service (ProSe) (e.g., (ProSe) direct communication services and (ProSe) direct discovery services) or V2X services (e.g., E-UTRA V2X sidelink communication services) or sidelink service (e.g., NR sidelink communication services). Each cell may have overlapped coverage areas with other cells.

[0045] As discussed previously, the frame structure for NR supports flexible configurations for accommodating various next generation (e.g., 5G) communication

requirements such as Enhanced Mobile Broadband (eMBB), Massive Machine Type Communication (mMTC), and Ultra-Reliable and Low-Latency Communication (URLLC), while fulfilling high reliability, high data rate and low latency requirements. The Orthogonal Frequency-Division Multiplexing (OFDM) technology in the 3rd Generation Partnership Project (3GPP) may serve as a baseline for an NR waveform. The scalable OFDM numerology such as adaptive sub-carrier spacing, channel bandwidth, and Cyclic Prefix (CP) may also be used.

[0046] Two coding schemes are considered for NR, specifically Low-Density Parity-Check (LDPC) code and Polar Code. The coding scheme adaption may be configured based on channel conditions and/or service applications.

[0047] At least DL transmission data, a guard period, and UL transmission data should be included in a transmission time interval (TTI) of a single NR frame. The respective portions of the DL transmission data, the guard period, and the UL transmission data should also be configurable based on, for example, the network dynamics of NR. Sidelink resources may also be provided in an NR frame to support ProSe services, V2X services (e.g., E-UTRA V2X sidelink communication services) or sidelink services (e.g., NR sidelink communication services). In contrast, sidelink resources may also be provided in an E-UTRA frame to support ProSe services, V2X services (e.g., E-UTRA V2X sidelink communication services) or sidelink services (e.g., NR sidelink communication services).

[0048] Mechanisms to support idle mode measurement (which may be also referred to as early measurement) while the public network (e.g., PLMN) and/or private network (e.g., SNPN or PNI-NPN) are disclosed in the present disclosure. The cross networks scenario, which includes one (or more than one) PLMN and/or one (or more than one) private network, are disclosed in the present disclosure. The disclosed implementations may include some implementations while only one Public network or only one private network is considered. The disclosed implementations include both the E-UTRA and NR protocols. However, the usage of the disclosed implementations is not limited to E-UTRA or NR protocols. The idle mode measurement may cover UE configurations/measurements/reports while the UE is staying in the (LTE/NR) RRC inactive state or the (LTE/NR) RRC idle state.

[0049] Private Network

[0050] The private network (e.g., NPN) may support vertical and LAN services. The private network may be classified into SNPN and PNI-NPN. Operators may focus on the PNI-NPN solutions applicable for a much wider range of use cases, such as Small Office Home Office (SOHO) and residential, private network coverage deployments and so on.

[0051] 5G system will be enhanced to support NPN. Two network identities are introduced for NPN: Non-public network ID (NID) and Closed Access Group (CAG) ID. 5G RAN may also implement NPN by enhancing features such as non-public network identification, discovery, selection/reselection, access control and mobility restrictions.

[0052] When Non-Public Network is introduced, a UE can be classified into “a UE in SNPN access mode” and “a UE in non-SNPN access mode (e.g., a UE not in SNPN access mode)”. A cell may be classified into “SNPN cell”, “CAG cell”, “PLMN cell”, “a cell supporting at least SNPN deployments”, “a cell supporting at least PNI-NPN deployments”, “a cell supporting at least PLMN deployments”, “a cell supporting at least SNPN and PNI-NPN deployments”, “a cell supporting at least SNPN and PLMN deployments”, “a cell supporting at least PNI-NPN and PLMN deployments”, and “a cell supporting SNPN, PNI-NPN and PLMN deployments”, etc.

[0053] An NPN-capable UE may (re)select a CAG cell based on automatic CAG selection mode, manual CAG selection mode, and network-controlled manual CAG selection. The network-controlled manual CAG selection (e.g., PLMN-controlled manual CAG selection) comes from the requirement: the 5G system may support a mechanism for a PLMN to control whether a user of a UE can manually select a non-public network hosted by the PLMN that the UE is not authorized to select automatically.

[0054] Examples of some selected terms are provided as follows.

[0055] Network (NW), Radio Access Network (RAN), cell, camped cell, serving cell, base station, gNB, eNB and ng-eNB may be used interchangeably in the present disclosure. In some implementations, some of these terms may refer to the same network entity.

[0056] Serving Cell: For a UE in RRC_CONNECTED not configured with CA/DC there is only one serving cell comprising of the primary cell. For a UE in RRC_CONNECTED configured with CA/DC the term ‘serving cells’ is used to denote the set of cells comprising of the Special Cell(s) and all secondary cells.

[0057] Special Cell: For Dual Connectivity operation the term Special Cell refers to the PCell of the MCG or the PSCell of the SCG, otherwise the term Special Cell refers to the PCell.

[0058] The disclosed implementations may be applied to any RAT. The RAT may be (but not limited to) NR, NR-U, LTE, E-UTRA connected to 5GC, LTE connected to 5GC, E-UTRA connected to EPC, and LTE connected to EPC. The disclosed implementations may be applied to UEs in public networks, or in private network (e.g., NPN such as SNPN and PNI-NPN).

[0059] The disclosed implementations may be used for licensed frequency and/or unlicensed frequency.

[0060] System information (SI) may refer to MIB, SIB1, and other SI. Minimum SI may include MIB and SIB1. Other SI may refer to SIB3, SIB4, SIB5, and other SIB(s) (e.g., SNPN-specific SIB, PNI-NPN-specific SIB).

[0061] Dedicated signaling may refer to (but not limited to) RRC message(s). For example, RRC (Connection) Setup Request message, RRC (Connection) Setup message, RRC (Connection) Setup Complete message, RRC (Connection) Reconfiguration message, RRC Connection Reconfiguration message including the mobility control information, RRC Connection Reconfiguration message without the mobility control information inside, RRC Reconfiguration message including the configuration with sync, RRC Reconfiguration message without the configuration with sync inside, RRC (Connection) Reconfiguration complete message, RRC (Connection) Resume Request message, RRC (Connection) Resume message, RRC (Connection) Resume Complete message, RRC (Connection) Reestablishment Request message, RRC (Connection) Reestablishment message, RRC (Connection) Reestablishment Complete message, RRC (Connection) Reject message, RRC (Connection) Release message, RRC System Information Request message, UE Assistance Information message, UE Capability Enquiry message, and UE Capability Information message. RRC message may be one type of dedicated signaling. The UE may receive the RRC message from the network via unicast/broadcast/groupacast.

[0062] The RRC_CONNECTED UE, RRC_INACTIVE UE, and RRC_IDLE UE may apply the disclosed implementations.

[0063] An RRC_CONNECTED UE may be configured with an active BWP with common search space configured to monitor system information or paging.

[0064] The disclosed implementations may be applied to the PCell and the UE. In some implementations, the disclosed implementations may be applied to the PSCell and the UE. The disclosed short message and/or paging DCI may be transmitted by the PSCell (or secondary node) to the UE. The UE may monitor the PDCCH monitoring occasions for paging configured by the PSCell (or secondary node).

[0065] Allowed CAG list: a per-PLMN list of CAG Identifiers the UE is allowed to access.

[0066] CAG cell: A cell broadcasting at least one CAG Identifier.

[0067] CAG Member Cell: for a UE, a cell broadcasting the identity of the selected PLMN, registered PLMN or equivalent PLMN, and for that PLMN, a CAG identifier belonging to the Allowed CAG list of the UE for that PLMN.

[0068] CAG Identifier: CAG Identifier identifies a CAG within a PLMN.

[0069] Network Identifier: Network Identifier identifies an SNPN in combination with a

PLMN ID.

[0070] Non-Public Network: A network deployed for non-public use.

[0071] NPN-only Cell: A cell that is only available for normal service for NPNs' subscriber. An NPN-capable UE determines that a cell is NPN-only Cell by detecting that the *cellReservedForOtherUse* IE is set to true while the *npn-IdentityInfoList* IE is present in *CellAccessRelatedInfo* IE.

[0072] PNI-NPN identity: an identifier of a PNI-NPN comprising of a PLMN ID and a CAG -ID combination.

[0073] Registered SNPN: This is the SNPN on which certain Location Registration outcomes have occurred.

[0074] Selected SNPN: This is the SNPN that has been selected by the NAS (e.g., the NAS of the UE, the NAS of the CN), either manually or automatically.

[0075] SNPN Access Mode: mode of operation in which the UE only selects SNPNs.

[0076] SNPN identity: an identifier of an SNPN comprising of a PLMN ID and an NID combination.

[0077] SNPN-only cell: a cell that is only available for normal service for SNPN subscribers.

[0078] An NPN-capable UE may correspond to a UE supporting CAG (or NPN).

[0079] Child node: IAB-node-DU's next hop neighbour node; the child node is also an IAB-node.

[0080] Parent node: IAB-node-MT's next hop neighbour node; the parent node can be IAB-node or IAB-donor-DU.

[0081] Downstream: Direction toward child node or UE in IAB-topology.

[0082] Upstream: Direction toward parent node in IAB-topology.

[0083] IAB-donor: gNB that provides network access to UEs via a network of backhaul and access links.

[0084] IAB-DU: gNB-DU functionality supported by the IAB-node to terminate the NR access interface to UEs and next-hop IAB-nodes, and to terminate the F1 protocol to the gNB-CU functionality, as defined in 3GPP TS 38.401, on the IAB-donor.

[0085] IAB-MT: IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise. IAB-MT function used in 38series of 3GPP Specifications corresponds to IAB-UE function defined in 3GPP TS 23.501.

[0086] IAB-node: RAN node that supports NR access links to UEs and NR backhaul links

to parent nodes and child nodes. The IAB-node may or may not support backhauling via LTE.

[0087] Multi-hop backhauling: Using a chain of NR (and/or LTE) backhaul links between an IAB-node and an IAB-donor-gNB.

[0088] NR backhaul link: NR link used for backhauling between an IAB-node and an IAB-donor-gNB, and between IAB-nodes in case of a multi-hop backhauling.

[0089] LTE backhaul link: LTE link used for backhauling between an IAB-node and an IAB-donor-gNB, and between IAB-nodes in case of a multi-hop backhauling.

[0090] Multi-Radio Dual Connectivity (MR-DC): Dual Connectivity between E-UTRA and NR nodes, or between two NR nodes. MR-DC may include E-UTRA-NR Dual Connectivity (EN-DC), NR-E-UTRA Dual Connectivity (NE-DC), NG-RAN E-UTRA-NR Dual Connectivity (NGEN-DC), and NR-NR Dual Connectivity (NR-DC).

[0091] Master Cell Group: in MR-DC, a group of serving cells associated with the Master Node, comprising of the SpCell (PCell) and optionally one or more SCells.

[0092] Master node: in MR-DC, the radio access node that provides the control plane connection to the core network. It may be a Master eNB (in EN-DC), a Master ng-eNB (in NGEN-DC) or a Master gNB (in NR-DC and NE-DC).

[0093] Secondary Cell Group: in MR-DC, a group of serving cells associated with the Secondary Node, comprising of the SpCell (PSCell) and optionally one or more SCells.

[0094] Secondary node: in MR-DC, the radio access node, with no control plane connection to the core network, providing additional resources to the UE. It may be an en-gNB (in EN-DC), a Secondary ng-eNB (in NE-DC) or a Secondary gNB (in NR-DC and NGEN-DC).

[0095] MeNB: Master eNB, an eNB as a master node associated with an MCG (Master Cell Group) in MR-DC scenarios.

[0096] SgNB: Secondary gNB, a gNB as a secondary node associated with an SCG (Secondary Cell Group) in MR-DC scenarios.

[0097] A first indication may be associated with NR, LTE connected to EPC, and/or LTE connected to 5GC. A second indication may be associated with NR, LTE connected to EPC, and/or LTE connected to 5GC. The first indication and the second indication may be associated with the same RAT (e.g., NR, LTE connected to EPC, LTE connected to 5GC) or different RATs. The UE supporting one RAT (e.g., IAB functionality via NR and/or NPN functionality via NR, if the one RAT is NR) may apply the first indication associated with NR and/or the second indication associated with NR. The UE supporting the one RAT may apply (or ignore) the first indication not associated with NR and/or the second indication not associated with NR.

[0098] In some implementations, if the UE considers itself barred by a cell or if the UE bars a cell, the UE may bar the cell for a period of time (e.g., 300s). The UE may not consider the cell as a candidate cell for cell (re)selectin for a period of time (e.g., 300s).

[0099] In some implementations, if the UE changes from the SNPN access mode to the PLMN access mode, (the NAS entity of) the UE may release (or delete or discard) the (stored or maintained) list of SNPN ID(s) if any.

[00100] In some implementations, if the UE changes from the PLMN access mode to the SNPN access mode, (the NAS entity of) the UE may release (or delete or discard) the (stored or maintained) list of PLMN ID(s) if any.

[00101] Downlink Control Information (DCI): DCI may refer to a PDCCH resource with Cyclic Redundancy Check (CRC) scrambled by an Radio Network Temporary Identifier (RNTI). The RNTI may relate to IAB. Implementations regarding DCI may be applied for a physical signal.

[00102] Medium Access Control Control Element (MAC CE): A MAC CE is a bit string that is byte aligned (e.g., multiple of 8 bits) in length.

[00103] In some implementations, if the UE with IAB functionality determines itself to be an IAB node or operate as an IAB node, and/or if the UE performs the design for IAB, and/or if the UE operates the IAB functions, the UE may transmit an indication to inform the network via dedicated signaling.

[00104] DAPS bearer: a bearer whose radio protocols are located in both the source gNB and the target gNB during DAPS handover to use both source gNB and target gNB resources.

[00105] Idle Mode Measurement Configuration & Reporting procedure

[00106] Idle mode measurement configuration (e.g., idleModeMeasurement configuration) is supported in 3GPP E-UTRA protocols (e.g., as shown in 3GPP TS 36.331) and New Radio (NR) protocols (e.g., 3GPP TS 38.331). A UE may receive idleModeMeasurement configuration from the serving cell via broadcast system information (e.g., idleModeMeasurement configuration may be transmitted in the SIB1 and the following SIB11) or via UE-specific dedicated control signaling (e.g., idleModeMeasurement configuration may be included in the RRC Release message while the UE is instructed by the serving RAN to move to RRC idle state or RRC inactive state). After receiving the idleModeMeasurement configuration, the UE may implement measurement while the UE is staying in (E-UTRA/NR) RRC inactive state or (E-UTRA/NR) RRC idle state. Different idleModeMeasurement configurations associated with different RATs (e.g., E-UTRA and NR) may be configured independently. For example, one E-UTRA-idleModeMeasurement configuration and one NR-

idleModeMeasurement configuration may be transmitted independently by the serving cell (e.g., E-UTRA cell or NR cell) to instruct the UE to implement idleModeMeasurement for E-UTRA/NR. The UE may implement NR-idleModeMeasurement and/or E-UTRA-idleModeMeasurement accordingly based on received configuration and also the UE's capability.

[00107] The UE may transmit idleModeMeasurement report to the serving cell (or report to the serving cell that 'idleModeMeasurement report' (or idleModeMeasurement results) is available at the UE side) while the UE is establishing (or resuming) its RRC connection with the serving RAN.

[00108] FIG. 1 illustrates a process 100 of idle mode measurement according to an implementation of the present disclosure. In action 112, the UE 102 may receive an idle mode measurement configuration from the NW 104 (e.g., a first BS) via broadcast system information or dedicated signaling (e.g., an RRC release message). In action 114, the UE 102 may perform measurement based on the idle mode measurement configuration received in action 112. In some implementations, the UE 102 performs the measurement in action 114 while the UE 102 is in the RRC_IDLE state or the RRC_INACTIVE state. In some implementations, the UE 102 performs the measurement in action 114 to obtain an idle mode measurement result. For example, the UE 102 may initiate a random access procedure with a second BS based on the idle mode measurement result or other measurement results observed by the UE. It should be noted that a first BS from which the UE 102 receives the idle mode measurement configuration in action 112 may be different from a second BS with which the UE 102 performs the random access procedure. For example, the first BS and the second BS may operate in different frequencies. The first BS and the second BS may correspond to different RATs (e.g., E-UTRA/NR) in some implementations and the first BS and the second BS may correspond to the same RAT (e.g., E-UTRA/NR) in some other implementations. The first BS and the second BS are represented as the NW 104 in FIG. 1. Therefore, in some implementations, the UE 102 may stay in the same RAT (e.g., E-UTRA/NR) with different RRC states (e.g., (E-UTRA/NR) RRC Connected state (e.g., action 112)/RRC Inactive state (e.g., action 114)/RRC Idle state (e.g., action 116)) during the process 100. In some other implementations, the UE may move from one RAT to another RAT (e.g., from NR to E-UTRA) and so the UE may stay in (NR) RRC Connected state (e.g., action 112)/(NR) RRC Inactive state (e.g., action 114) and (E-UTRA) RRC Idle state (e.g., action 116) during the process 100. In some implementations, the first BS and the second BS may belong to the same mobile communication network (e.g., the same PLMN/SNPN). In some other implementations, the

first BS and the second BS may belong to different mobile communication networks (e.g., the first BS belongs to a PLMN #1 and the second BS belongs to an SNPN #1 and in this scenario, both the PLMN #1 and the SNPN #1 may be considered as part of the NW 104). In some implementations, the first BS and the second BS may be the same BS.

[00109] In action 116, the UE 102 may transmit a selected preamble (msg1) at the beginning of the random access procedure to the NW 104 (e.g., with the second BS). In action 118, the NW 104 may transmit a Random Access Response (RAR) message (msg2), which may include timing advance command, UL grant, and a (temporary) UE-ID (e.g., (temporary) C-RNTI) for the UE 102 to transmit the following RRC-Request message (msg3) in the UL direction. In action 120, the UE 102 may transmit an RRC (Connection) Resume Request message (e.g., if the UE 102 is in (LTE/NR) RRC inactive state and the UE 102 is requesting to resume its RRC connection with the serving RAN) or an RRC (connection) Setup Request message (e.g., if the UE 102 is in (LTE/NR) RRC idle state and the UE 102 is requesting to build its RRC connection with the serving RAN) to its serving cell.

[00110] In action 122, the NW 104 may transmit an RRC Response message to the UE 102. The RRC response message may be an RRC (connection) Resume message or an RRC (connection) Setup message. In some implementations, the NW 104 may transmit an idle mode measurement request to the UE 102 via the RRC Response message. For example, an '*idleModeMeasurementReq*' IE may be included in the RRC (connection) Resume message or the RRC (connection) Setup message. In some implementations, the NW 104 may further indicate the RAT(s) associated with the idle mode measurement request. For example, the NW 104 may configure '*idleModeMeasurementReq*'={NR}, '*idleModeMeasurementReq*'={E-UTRA}, or '*idleModeMeasurementReq*'={NR & E-UTRA} in the RRC Response message (e.g., RRC Resume message or RRC Setup message). In some implementations, the NW 104 may just request the UE 102 to report an idle mode measurement report (e.g., by setting an IE '*idleModeMeasurement report=true*' via DL control signaling (e.g., broadcast system information or UE-specific RRC signaling). In other words, the NW 104 may not explicitly indicate the target RAT for report. Then the UE 102 may transmit the idle mode measurement report to the NW 104 based on the stored idle mode measurement result directly (e.g., no matter which RATs), which may cover E-UTRA and/or NR.

[00111] After receiving the RRC-Response message (msg4) in action 122, the UE 102 may prepare to reply with an RRC-Complete message (msg5) to the NW 104 in action 124. The UE 102 may transmit an RRCResumeComplete message as the msg5 to the NW 104 if the UE receives the RRCResume message in the msg4. The UE 102 may transmit an

RRCSetupComplete message as the msg5 to the NW 104 if the UE 102 receives the RRCSetup message in the msg4. In some implementations, the UE 102 may transmit the idle mode measurement result to the NW 104 in the msg5 in action 124. The idle mode measurement result may be in response to the RAT(s) indicated in the idle mode measurement request. The UE 102 may include E-UTRA-idleModeMeasurement report and/or NR-idleModeMeasurement report in the msg5. For example, the UE 102 may transmit the NR-idleModeMeasurement report in the msg5 if the UE 102 receives '*idleModeMeasurementReq*'=*{NR}*. The UE 102 may transmit the E-UTRA-idleModeMeasurement report in the msg5 if the UE 102 receives '*idleModeMeasurementReq*'=*{E-UTRA}*. The UE 102 may transmit both the E-UTRA-idleModeMeasurement report and the NR-idleModeMeasurement report in the msg5 if the UE receives '*idleModeMeasurementReq*'=*{NR & E-UTRA}*.

[00112] In some implementations, the NW 104 (or the serving cell) does not request idleModeMeasurement report in the msg4 delivery. The UE 102 may transmit an IE to the NW 104 to indicate the availability of the idle mode measurement result. For example, the IE transmitted by the UE may be '*idleMeasAvailable*'=*{true}*' or '*idleMeasAvailableNR*'=*{true}*' or '*idleMeasAvailableEUTRA*'=*{true}*' (or '*idleMeasAvailable*'=*{NR}*', '*idleMeasAvailable*'=*{E-UTRA}*', '*idleMeasAvailable*'=*{NR & E-UTRA}*'). The NW 104 may request the idleModeMeasurement report from the UE 102 (which has available idleModeMeasurement results) later.

[00113] In some implementations, the idle mode measurement reporting procedure may be applicable to not only the 4-step random access procedure (as illustrated in FIG. 1) but also the 2-step random access procedure. FIG. 2 illustrates a process 200 of idle mode measurement including a 2-step random access procedure according to an implementation of the present disclosure. Action 212 and action 214 illustrated in FIG. 2 may correspond to action 112 and action 114 illustrated in FIG. 1, respectively. In some implementations, in process 200, the UE may receive the idle Mode Measurement Configuration (e.g., action 212) from a first BS and then the UE may initiate the 2-step RA procedure (e.g., action 216) with a second BS. The first BS and the second BS may correspond to different RATs (e.g., E-UTRA/NR) in some implementations and the first BS and the second BS may correspond to the same RAT (e.g., E-UTRA/NR) in some other implementations. The first BS and the second BS are represented as the NW 204 in FIG. 2. Therefore, in some implementations, the UE may stay in the same RAT (e.g., E-UTRA/NR) with different RRC states (e.g., (E-UTRA/NR) RRC Connected state (e.g., action 212)/RRC Inactive state (e.g., action 214)/RRC Idle state (e.g., action 216)) during the process 200. In some other implementations, the UE may move from one RAT to another RAT

(e.g., from NR to E-UTRA) and so the UE may stay in (NR) RRC Connected state (e.g., action 212)/(NR) RRC Inactive state (e.g., action 214) and (E-UTRA) RRC Idle state (e.g., action 216) during the process 200. In some implementations, the first BS and the second BS may belong to the same mobile communication network (e.g., the same PLMN/SNPN). In some other implementations, the first BS and the second BS may belong to different mobile communication networks (e.g., the first BS belongs to a PLMN #2 and the second BS belongs to an SNPN #2 and in this scenario, both the PLMN #2 and the SNPN #2 may be considered as part of the NW 204). In some implementations, the first BS and the second BS may be the same BS.

[00114] In the 2-step random access procedure, in action 216, the UE 202 may transmit a preamble (e.g., on a PRACH resource) and an RRC-Request message (e.g., on a PUSCH resource) to the NW 204 (or the serving cell) via msgA transmission. In action 218, the NW 204 (or the serving cell) may transmit an RAR and an RRC-Response message to the UE 202 via msgB transmission. In some implementations, the NW 204 may transmit an idle mode measurement request (e.g., *'idleModeMeasurementReq'*) to the UE 202 via the msgB. In action 220, the UE 202 may transmit the requested idleModeMeasurement report in an RRC-Complete message based on the serving cell's request. In some implementations, the UE 202 may also indicate *'idleMeasAvailable'* in the RRC-Complete message after the 2-step RA procedure. The NW 204 may request the idleModeMeasurement Report from the UE 202 after the 2-step RA procedure.

[00115] In some implementations, the idleModeMeasurement configuration may include one (or more than one) target cell associated with one provided frequency carrier for the UE to measure. Each given target cell may be associated with one cell-ID for UE to identify and record each cell. In some implementations, the cell-ID may be the physical cell identity (PCI), which is broadcast by the cell in the Synchronization burst set (SSB-set) or primary synchronization signal (PSS)/Secondary synchronization signal (SSS). In some implementations, the cell-ID may be the cellidentity, which is broadcast by the cell in the broadcast system information (e.g., SIB1). To each target frequency carrier, the UE may monitor and record the cell quality of the observed target cell. For example, the UE may record the downlink RSRP, downlink Reference Signal Received Quality (RSRQ), downlink Received Signal Strength Indication (RSSI), or downlink Signal to Interference plus Noise Ratio (SINR) which the UE receives from the observed cell, which may be Layer-1 measurement results and/or Layer-3 measurement results of the observed cell. The UE may not be limited to only record the target cells indicated by the serving RAN. For example, the UE may also record

some of the most strongest cells (based on the DL-RSRP/DL-RSRQ/DL-RSSI/DL-SINR) that the UE observes on one indicated frequency carrier during its measurement periods. In some implementations, the UE may record as many as eight strongest cells in each indicated frequency carrier. The observations (e.g., cell qualities of the observed cells) may be stored in the UE as idleModeMeasurement results.

[00116] The disclosed implementations may be applied to measuring NR frequency carrier (e.g., NR-idleModeMeasurement) and/or E-UTRA frequency carrier (e.g., E-UTRA-idleModeMeasurement). Each NR frequency may be presented by NR-ARFCN. Each E-UTRA frequency may be presented by E-UTRA-ARFCN. In addition, in the idleModeMeasurement results, the UE may further indicate idleModeMeasurement results for different RATs, such as NR-idleModeMeasurement results and E-UTRA-idleModeMeasurement results.

[00117] Impacts of SNPN Access Mode/Non-SNPN Access Mode Switch & PLMNs

[00118] In Release-16, a UE that is enabled to access SNPN (e.g., a UE is SNPN enabled) may be configured to operate in an SNPN access mode (e.g., to activate/move to/switch to the SNPN access mode) or not to operate in the SNPN access mode (e.g., to deactivate/leave the SNPN access mode). For a UE operating in the SNPN access mode, the UE may perform SNPN selection (and the following cell selection/reselection procedures based on the selected/registered SNPN) to camp on a (suitable/acceptable) cell (e.g., as specified in TS 38.304). For a UE that is not operating in the SNPN access mode, the UE may perform PLMN selection (and the following cell selection/reselection procedures based on the selected/registered PLMN) to camp on a (suitable/acceptable) cell. From Access Stratum's point of view, Non-Access Stratum may switch the SNPN access mode (e.g., activate/deactivate the SNPN access mode) and forward this decision (e.g., from the NAS layer) to the AS layer in the UE. Then the AS layer in the UE may be triggered to implement SNPN selection (e.g., when the NAS layer activates the deactivated SNPN access mode) or implement PLMN selection (e.g., when the NAS layer deactivates the activated SNPN access mode).

[00119] FIG. 3 illustrates a process 300 of SNPN access mode change according to an example implementation of the present disclosure. In action 302, the UE may perform an SNPN access mode change, which may be instructed by the NAS of the UE. In action 304, the UE may determine whether the SNPN access mode is activated or deactivated, which may be indicated by the NAS of the UE. If the SNPN access mode is activated, the UE may perform SNPN selection in action 306. In some implementations, only an SNPN may be selected by the UE (at once) in action 306. If the SNPN access mode is deactivated, the UE may perform PLMN selection in action 308. In some implementations, only a PLMN may be selected by the

UE (at once) in action 308.

[00120] In some implementations, the UE (e.g., the NAS layer at the UE side) may send a request to indicate its preferred access mode (e.g., whether the UE prefers the SNPN Access Mode to be activated or deactivated) to the network (e.g., the NAS layer at the CN side).

[00121] In some implementations, the idleModeMeasurement configuration may be configured to be associated with specific PLMN(s). Table 1 illustrates an NR-idleModeMeasurement configuration according to an example implementation of the present disclosure. The UE may be configured with the NR-idleModeMeasurement configuration illustrated in Table 1, which includes one or more than one target NR frequency (represented by NR-ARFCN) for the UE to monitor. Moreover, the associated PLMN(s) deployed on these given NR frequency carrier may also be provided in the NR-idleModeMeasurement configuration (represented by PLMN identity, such as PLMN_ID #1 - PLMN_ID #2 in table 1). So, it shows two possible questions to the idleModeMeasurement:

[00122] Table 1

NR frequency ID (e.g., NR-ARFCN)	Associated NW
Freq. #1	PLMN_ID #1,
Freq. #2	PLMN_ID #1, PLMN_ID #2
Freq. #3	N.A.

[00123] In some implementations, (all or part of) the stored idleModeMeasurement configuration may not be valid if the UE switches from the non-SNPN access mode (e.g., the PLMN access mode) to the SNPN access mode (and vice versa). In some other implementations, (all or part of) the stored idleModeMeasurement configuration may be still valid if the UE switches from the non-SNPN access mode (e.g., the PLMN access mode) to the SNPN access mode (and vice versa).

[00124] In some implementations, none of the indicated PLMN(s) in the idleModeMeasurement configuration is the selected PLMN, registered PLMN, or interested PLMN to the UE. Therefore, the UE may not access these NR frequency carriers at all and the idleModeMeasurement configuration may be useless to the UE. In some implementations, the UE may change its registered PLMN/selected PLMN/interested PLMN according to the instructions of the upper layers (e.g., NAS layer). Therefore, a valid idleModeMeasurement configuration may become invalid after an instruction is delivered from the upper layers (e.g., the NAS layer) to the AS layers. Implementations are provided to solve the problems raised

above.

[00125] Impact of SNPN and SNPN Access Mode

[00126] In some implementations, the idleModeMeasurement configuration may be only associated with (one or more than one) PLMN(s), which may or may not be supported by the UE. Moreover, the idleModeMeasurement configuration may not be associated with NPN (e.g., SNPN, PNI-NPN, or CAG). In some implementations, the UE may remove/release/discard the stored idleModeMeasurement configuration (if there is any) when the UE switches (from the non-SNPN access mode) to the SNPN access mode. For example, the NAS layer may instruct the AS layer of the UE to enter/move to/switch to the SNPN access mode. The UE in the SNPN access mode may attempt to select a target SNPN, rather than a PLMN, during the network selection and the following cell (re)selection procedure.

[00127] In some implementations, the idleModeMeasurement configuration is only associated with supported PLMN(s). In other words, the idleModeMeasurement configuration may not be associated with SNPN and CAG (or PNI-NPN).

[00128] - Moreover, the UE may switch its access mode (e.g., SNPN access mode/Non-SNPN access mode) when the UE is already configured with one or more than one idle mode measurement configuration(s).

[00129] • The stored idleModeMeasurement configuration may be released/suspended when the UE switches (from the Non-SNPN access mode or the PLMN access mode) to the SNPN access mode (e.g., based on the instructions from the upper layers or by manual operation of user).

[00130] • The stored idleModeMeasurement configurations may include the measurement configuration associated with NR (e.g., NR-idleModeMeasurement configuration) and/or the measurement configuration associated with E-UTRA (e.g., E-UTRA-idleModeMeasurement configuration).

[00131] • In some implementations, the idle mode measurement result includes an NR idle mode measurement result and/or an E-UTRA idle mode measurement result. The UE may obtain the NR-idleModeMeasurement result based on the received NR-idleModeMeasurement configuration and/or the E-UTRA-idleModeMeasurement configuration. (All or part of) the NR-idleModeMeasurement result stored at the UE side may be released (or removed/cleared/discarded) when the UE switches (from the Non-SNPN access mode or the PLMN access mode) to the SNPN access mode. In some implementations, (All or part of) the stored NR-idleModeMeasurement results may not be released if the UE moves from the Non-SNPN access mode to the SNPN access mode.

[00132] • In some implementations, when the UE operates in the SNPN access mode, the UE may ignore (all or part of) the idleModeMeasurement configuration, which may be transmitted in the broadcast system information (if the idleModeMeasurement configuration is provided in the SIB1 of the camped cell (to the UE)).

[00133] - The same concept may also be applied to E-UTRA-idleModeMeasurement configuration.

[00134] • (All or part of) the stored E-UTRA-idleModeMeasurement configuration may be released/suspended when the UE switches (from the Non-SNPN access mode or the PLMN access mode) to the SNPN access mode.

[00135] • In some implementations, the idle mode measurement result includes an NR idle mode measurement result and/or an E-UTRA idle mode measurement result. The UE may obtain the E-UTRA-idleModeMeasurement result based on the configured (stored) E-UTRA-idleModeMeasurement configuration. (All or part of) the stored E-UTRA-idleModeMeasurement result may be released when the UE switches (from the Non-SNPN access mode or the PLMN access mode) to the SNPN access mode. In some implementations, (all or part of) the stored E-UTRA-idleModeMeasurement results may not be released when the UE moves from the Non-SNPN access mode to the SNPN access mode.

[00136] - In some implementations, a validity timer (e.g., T331 or another validity different from the T331) may be configured in the (NR/E-UTRA) idleModeMeasurement configuration (respectively).

[00137] • For example, the serving cell (e.g., the first BS in the process 100/process 200) may configure the initial value of the validity timer and the NR-idleModeMeasurement configuration jointly in the (LTE/NR) RRC Release message when the serving cell instructs the UE to move to the (LTE/NR) RRC inactive/idle state.

[00138] • The UE may start the validity timer (e.g., counting from the initial value to zero) after the UE moves to the (LTE/NR) RRC inactive/idle state. The UE may start to perform idle mode measurement based on the received NR-idleModeMeasurement configuration. In some implementations, the UE may start the validity timer when the UE starts the idle mode measurement based on the received idleModeMeasurement configuration (There may be no RRC state changes in this condition). In some implementations, the UE may start the validity timer when the UE configures the idle mode measurement based on the received NR-idleModeMeasurement configuration.

[00139] • The NR-idleModeMeasurement configuration may be considered valid when the validity timer is running. When the validity timer expires, the UE may release the stored

NR-idleModeMeasurement configuration. The stored NR-idleModeMeasurement results may or may not be released upon expiry of the validity timer.

[00140] • Implementations regarding the validity timer may also be applicable to the E-UTRA-idleModeMeasurement configuration and the E-UTRA-idleModeMeasurement results.

[00141] - In some implementations, the validity timer (which may be associated with the E-UTRA-idleModeMeasurement configuration and/or the NR-idleModeMeasurement configuration) may be stopped (or released) when the UE enters/moves to/switches to the SNPN access mode. The stored idle mode measurement configuration (which may be also referred to as early measurement configuration) may also be released/removed/suspended/discarded. In some implementations, the validity timer may be stopped (or released) when the UE switched from the SNPN access mode to the non-SNPN access mode (e.g., if an idleModeMeasurement configuration and the associated validity timer is provided associated with SNPN(s)).

[00142] - In some implementations, the validity timer (which may be associated with the E-UTRA-idleModeMeasurement configuration and/or the NR-idleModeMeasurement configuration) may not be stopped (or released) when the UE enters/moves to/switches to the SNPN access mode. In some implementations, the validity timer may not be stopped (or released) when the UE switches from the SNPN access mode to the non-SNPN access mode (e.g., if an idleModeMeasurement configuration and the associated validity timer is provided associated with SNPN(s)). The stored idle mode measurement configuration (which may be also referred to as early measurement configuration) may also not be released/removed/suspended/discarded.

[00143] In some implementations, the E-UTRA-idleModeMeasurement and the NR-idleModeMeasurement may not be interrupted/impacted when the UE switches from the non-SNPN access mode to the SNPN access mode.

[00144] - In some implementations, the UE may not release (all or part of) the stored E-UTRA-idleModeMeasurement configuration/NR-idleModeMeasurement configuration when the UE switches (from the non-SNPN access mode) to the SNPN access mode.

[00145] - In some implementations, the UE may not release (all or part of) the stored E-UTRA-idleModeMeasurement configuration/NR-idleModeMeasurement configuration when the UE switches from the SNPN access mode to the non-SNPN access mode.

[00146] - In some implementations, the UE may not release (all or part of) the stored E-UTRA-idleModeMeasurement results/NR-idleModeMeasurement results when the UE switches (from the non-SNPN access mode) to the SNPN access mode.

[00147] - In some implementations, the UE may not release (all or part of) the stored E-UTRA-idleModeMeasurement results/NR-idleModeMeasurement results when the UE switches from the SNPN access mode to the non-SNPN access mode.

[00148] - In some implementations, the (active) validity timer (associated with E-UTRA-idleModeMeasurement configuration and/or NR-idleModeMeasurement configuration) may not be stopped when the UE switches the access mode (e.g., from the non-SNPN access mode to the SNPN access mode, from the SNPN access mode to the non-SNPN access mode). In some implementations, the UE may keep the validity timer running (e.g., keep counting to zero) when the UE switches from the non-SNPN access mode to the SNPN access mode or when the UE switches from the SNPN access mode to the non-SNPN access mode.

[00149] In some implementations, one or more than one NR frequency indicated in the NR-idleModeMeasurement configuration may be associated with none, one or more than one NW. In addition, the NW may include any combinations of one or more PLMN, SNPN, and/or PNI-NPN.

[00150] - In some implementations, one NR-idleModeMeasurement configuration specific to PLMN(s) (e.g., *NR-idleModeMeasurement_plmn*) may be configured (in the broadcast SIB1). In addition, another NR-idleModeMeasurement configuration specific to SNPN(s) (e.g., *NR-idleModeMeasurement_snpn*) may also be configured in the SIB1.

[00151] - For a (NR/E-UTRA) cell that supports both PLMN and SNPN, both of the *NR-idleModeMeasurement_plmn* and *NR-idleModeMeasurement_snpn* may be configured in the SIB1 of the cell. In some implementations, only *NR-idleModeMeasurement_plmn* or *NR-idleModeMeasurement_snpn* may be configured in the SIB1 even though the cell (or base station) supports both PLMN and SNPN or the cell only supports either PLMN(s) or SNPN(s).

[00152] - In some implementations, the UE may receive the *NR-idleModeMeasurement_plmn* and/or *NR-idleModeMeasurement_snpn* in the RRC (Connection) Release message transmitted by the (LTE/NR) serving cell.

[00153] - To the UE side, the UE may only store the received *NR-idleModeMeasurement_plmn* if the UE is operating in the PLMN access mode (or non-SNPN access mode). Moreover, in this condition (if the UE is operating in the PLMN access mode (or non-SNPN access mode)), the UE may ignore the received *NR-idleModeMeasurement_snpn* configuration.

[00154] - To the UE side, the UE may only store the received *NR-idleModeMeasurement_snpn* if the UE is operating in the SNPN access mode. Moreover, in this condition (if the UE is operating in the SNPN access mode), the UE may ignore the

received *NR-idleModeMeasurement_plmn* configuration.

[00155] - In some implementations, the *NR-idleModeMeasurement_plmn* may further indicate association between the target NR frequency carrier (e.g., one NR frequency carrier is represented by one NR-ARFCN) and the PLMN (e.g., one PLMN is represented by one PLMN identifier), as previously illustrated in Table 1.

[00156] - In some implementations, the UE may release the stored *NR-idleModeMeasurement_plmn* if there is no interested NR frequency for early measurement. The UE may determine the interested NR frequency based on the PLMN(s) that the UE is configured to monitor (for early measurement), such as the selected PLMN, registered PLMN, equivalent PLMN, or any PLMN configured by the upper layer (e.g., the NAS layer) or the AS layers. The interested NR frequency may change when the PLMN(s) configured to the UE (for early measurement) changes.

[00157] - In some implementations (e.g., if the UE receives the *NR-idleModeMeasurement_plmn* configuration via UE-specific control signaling, such as RRC Release message), the UE may not release (all or part of) the stored *NR-idleModeMeasurement_plmn* configuration immediately when the PLMN(s) configured for early measurement changes. Instead, the UE may keep the stored configuration if the validity timer (e.g., T331) is still running. The UE may obtain the initial value of the validity timer in the RRC Release message and then the UE may trigger (start or restart) the validity timer after the UE moves to the RRC Inactive/Idle state based on the received RRC Release message. After the validity timer expires, the UE may remove/release/discard the stored *NR-idleModeMeasurement_plmn* configuration if there is still no interested NR frequency carrier for idle mode measurement.

[00158] - In some implementation, The *NR-idleModeMeasurement_plmn* may further indicate association between the target NR frequency carrier (e.g., one NR frequency carrier is represented by one NR-ARFCN number) and the PLMN (e.g., one PLMN is represented by one PLMN identifier), as illustrated in Table 1. The *NR-idleModeMeasurement_snpn* may further indicate association between the target NR frequency carrier (e.g., one NR frequency carrier is represented by one NR-ARFCN number) and the SNPN (e.g., one SNPN is represented by one SNPN identifier). Table 2 illustrates an *NR-idleModeMeasurement* configuration according to an example implementation of the present disclosure.

[00159] **Table 2**

NR frequency ID (e.g., NR-ARFCN)	Associated NW
----------------------------------	---------------

Freq. #1	SNPN_ID #1,
Freq. #2	SNPN_ID #1, SNPN_ID #2
Freq. #3	N.A.

[00160] - In some implementations, the UE may release the stored *NR-idleModeMeasurement_snpn* if there is no interested NR frequency for early measurement. UE may determine the interested NR frequency based on the SNPN(s) that the UE is configured to monitor (for early measurement), such as the selected SNPN, registered SNPN, equivalent SNPN, or any SNPN configured by the upper layer (e.g., the NAS layer) or the AS layer. The interested NR frequency may change when the SNPN(s) configured to the UE (for early measurement) changes.

[00161] - In some implementation (e.g., if the UE receives the *NR-idleModeMeasurement_snpn* configuration via UE-specific control signaling, such as RRC Release message), the UE may not release the stored *NR-idleModeMeasurement_snpn* configuration immediately while the SNPN(s) configured for early measurement changes. Instead, the UE may keep the stored configuration if the validity timer (e.g., T331) is still running. The UE may obtain the initial value of the validity timer in the RRC Release message and then the UE may trigger (start or restart) the validity timer after the UE moves to the RRC Inactive/Idle state based on the received RRC Release message. After the validity timer expires, the UE may remove/release/discard the stored *NR-idleModeMeasurement_snpn* configuration if there is still no interested NR frequency carrier.

[00162] The implementations disclosed previously may also be applicable to the *E-UTRA-idleModeMeasurement* configuration.

[00163] In some implementations, one *NR-idleModeMeasurement* configuration may cover the configuration for both PLMN and SNPN. In this condition, the UE may receive and store the *NR-idleModeMeasurement* configuration no matter whether the UE is operating in the SNPN access mode or not. In some implementations, (all or part of) the stored *NR-idleModeMeasurement* results may also not be impacted by switching between the SNPN access mode and the non-SNPN access mode.

[00164] In some implementation, the *idleModeMeasurement* may further indicate association between the target NR frequency carrier (e.g., one NR frequency carrier is represented by one NR-ARFCN number) and the PLMN/SNPN (e.g., one PLMN/SNPN is represented by one PLMN/SNPN identifier). Table 3 illustrates an *NR-idleModeMeasurement*

configuration according to an example implementation of the present disclosure.

[00165] Table 3

NR frequency ID (e.g., NR-ARFCN)	Associated NW
Freq. #1	SNPN_ID #1,
Freq. #2	SNPN_ID #1, SNPN_ID #2
Freq. #3	PLMN_ID #1, SNPN_ID #3
Freq. #4	N.A.

[00166] It should be noted that the NR frequency carrier IDs illustrated in Table 1, Table 2 and Table 3 are exemplary rather than limiting. The disclosed implementations may also be applicable to E-UTRA frequency carriers, which may be represented by E-UTRAN ARFCN.

[00167] In some implementations, the UE may release (all or part of) the stored *idleModeMeasurement* configuration (e.g., *NR-idleModeMeasurement* configuration) if there is no interested NR frequency for idle mode measurement. The UE may determine the interested NR frequency based on the PLMN(s)/SNPN(s) that the UE is configured to monitor (for idle mode measurement), such as the selected PLMN/SNPN, registered PLMN/SNPN, equivalent PLMN/SNPN, or any PLMN/SNPN configured by the upper layer (e.g., the NAS layer) or any PLMN/SNPN in which the UE has interest (e.g., in some implementations, based on UE stored information, as specified in 3GPP TS 38.304). The interested frequency carrier (e.g., NR frequency carrier) may change when the PLMN(s)/SNPN(s) configured to the UE (for idle mode measurement) changes. However, (all or part of) the stored *idleModeMeasurement* results may or may not be released jointly with the release of *idleModeMeasurement* configuration.

[00168] In some implementations, the UE may stop monitoring one NR frequency carrier if the UE has no interest in the PLMN/SNPN associated with the NR frequency carrier. However, the UE may still monitor other given NR frequency carriers in the *idleModeMeasurement* configuration. Moreover, the UE may or may not release the stored *idleModeMeasurement* results which the UE has no interest (e.g., when the UE changes its interested PLMN during *idleModeMeasurement* procedure) when the monitoring procedure associated with the concerned NR frequency carrier is stopped. In addition, during the *idleModeMeasurement* reporting procedure (such as process 100 illustrated in FIG. 1), the UE may or may not report the *idleModeMeasurement* results associated with an NR frequency carrier if the UE has no interest in the NR frequency carrier.

[00169] For an NR frequency carrier not associated with any PLMN/SNPN in the *idleModeMeasurement* configuration, the UE may still consider the NR frequency carrier valid and the UE may still implement *idleModeMeasurement* on the NR frequency carrier.

[00170] In some implementation (e.g., if the UE receives the *idleModeMeasurement* configuration via UE-specific control signaling, such as *RRC(Connection)Release* message), the UE may not release (part or all of) the stored *idleModeMeasurement* results immediately when the PLMN(s)/SNPN(s) configured for *idleModeMeasurement* changes. Instead, the UE may keep (part or all of) the stored idle mode measurement configuration if the validity time is still running. The UE may obtain the initial value of the validity timer in the *RRC(Connection)Release* message and the UE may trigger (start or restart) the validity timer after the UE moves to the RRC inactive/idle state based on the received RRC Release message. After the validity timer expires, the UE may remove/release/discard (all or part of) the stored *idleModeMeasurement* configuration if there is still no interested NR frequency carrier in the stored *idleModeMeasurement* configuration. In some implementations, the stored *idleModeMeasurement* results may or may not be removed jointly with the removal of *idleModeMeasurement* configuration. In some implementations, the UE may just remove the NR frequency carrier(s) in which the UE has no interest from the stored *idleModeMeasurement* configuration.

[00171] In some implementations, the UE may be triggered to move from the RRC inactive state to the RRC idle state when the access mode (e.g., SNPN access mode or non-SNPN access mode) changes. During the (NR/LTE) RRC state transition, the UE may determine whether to keep (or release) the stored *idleModeMeasurement* configuration or *idleModeMeasurement* results.

[00172] In some implementations, the serving cell, which requests *idleModeMeasurement* from the UE (or the serving cell to which the UE indicates *idleModeMeasurement* is available), may only support some NR/E-UTRA frequency carriers (based on the networks associated with the NR/E-UTRA frequency carrier in the stored *idleModeMeasurement* configuration) in the stored *idleModeMeasurement* configuration. In other words, the serving cell may only support a subset of the networks (e.g., PLMN/SNPN/PNI-NPN) of the stored *idleModeMeasurement* results.

[00173] In this condition, the UE may only report the measurement results of target NR/E-UTRA frequency carriers (and the measured cells in these NR/E-UTRA frequency carriers) that the serving cell/serving NW supports (based on the networks supported by the serving cell) in the *idleModeMeasurement* report to the serving cell. In some other implementations, the UE

may report the measurement results of target NR/E-UTRA regardless of the frequency carriers which the serving cell/serving NW supports.

[00174] In contrast, in the idleModeMeasurement report to the serving cell, the UE may not report the measurement results of target NR/E-UTRA frequency carriers (and the measured cells in these NR/E-UTRA frequency carriers) that the serving cell does not support (based on the networks supported by the serving cell).

[00175] (All or part of) the idleModeMeasurement results (associated with the networks that the serving cell does not support) may or may not be released if the serving cell does not support the networks associated with the stored idleModeMeasurement results.

[00176] In some implementations, if there is no available (or appropriate) idleModeMeasurement report to the serving cell (based on networks which the serving cell supports), the UE may report idleModeMeasurement={None} (or empty or N.A.) in the UL RRC signaling (e.g., *RRCResumeComplete* message or *RRCSetupComplete* message) to the serving cell.

[00177] In some implementations, the UE may not report idleModeMeasurement is available (e.g., the UE may not indicate idleMeasAvailable={true}) to the serving cell/NW in the UL RRC signaling (e.g., *RRCResumeComplete* message or *RRCSetupComplete* message) to the serving cell if there is no appropriate (or suitable) idleModeMeasurement report to the serving cell (based on the networks that the serving cell supports). For example, the UE may not report available E-UTRA idle mode measurement results to the serving SNPN (or a serving cell which belongs to the registered/selected SNPN) if the E-UTRA idle mode measurement results are not appropriate (or suitable) to the serving SNPN (or to the serving cell). This condition may happen due to the SNPN does not support E-UTRA RAT.

[00178] The UE may identify the networks that the serving cell supports by reading the SIB1 broadcast by the serving cell.

[00179] Signaling for Idle Mode Measurement Configuration

[00180] A cell (e.g., a NR cell or an E-UTRA cell) may transmit an *NR-idleModeMeasurement* configuration, which includes a list of target NR frequency carriers, to the UE. The NR early measurement configuration may be transmitted via the *RRCRelease* message. An information element ‘*measIdleConfig*’ may be included in the *RRCRelease* message. Table 4 illustrates a data structure of the *measIdleConfig* IE according to an example implementation of the present disclosure.

[00181] Table 4

```

measIdleConfig ::= SEQUENCE {
    measIdleCarrierListNR-r16      SEQUENCE (SIZE (1..maxFreqIdle-r16)) OF
    MeasIdleCarrierNR-r16        OPTIONAL,      -- Need N
    measIdleCarrierListEUTRA-r16   SEQUENCE (SIZE (1..maxFreqIdle-r16))
    OF MeasIdleCarrierEUTRA-r16  OPTIONAL,      -- Need N
    measIdleDuration-r16           ENUMERATED{sec10, sec30, sec60,
    sec120, sec180, sec240, sec300, spare},
    validityAreaList-r16          ValidityAreaList-r16
    OPTIONAL,      -- Need N
    ...
}

```

[00182] The *measIdleConfig* may include target frequency carriers for NR and/or E-UTRA. In some implementations, associated with each indicated NR/E-UTRA frequency carrier, the UE may also receive (one or more than one) cell identities (e.g., the Physical Cell Identity, PCI) of target cells (e.g., NR cell or E-UTRA cell) applicable for the early measurement.

[00183] In some implementations, the UE may receive the *idleModeMeasurement* configuration through system information reception. For example, the UE may firstly receive SIB1, which includes an IE '*idleModeMeasurements={E-UTRA, NR}*', from its serving cell. Then, after receiving the *idleModeMeasurements* in SIB1, the UE may know that the idle mode measurement is applicable to the serving cell. In addition, the UE may also receive a system information block (e.g., SIB11), which may include an information element '*measIdleConfigSIB*'. Table 5 illustrates a data structure of the *measIdleConfigSIB* IE according to an example implementation of the present disclosure.

[00184] Table 5

```

MeasIdleConfigSIB ::= SEQUENCE {
    measIdleCarrierListNR-r16      SEQUENCE (SIZE (1..maxFreqIdle-
r16)) OF MeasIdleCarrierNR-r16  OPTIONAL,      -- Need S
    measIdleCarrierListEUTRA-r16   SEQUENCE (SIZE (1..maxFreqIdle-
r16)) OF MeasIdleCarrierEUTRA-r16  OPTIONAL,      -- Need S
    ...
}

```

[00185] The *measIdleConfigSIB* may include target frequency carriers for NR and/or E-UTRA. In some implementations, the UE may also receive (one or more than one) cell identities (e.g., PCI) of target cells (e.g., NR cell or E-UTRA cell) applicable for early measurement, where each target cell may be associated with each indicated NR/E-UTRA frequency carrier.

[00186] The UE may measure the target (NR/E-UTRA) frequency carriers (and the indicated target cells) based on the received *idleModeMeasurement* configuration while the UE is staying in (NR/LTE) RRC inactive state or (NR/LTE) RRC idle state.

[00187] However, for one (NR) frequency carrier, there may be deployed with one (or some) Public Land Mobile Network (PLMN) that the UE does not support. This condition may cause the UE to measure one indicated target frequency carrier that the UE cannot access at all. To prevent this problem, associations between the deployed PLMN(s) and a target NR frequency carrier may be indicated to the UE. In some implementations, the UE may only measure the target (NR) frequency carriers that the UE can access (e.g., based on the received registered PLMN ID or selected PLMN ID indicated by the NAS layer at the UE side, where the registered PLMN ID may identify the registered PLMN and the selected PLMN ID may identify the selected PLMN). Similar issue may also happen when NPN is introduced. For example, the UE may only have interest in a subset of SNPN(s) or the UE can only access some CAGs (or PNI-NPN(s)) in a specific target NR frequency carrier. In some conditions, this problem may not happen to E-UTRA cell(s). The same issue may also happen to NR cell(s) when SNPN (and CAG) is taken into consideration.

[00188] In some implementations, the UE may receive a network (e.g., PLMN or SNPN) list from the serving cell. For example, the serving cell may broadcast the network(s) that the serving cell supports by delivering *plmn-IdentityList* or *n timer-IdentityList* periodically in the system information (e.g., SIB1).

[00189] In some implementations, a cell may transmit both *plmn-IdentityList* and the *n timer-IdentityInfoList* in the SIB1.

[00190] In the *idleModeMeasurement* configuration, a target (NR) frequency carrier may be associated with two bitmaps, including *Bitmap_PLMN* and *Bitmap_NPN*.

[00191] Both of the *Bitmap_PLMN* and *Bitmap_NPN* may be delivered along with the *cell identity* list in the other SI (e.g., SIB11).

[00192] In the *Bitmap_PLMN*, each bit in the *Bitmap_PLMN* may be associated with one PLMN entry provided in the *plmn-IdentityList*. In some conditions, the sequence of bits (e.g., Bit_PLMN) in the *Bitmap_PLMN* from the leftmost bit to the rightmost bit may be mapped to

each plmn-Identity with ascending (or descending) order in the *plmn-IdentityList*.

[00193] One configured NR frequency carrier (which is configured in the idleModeMeasurement configuration) may be associated with one *Bitmap_PLMN*. In addition, one Bit_PLMN in the *Bitmap_PLMN* may be set to '1' if the PLMN (associated with the Bit_PLMN) supports the configured NR frequency carrier. It means that the UE may be able to find out a candidate cell that belongs to the indicated PLMN. The UE may consider implementing the idle mode measurement in this NR frequency carrier if the UE could access the network associated with the Bit_PLMN.

[00194] In contrast, one Bit_PLMN in the *Bitmap_PLMN* may be set to '0' if the PLMN (associated with the Bit_PLMN) does not support the configured NR frequency carrier. It means that the UE may not be able to find out a candidate cell that belongs to the indicated PLMN. The UE may not consider implementing idle mode measurement in this NR frequency carrier if the UE wants to measure any cell belonging to the indicated PLMN.

[00195] In the *Bitmap_NPN*, each bit in the *Bitmap_NPN* may be associated with one SNPN (or PNI-NPN) entry provided in the *nnp-IdentityList*. In some conditions, the sequence of bits (e.g., Bit_NPN) in the *Bitmap_NPN* from the leftmost bit to the rightmost bit may be mapped to each npn-Identity with ascending (or descending) order in the *nnp-IdentityList*.

[00196] One configured NR frequency carrier (which is configured in the idleModeMeasurement configuration) may be associated with one *Bitmap_NPN*. In addition, one Bit_NPN in the *Bitmap_NPN* may be set to '1' if the SNPN (or PNI-NPN) (associated with the Bit_NPN) supports the configured NR frequency carrier. It means that the UE may be able to find out a candidate cell that belongs to the indicated NPN. The UE may consider implementing idle mode measurement in this NR frequency carrier if the UE could access the network associated with the Bit_NPN.

[00197] In contrast, one Bit_NPN in the *Bitmap_NPN* may be set to '0' if the SNPN (or PNI-NPN) (associated with the Bit_NPN) does not support the configured NR frequency carrier. It means that the UE may not be able to find out a candidate cell that belongs to the indicated SNPN (or PNI-NPN). The UE may not consider implementing idle mode measurement in this NR frequency carrier if the UE wants to measure any cell belonging to the indicated SNPN (or PNI-NPN).

[00198] In some implementations, a UE operating in the SNPN access mode UE may only consider *Bitmap_NPN* when the UE determines which target NR frequency carrier for measurement. The UE operating in the SNPN access mode may ignore the *Bitmap_PLMN*.

[00199] In some implementations, a UE operating in the non-SNPN access mode may only

consider *Bitmap_PLMN* when the UE determines which target NR frequency carrier for measurement. The UE operating in the non-SNPN access mode may ignore the *Bitmap_NPN*.

[00200] In some implementations, the UE may receive and store the received idleModeMeasurement configuration, which includes the *Bitmap_PLMN* and *Bitmap_NPN*, no matter which mode (e.g., SNPN access mode or non-SNPN access mode/PLMN access mode) or which network (e.g., PNI-NPN, which the UE is accessing or trying to access) the UE is staying in.

[00201] In some implementations, the *Bitmap_NPN* and *Bitmap_PLMN* are provided along with the associated NR frequency carrier in the SIB1.

[00202] In some implementations, the UE may not monitor SIB11 if the UE identifies no interested frequency carrier for the idle mode measurement after the UE receiving the SIB1.

[00203] In some implementations, more than one cellidentity list, of which each one is associated with the supported PLMN/SNPN/PNI-NPN, may be configured respectively to a target NR frequency carrier in the SIB11.

[00204] In some implementations, the NW identity (e.g., PLMN identity, SNPN identity, PNI-NPN identity) may be explicitly provided to be associated with the concerned frequency carrier in the SIB1 or SIB11.

[00205] FIG. 4 illustrates a method 400 performed by a UE for idle mode measurement according to an example implementation of the present disclosure. In action 402, the UE may receive an idle mode measurement configuration from a BS. The UE may receive the idle mode measurement configuration via (broadcasting) system information or an (UE-specific) RRC release message. The idle mode measurement configuration may include at least one of an NR idle mode measurement configuration and an E-UTRA idle mode measurement configuration. In some implementations, the UE may ignore the E-UTRA idle mode measurement configuration upon receiving the idle mode measurement configuration while the UE operates in the SNPN access mode.

[00206] In action 404, the UE may perform measurement based on the idle mode measurement configuration to obtain an idle mode measurement result while the UE is in one of an RRC_IDLE state and an RRC_INACTIVE state. The idle mode measurement result may include at least one of an NR idle mode measurement result and an E-UTRA idle mode measurement result.

[00207] In action 406, the UE may release at least a portion of the idle mode measurement configuration and the idle mode measurement result when the UE enters an SNPN access mode. In some implementations, the released portion of the idle mode measurement configuration and

the idle mode measurement result includes at least one of the E-UTRA idle mode measurement configuration and the E-UTRA idle mode measurement result. In some implementations, the UE may release the E-UTRA idle mode measurement configuration upon entering the SNPN access mode. In some implementations, the UE may release the E-UTRA idle mode measurement result upon entering the SNPN access mode. In some implementations, the UE may determine to release the at least one of the E-UTRA idle mode measurement configuration and the E-UTRA idle mode measurement result if the UE has a registered/selected SNPN that does not support E-UTRA or a selected SNPN that does not support E-UTRA. In some additional implementations, the UE may determine not to release the E-UTRA idle mode measurement configuration and/or the E-UTRA idle mode measurement results even if the UE has a registered/selected SNPN that does not support E-UTRA.

[00208] FIG. 5 illustrates a process 500 of idle mode measurement with a request from a BS according to an example implementation of the present disclosure. Action 512 and action 514 illustrated in FIG. 5 may correspond to action 402 and action 404 illustrated in FIG. 4, respectively. In action 516, the UE 502 may receive an idle mode measurement request from the BS 504 during a random access (RA) procedure. After obtaining the idle mode measurement result in action 514, in action 518, the UE 502 may transmit the idle mode measurement result to the BS 504. The RA procedure may be one of a 2-step RA procedure and a 4-step RA procedure. For example, the idle mode measurement request may be transmitted via msg4 of the 4-step RA procedure or msgB of the 2-step RA procedure.

[00209] In some implementations, the UE 502 may receive the idle mode measurement request via one of an RRC resume message and an RRC setup message in action 516. In action 518, the UE 502 may transmit the idle mode measurement result via one of an RRC resume complete message and an RRC setup complete message corresponding to the idle mode measurement request. In some implementations, the idle mode measurement request may indicate at least one RAT. The idle mode measurement result transmitted to the BS 504 may be in response to the at least one RAT indicated in the idle mode measurement request.

[00210] FIG. 6 illustrates a process 600 of idle mode measurement with a UE indicating availability of the idle mode measurement result according to an example implementation of the present disclosure. Action 612 and action 614 illustrated in FIG. 6 may correspond to action 512 and action 514 illustrated in FIG. 5, respectively. In action 616, the UE 602 may receive a first indicator via broadcast system information from the BS 604. The first indicator may indicate that the BS 604 supports the UE 602 to report a specific idle mode measurement result associated with at least one specific RAT. In action 618, the UE 602 may transmit a second

indicator to the BS 604 after a random access procedure associated with the BS 604. The second indicator may indicate availability of the specific idle mode measurement result associated with the at least one specific RAT. For example, the second indicator may include an *idleMeasAvailable* IE. In some implementations, the value of the second indicator may include one or more than one specific RAT. In some implementations, the UE 602 may indicate to the BS 604 that there is no available measurement result via the second indicator. For example, the second indicator may be '*idleMeasAvailable*={true}', '*idleMeasAvailableNR*={true}', '*idleMeasAvailableEUTRA*={true}', '*idleMeasAvailable*={NR}', '*idleMeasAvailable*={E-UTRA}', '*idleMeasAvailable*={NR & E-UTRA}', '*idleModeMeasurement*={None}' (or empty or N.A.), etc.

[00211] FIG. 7 illustrates a method 700 performed by a UE for idle mode measurement with a validity timer according to an example implementation of the present disclosure. In action 702, the UE may receive an idle mode measurement configuration from a BS, where the idle mode measurement configuration configures a validity timer. The idle mode measurement configuration may be considered valid when the validity timer is running. Action 704 and action 706 illustrated in FIG. 7 may correspond to action 404 and action 406 illustrated in FIG. 4, respectively. In action 708, the UE may start the validity timer when the UE configures idle mode measurement based on the received idle mode measurement configuration. In action 710, the UE may stop/release the validity timer when the UE enters the SNPN access mode. It should be noted that actions 702, 704, 706, 708, and 710 should not be construed as necessarily order dependent in their performance. The order in which the process is described is not intended to be construed as a limitation, and any number of the described actions may be combined in any order to implement the method or an alternate method. Moreover, one or more of the actions illustrated in FIG. 7 may be omitted in some implementations.

[00212] FIG. 8 is a block diagram illustrating a node 800 for wireless communication according to an implementation of the present disclosure. As illustrated in Fig. 8, a node 800 may include a transceiver 820, a processor 828, a memory 834, one or more presentation components 838, and at least one antenna 836. The node 800 may also include a Radio Frequency (RF) spectrum band module, a BS communications module, a network communications module, and a system communications management module, Input / Output (I/O) ports, I/O components, and a power supply (not illustrated in Fig. 8).

[00213] Each of the components may directly or indirectly communicate with each other over one or more buses 840. The node 800 may be a UE or a BS that performs various functions disclosed with reference to FIGS. 1 through 7.

[00214] The transceiver 820 has a transmitter 822 (e.g., transmitting/transmission circuitry) and a receiver 824 (e.g., receiving/reception circuitry) and may be configured to transmit and/or receive time and/or frequency resource partitioning information. The transceiver 820 may be configured to transmit in different types of subframes and slots including but not limited to usable, non-usable and flexibly usable subframes and slot formats. The transceiver 820 may be configured to receive data and control channels.

[00215] The node 800 may include a variety of computer-readable media. Computer-readable media may be any available media that may be accessed by the node 800 and include both volatile and non-volatile media, removable and non-removable media.

[00216] The computer-readable media may include computer storage media and communication media. Computer storage media include both volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or data.

[00217] Computer storage media include RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, Digital Versatile Disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices. Computer storage media do not include a propagated data signal. Communication media typically embody computer-readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism and include any information delivery media.

[00218] The term “modulated data signal” means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. Communication media include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media. Combinations of any of the previously listed components should also be included within the scope of computer-readable media.

[00219] The memory 834 may include computer-storage media in the form of volatile and/or non-volatile memory. The memory 834 may be removable, non-removable, or a combination thereof. Example memory includes solid-state memory, hard drives, optical-disc drives, etc. As illustrated in Fig. 8, the memory 834 may store computer-readable, computer-executable instructions 832 (e.g., software codes) that are configured to cause the processor 828 to perform various disclosed functions, for example, with reference to FIGS. 1 through 7. Alternatively, the instructions 832 may not be directly executable by the processor 828 but be configured to cause the node 800 (e.g., when compiled and executed) to perform various

disclosed functions.

[00220] The processor 828 (e.g., having processing circuitry) may include an intelligent hardware device, e.g., a Central Processing Unit (CPU), a microcontroller, an ASIC, etc. The processor 828 may include memory. The processor 828 may process data 830 and the instructions 832 received from the memory 834, and information transmitted and received via the transceiver 820, the base band communications module, and/or the network communications module. The processor 828 may also process information to be sent to the transceiver 820 for transmission via the antenna 836 to the network communications module for transmission to a core network.

[00221] One or more presentation components 838 present data indications to a person or another device. Examples of presentation components 838 include a display device, a speaker, a printing component, and a vibrating component, etc.

[00222] In view of the present disclosure, it is obvious that various techniques may be used for implementing the concepts in the present disclosure without departing from the scope of those concepts. Moreover, while the concepts have been disclosed with specific reference to certain implementations, a person of ordinary skill in the art will recognize that changes may be made in form and detail without departing from the scope of those concepts. As such, the disclosed implementations are to be considered in all respects as illustrative and not restrictive. It should also be understood that the present disclosure is not limited to the particular implementations disclosed and many rearrangements, modifications, and substitutions are possible without departing from the scope of the present disclosure.

CLAIMS

WHAT IS CLAIMED IS:

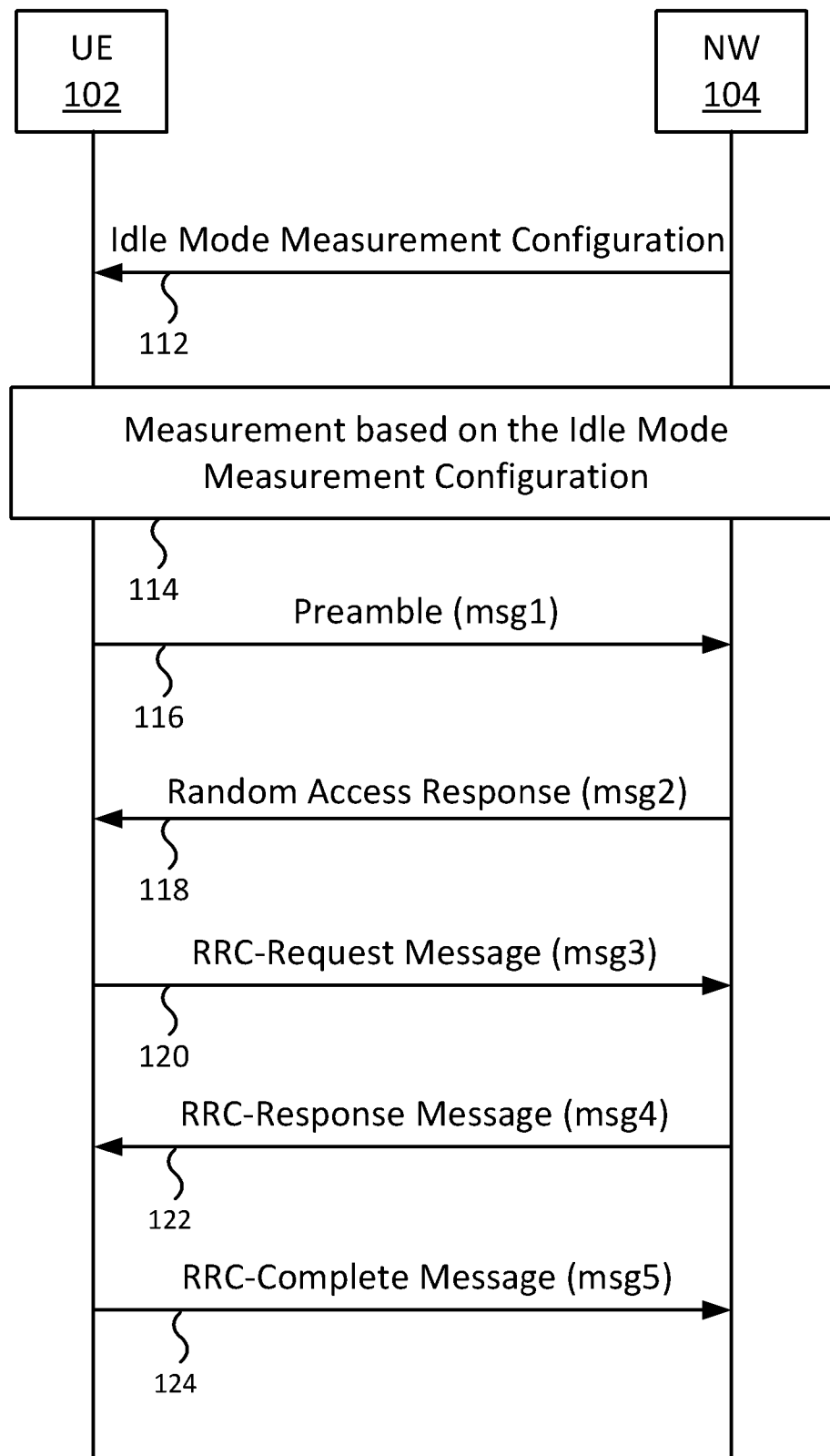
1. A method performed by a user equipment (UE) for idle mode measurement, the method comprising:
 - receiving an idle mode measurement configuration from a base station (BS);
 - performing measurement based on the idle mode measurement configuration to obtain an idle mode measurement result while the UE is in one of a Radio Resource Control (RRC)_IDLE state and an RRC_INACTIVE state; and
 - releasing at least a portion of the idle mode measurement configuration and the idle mode measurement result when the UE enters a Standalone Non-Public Network (SNPN) access mode.
2. The method of claim 1, wherein:
 - the idle mode measurement configuration includes at least one of a New Radio (NR) idle mode measurement configuration and an Evolved Universal Terrestrial Radio Access (E-UTRA) idle mode measurement configuration; and
 - the idle mode measurement result includes at least one of an NR idle mode measurement result and an E-UTRA idle mode measurement result.
3. The method of claim 2, wherein the released portion of the idle mode measurement configuration and the idle mode measurement result includes at least one of the E-UTRA idle mode measurement configuration and the E-UTRA idle mode measurement result.
4. The method of claim 3, wherein the UE has one of a registered SNPN that does not support E-UTRA and a selected SNPN that does not support E-UTRA.
5. The method of claim 2, further comprising:
 - ignoring the E-UTRA idle mode measurement configuration upon receiving the idle mode measurement configuration while the UE operates in the SNPN access mode.
6. The method of claim 1, wherein the idle mode measurement configuration is received by the UE via system information or an RRC release message.

7. The method of claim 1, further comprising:
receiving an idle mode measurement request from the BS during a random access procedure; and
transmitting the idle mode measurement result to the BS after receiving the idle mode measurement request from the BS.
8. The method of claim 7, wherein the random access procedure is one of a 2-step random access procedure and a 4-step random access procedure.
9. The method of claim 7, wherein:
the idle mode measurement request is received via one of an RRC resume message and an RRC setup message; and
the idle mode measurement result is transmitted via one of an RRC resume complete message and an RRC setup complete message corresponding to the idle mode measurement request.
10. The method of claim 7, wherein:
the idle mode measurement request indicates at least one Radio Access Technology (RAT); and
the idle mode measurement result transmitted to the BS is in response to the at least one RAT indicated in the idle mode measurement request.
11. The method of claim 1, further comprising:
receiving a first indicator via broadcast system information from the BS, the first indicator indicating that the BS supports the UE to report a specific idle mode measurement result associated with at least one specific Radio Access Technology (RAT).
12. The method of claim 11, further comprising:
transmitting a second indicator to the BS after a random access procedure associated with the BS, the second indicator indicating availability of the specific idle mode measurement result associated with the at least one specific RAT.
13. The method of claim 1, wherein:

the idle mode measurement configuration configures a validity timer;
the idle mode measurement configuration is considered valid when the validity timer is running; and
the method further comprises:
starting the validity timer when the UE configures idle mode measurement based on the received idle mode measurement configuration.

14. The method of claim 13, further comprising:
stopping the validity timer when the UE enters the SNPN access mode.

15. A user equipment (UE) for idle mode measurement, the UE comprising:
one or more processors; and
at least one memory coupled to at least one of the one or more processors, wherein the at least one memory stores a computer-executable program that, when executed by the at least one of the one or more processors, causes the UE to perform the method of any of claims 1 to 14.

1/8**100****FIG. 1**

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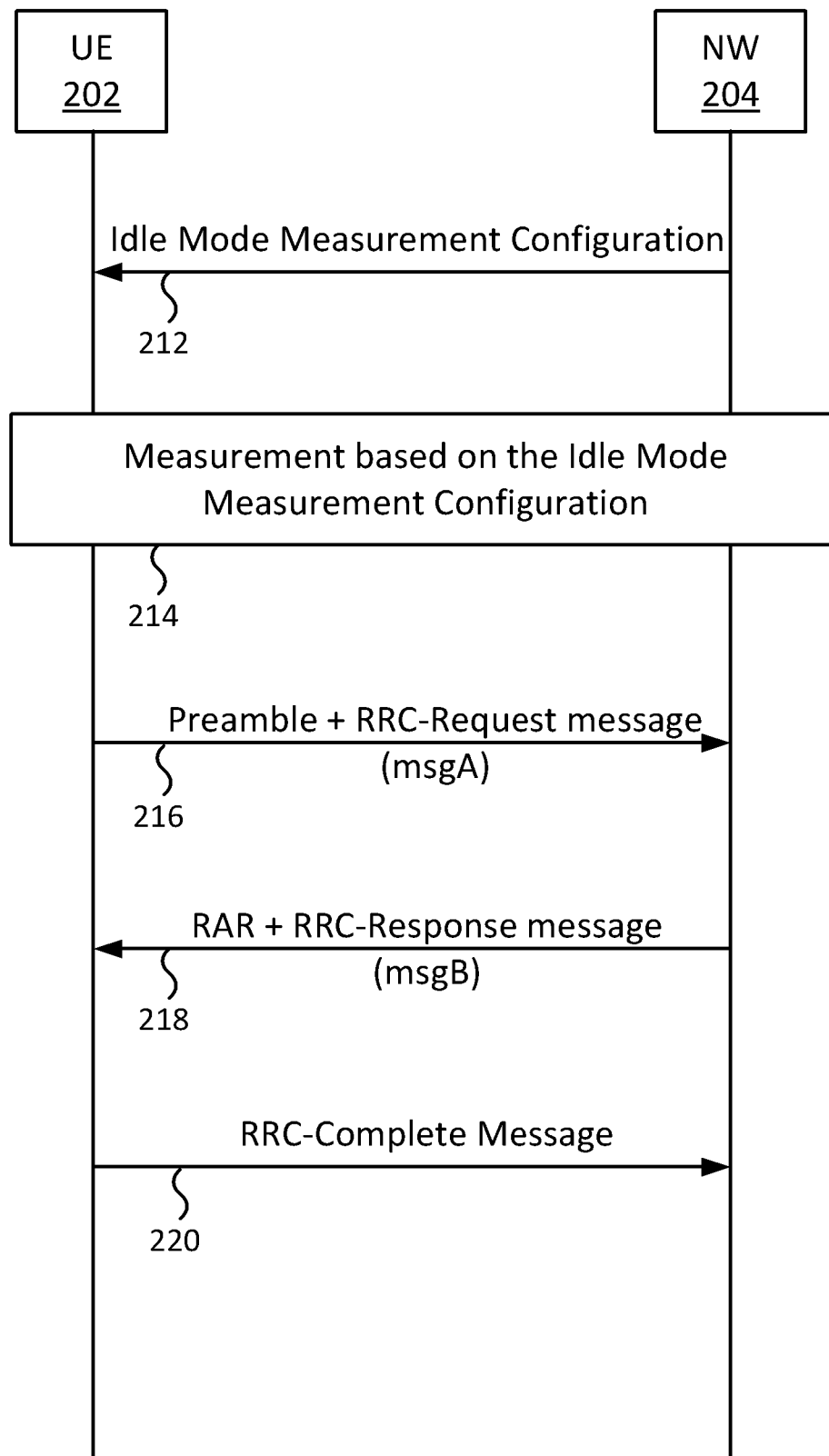
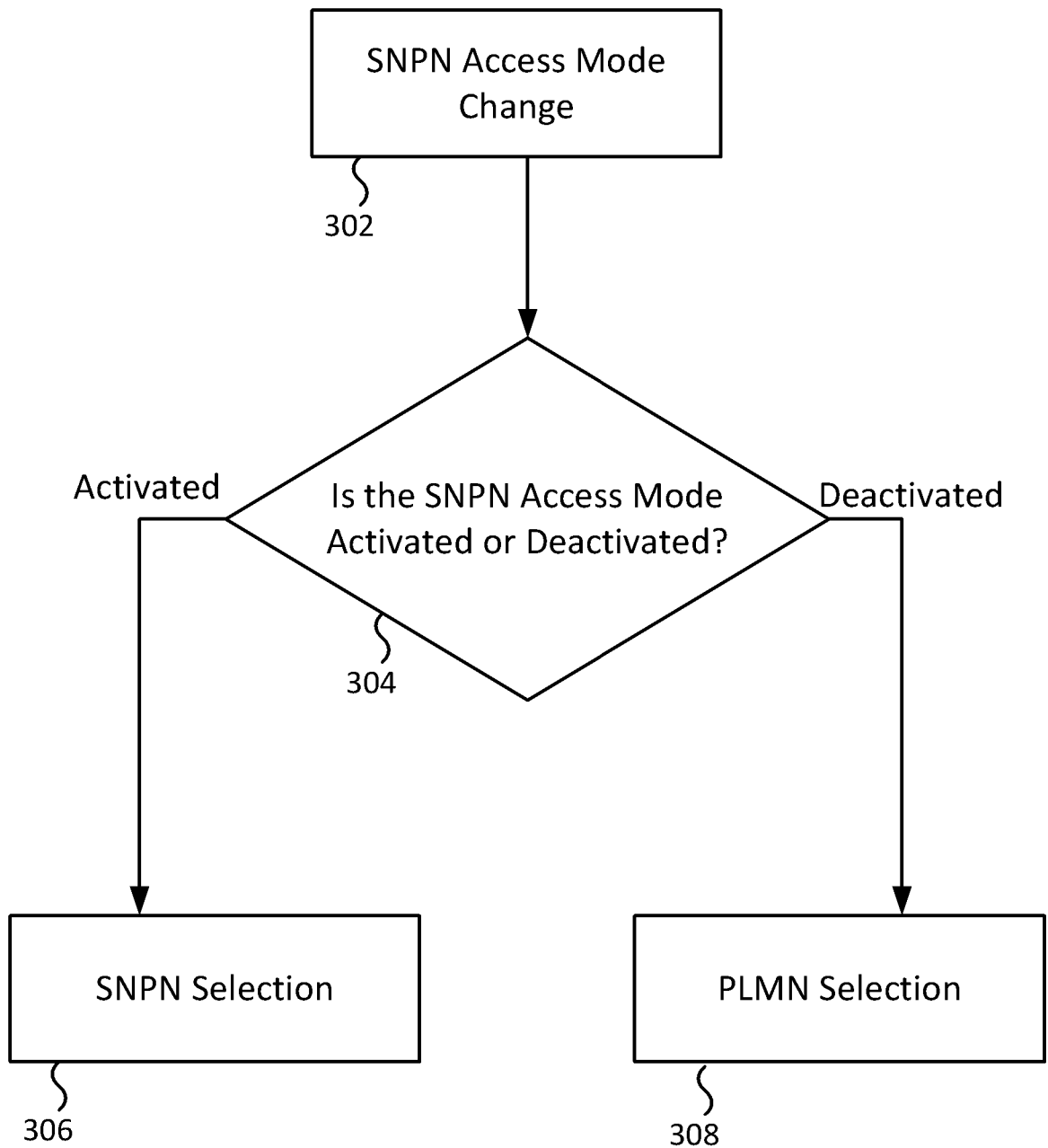
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FIG. 2

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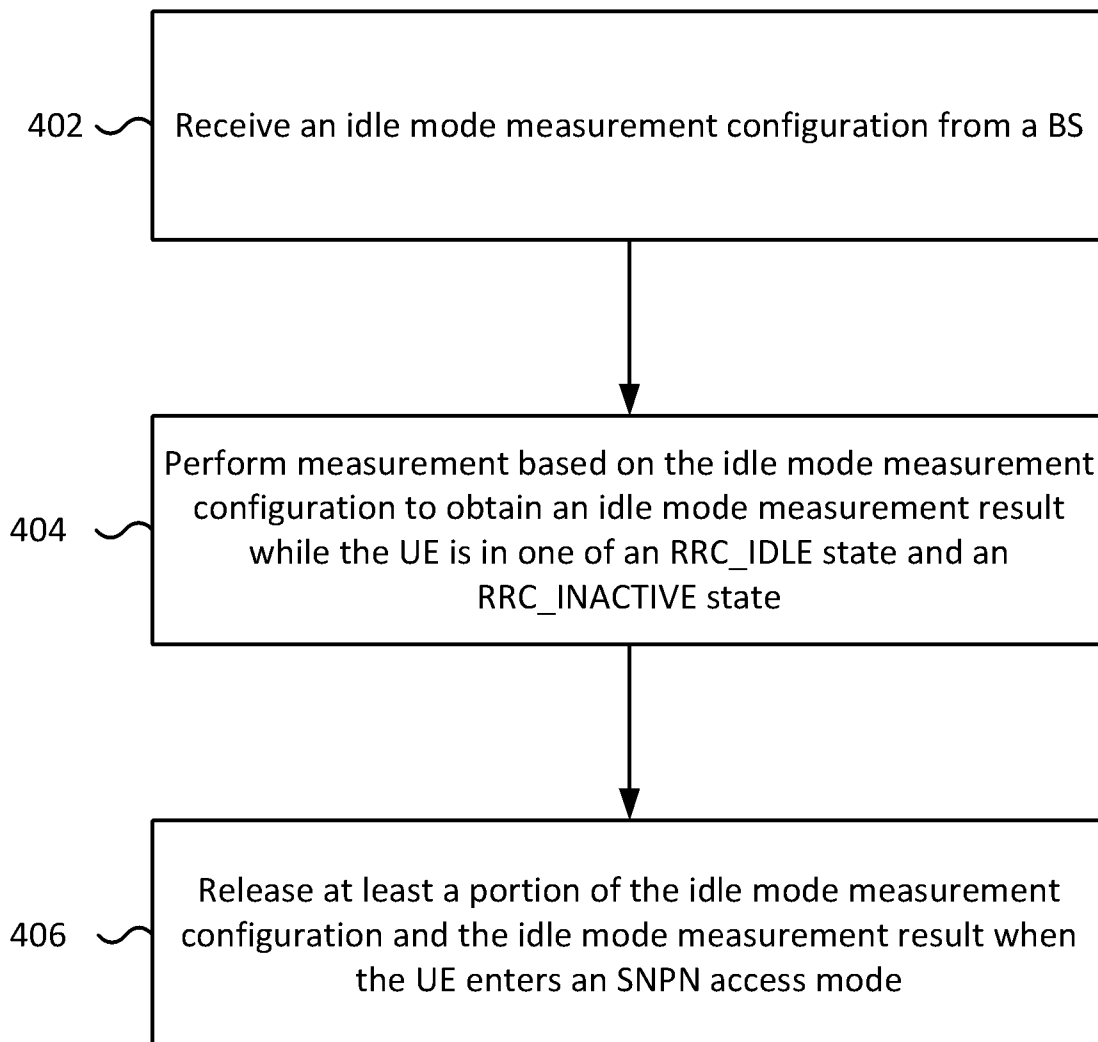
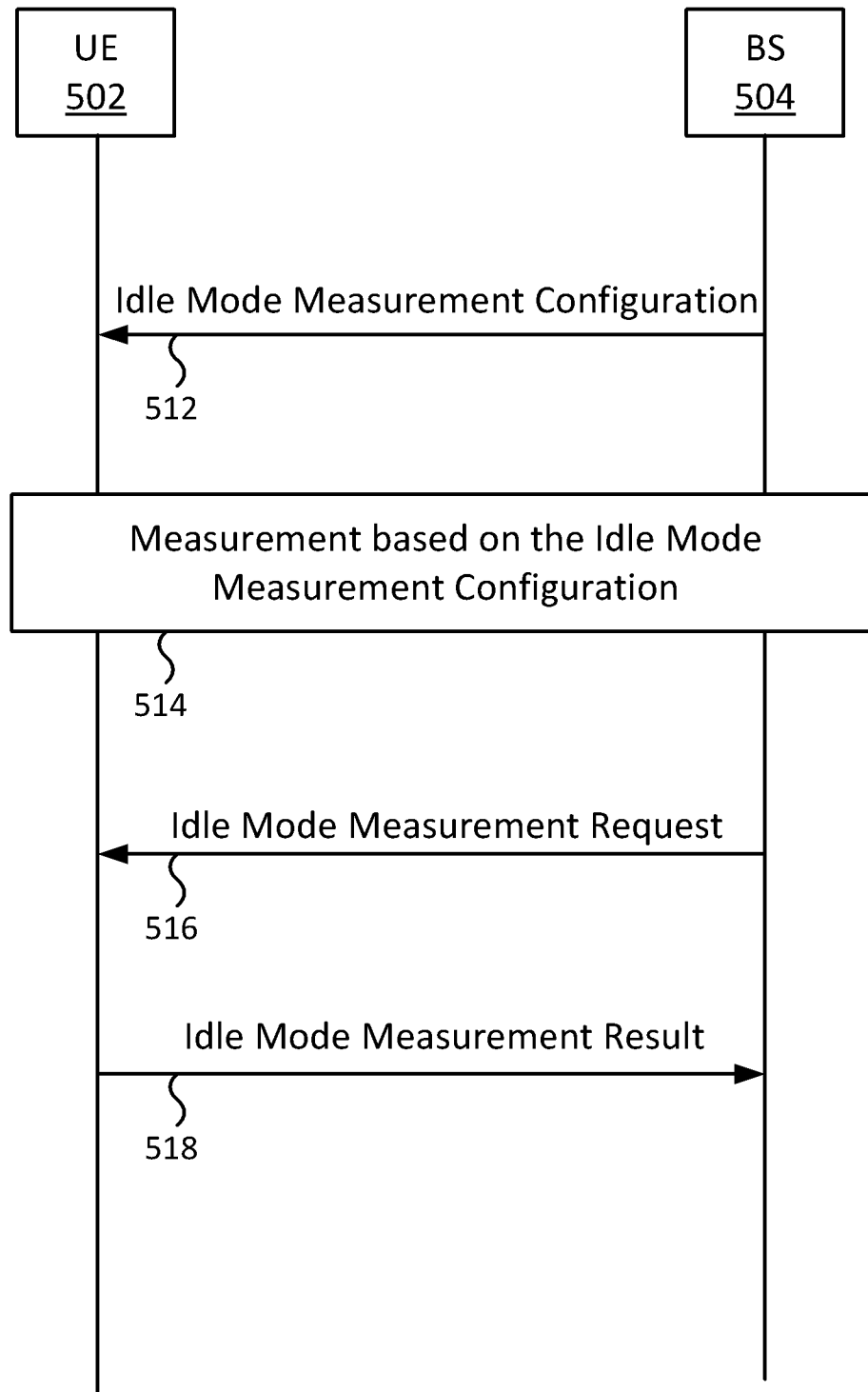
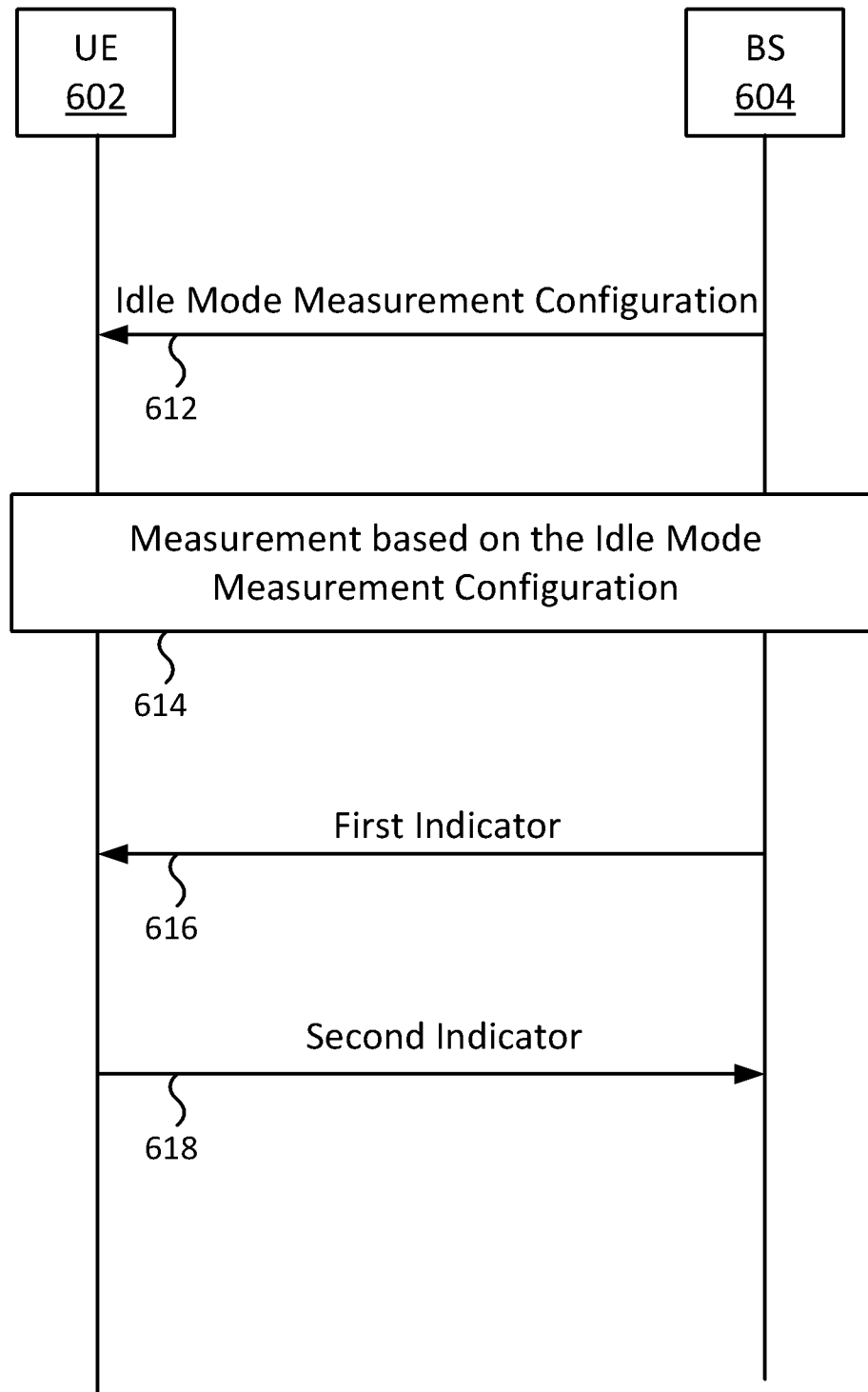
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FIG. 4

5/8**500****FIG. 5**

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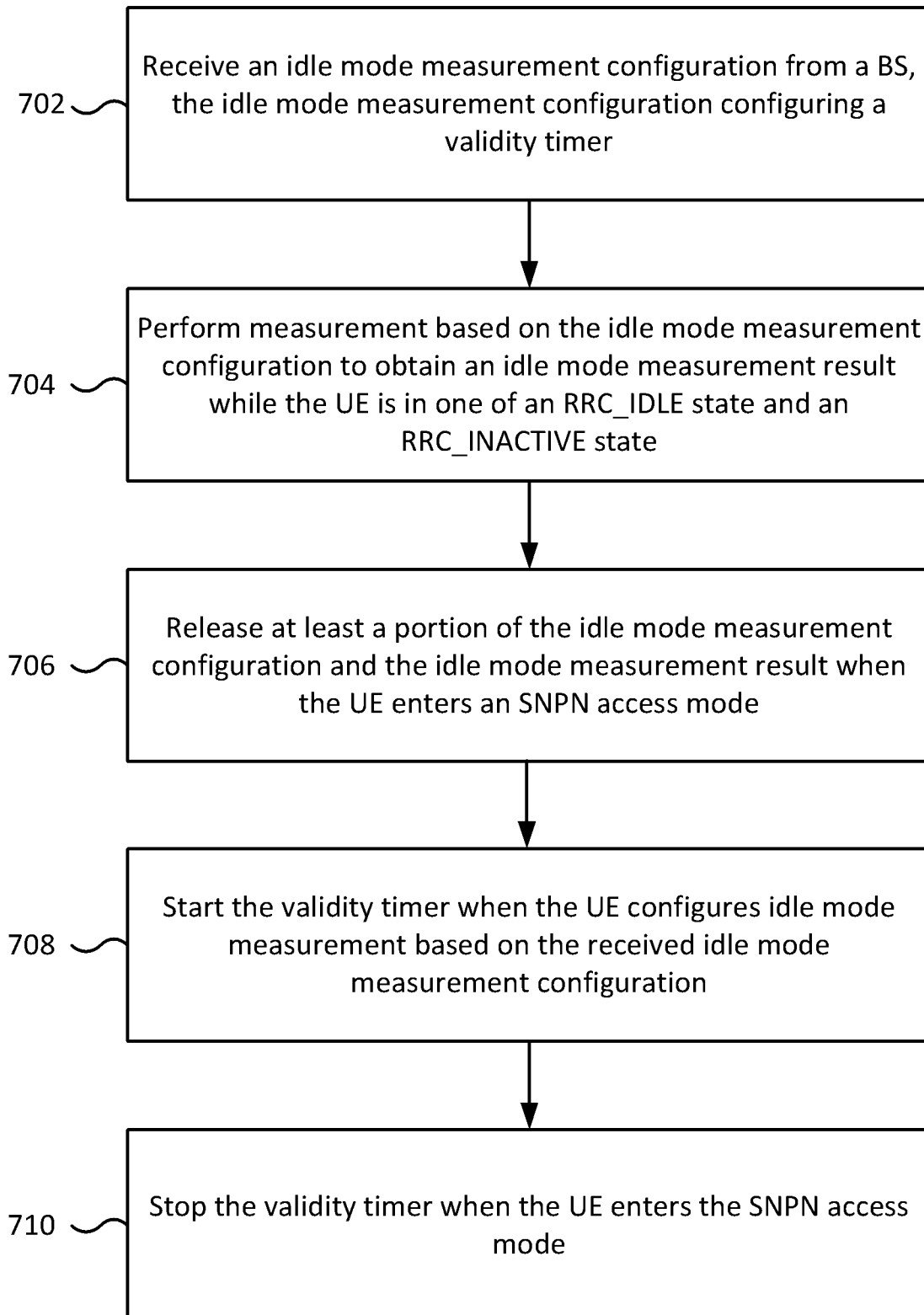
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FIG. 7

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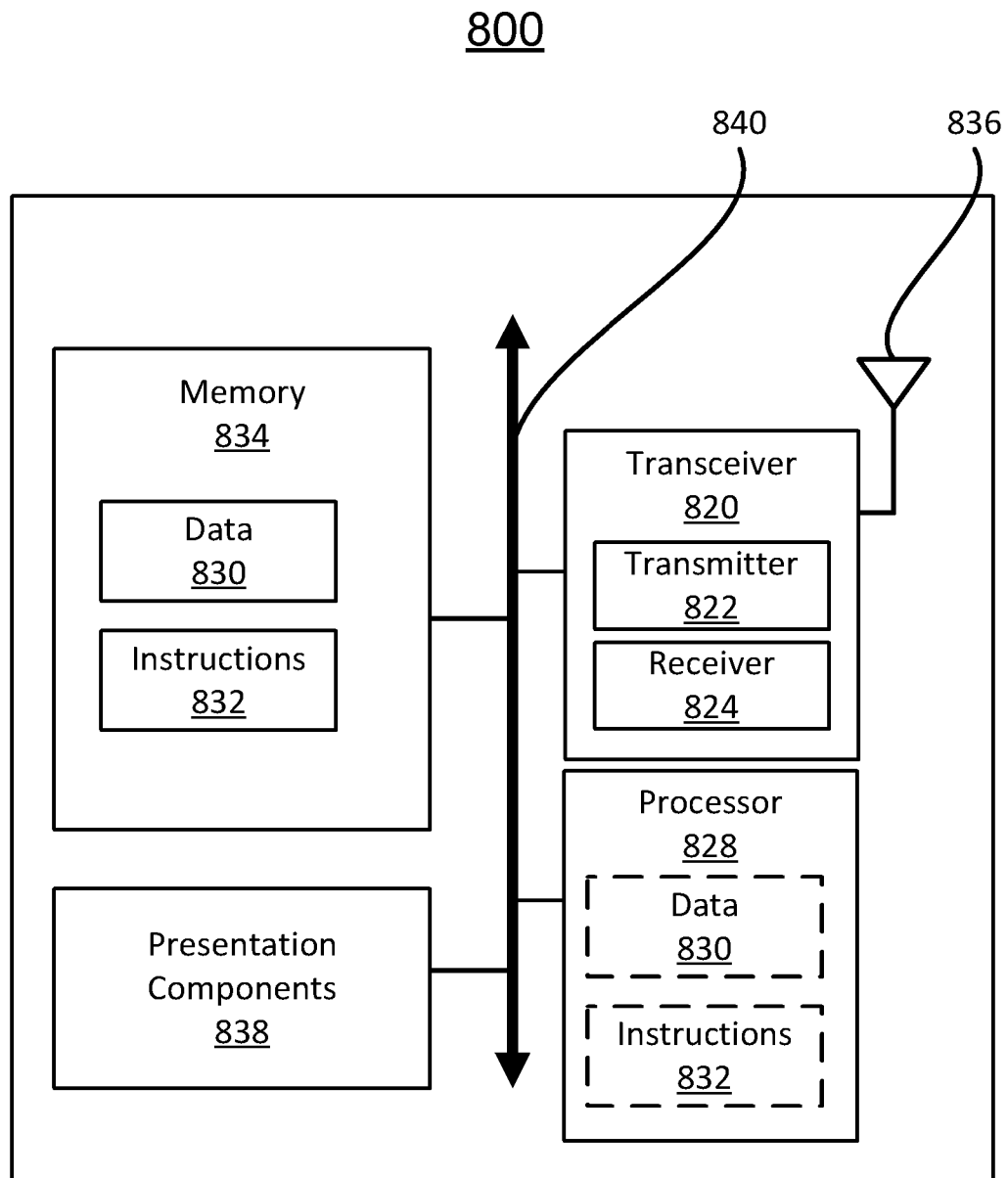


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/106253

A. CLASSIFICATION OF SUBJECT MATTER

H04W 24/08(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W

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

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

CNPAT,CNKI,EPODOC,WPL,3GPP: idle, SNPN, NPN, mode, state, measurement, configuration, result, RRC_IDLE, RRC_INACTIVE, switch, cancel, release, delete

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	3GPP. "3GPP TS 38.300 V16.1.0 (2020-03)" <i>3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NR and NG-RAN Overall Description; Stage 2(Relase 16)</i> , 08 April 2020 (2020-04-08), pages 76,111,112	1-15
A	CN 110035447 A (VIVO MOBILE COMMUNICATION CO., LTD.) 19 July 2019 (2019-07-19) the whole document	1-15
A	CN 109309969 A (KT CORPORATION) 05 February 2019 (2019-02-05) the whole document	1-15
A	US 2020221372 A1 (FG INNOVATION COMPANY LIMITED) 09 July 2020 (2020-07-09) the whole document	1-15
A	CATT. "Idle and Inactive Open Issues for NPN" <i>3GPP TSG RAN WG2#109-e R2-2000004</i> , 14 February 2020 (2020-02-14), the whole document	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"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

11 October 2021

Date of mailing of the international search report

20 October 2021

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2021/106253

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	110035447	A	19 July 2019	None			
CN	109309969	A	05 February 2019	US	2019037425	A1	31 January 2019
US	2020221372	A1	09 July 2020	WO	2020140830	A1	09 July 2020