(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
18 November 2021 (18.11.2021)

WIPO | PCT

(10) International Publication Number
WO 2021/228243 A1

(51) International Patent Classification:
H04W 68/12 (2009.01)

(21) International Application Number:
PCT/CN2021/093897

(22) International Filing Date:
14 May 2021 (14.05.2021)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/025,875 15 May 2020 (15.05.2020) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW,

(54) Title: USER EQUIPMENT AND METHOD FOR MULTI-SIM OPERATION

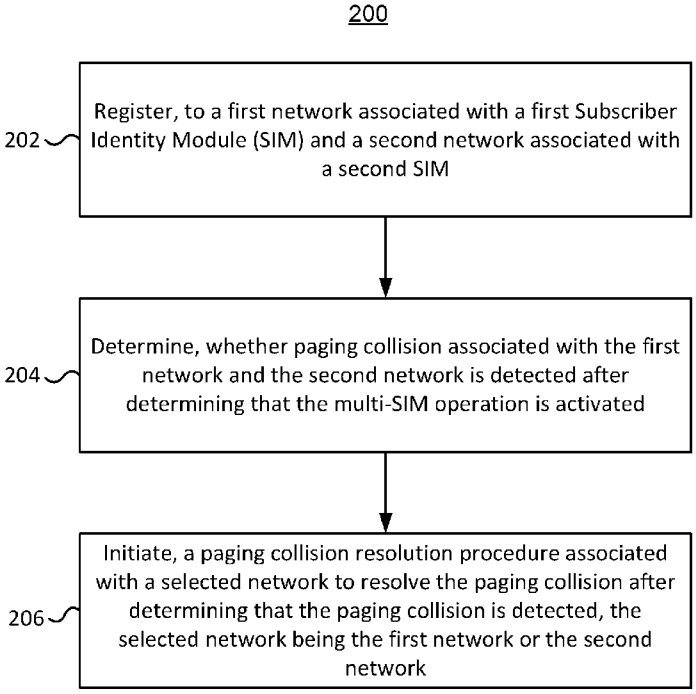


FIG. 2

(57) Abstract: A user equipment and a method for multi-Subscriber Identity Module (SIM) operation are provided. The method includes registering, to a first network associated with a first Subscriber Identity Module (SIM) and a second network associated with a second SIM; determining, whether paging collision associated with the first network and the second network is detected after determining that the multi-SIM operation is activated; and initiating, a paging collision resolution procedure associated with a selected network to resolve the paging collision after determining that the paging collision is detected. The selected network is the first network or the second network.

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SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

USER EQUIPMENT AND METHOD FOR MULTI-SIM OPERATION

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] The present disclosure claims the benefit of and priority of provisional U.S. Patent Application Serial No. 63/025,875, filed on May 15, 2020, entitled "Mechanism for Resolving Paging Collision in Multi-SIM Operation" ("the '875 provisional"). The disclosure of the '875 provisional is hereby incorporated fully by reference into the present disclosure for all purposes.

FIELD

[0002] The present disclosure is related to wireless communication, and specifically, to user equipment and method for multi-subscriber identity module (SIM) operation.

BACKGROUND

[0003] Various efforts have been made to improve different aspects of wireless communication for cellular wireless communication systems, such as 5G 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 eMBB, mMTC, and 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 multi-SIM operation in cellular wireless communication networks.

[0005] According to an aspect of the present disclosure, a method for multi-SIM operation performed by a UE is provided. The method includes registering, to a first network associated with a first SIM and a second network associated with a second SIM; determining, whether paging collision associated with the first network and the second network is detected after determining that the multi-SIM operation is activated; and initiating, a paging collision resolution procedure associated with a selected network to resolve the paging collision after determining that the paging collision is detected. The selected network is the first network or the second network.

[0006] According to another aspect of the present disclosure, a UE for multi-SIM operation is provided. The UE includes a processor and a memory coupled to the processor. The memory stores a computer-executable program that when executed by the processor, causes the processor to registering, to a first network associated with a first SIM and a second network associated with a second SIM;

determining, whether paging collision associated with the first network and the second network is detected after determining that the multi-SIM operation is activated; initiating, a paging collision resolution procedure associated with a selected network to resolve the paging collision after determining that the paging collision is detected. The selected network is the first network or the second network.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Aspects of the disclosure are best understood from the following detailed disclosure 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.

[0008] FIG. 1 shows a schematic diagram of paging collision according to an example implementation of the present disclosure.

[0009] FIG. 2 is a flowchart illustrating a method performed by a UE for the multi-SIM operation according to an example implementation of the present disclosure.

[0010] FIG. 3 is a flowchart illustrating a method performed by a UE for the multi-SIM operation according to another example implementation of the present disclosure.

[0011] FIG. 4 is a block diagram illustrating a node for wireless communication according to an example implementation of the present disclosure.

DESCRIPTION

[0012] The following contains specific information related to implementations of the present disclosure. The drawings and their accompanying detailed disclosure 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. 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.

[0013] 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 different in other respects and shall not be narrowly confined to what is illustrated in the drawings.

[0014] 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 via 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-disclosed 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."

[0015] 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.

[0016] 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 disclosure of well-known methods, technologies, systems, and architectures are omitted so as not to obscure the present disclosure with unnecessary details.

[0017] 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.

[0018] 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).

[0019] 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 as a 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.

[0020] 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 base station (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-UTRAN), a 5G Core (5GC), or an internet via a RAN established by one or more BSs.

[0021] 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 a 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.

[0022] The 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.

[0023] The 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, an ng-eNB in an Evolved Universal Terrestrial Radio Access (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 a radio interface.

[0024] 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.

[0025] 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 DL and optionally 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.

[0026] A cell may allocate sidelink (SL) resources for supporting Proximity Service (ProSe) or Vehicle to Everything (V2X) service. Each cell may have overlapped coverage areas with other cells.

[0027] In Multi-RAT Dual Connectivity (MR-DC) cases, the primary cell of a Master Cell Group (MCG) or a Secondary Cell Group (SCG) may be called a Special Cell (SpCell). A Primary Cell (PCell) may refer to the SpCell of an MCG. A Primary SCG Cell (PSCell) may refer to the SpCell of an SCG. MCG may refer to a group of serving cells associated with the Master Node (MN), comprising of the SpCell and optionally one or more Secondary Cells (SCells). An SCG may refer to a group of serving cells associated with the Secondary Node (SN), comprising of the SpCell and optionally one or more SCells.

[0028] As previously disclosed, 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.

[0029] 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.

[0030] At least DL transmission data, a guard period, and a 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. SL resources may also be provided in an NR frame to support ProSe services or V2X services.

[0031] Multi-USIM devices have been more and more popular in different areas and countries. For example, a user may have both a personal subscription and a business subscription in one device or has two personal subscriptions in one device for different services (e.g., one individual subscription and one “family circle” plan subscription). However, support for multi-USIM (Universal Subscriber Identity Module) within a device is currently handled in an implementation-specific manner without any support from 3GPP specifications, resulting in a variety of implementations and UE behaviors. Such situation may cause an increasing complexity for UE vendors, unexpected UE behavior for network vendors or operators, and degraded user experience. It would be beneficial to provide standardization support for a multi-USIM (or multi-SIM) UE from a performance perspective in that network functionality can be based on predictable UE behaviors.

[0032] For a multi-USIM (or multi-SIM) UE or a dual-USIM (or dual-SIM) UE, the UE may

register to more than one network (e.g., a first network and a second network) from which the UE may receive pages. The term "multi-SIM" may be replaced by another term "multi-USIM", "dual-SIM" or "dual-USIM". That is, the terms "multi-SIM", "multi-USIM", "dual-SIM" and "dual-USIM" may be exchangeable in some implementations of the present disclosure. The first network may refer to as "Network A" in the present disclosure, and the second network may refer to as "Network B" in the present disclosure. Depending on UE capabilities (e.g., RX and TX capabilities), it may happen that the RX of the UE may be occupied to receive/monitor pages from Network A while pages from Network B may also be sent. Therefore, a mechanism for addressing the paging collision due to page reception when the UE is in IDLE State (e.g., RRC_IDLE State) or Inactive State (e.g., RRC_INACTIVE State) in both (registered/selected) Network A and Network B associated with the respective SIMs (e.g., a first SIM and a second SIM) is required. The methods for a multi-SIM UE to resolve the paging collision in both networks associated with respective SIMs are disclosed in the present disclosure.

[0033] Multi-SIM operation

[0034] A Multi-SIM device (or a Dual-SIM device) may operate either in Dual SIM Dual Standby (DSDS) or Dual SIM Dual Active (DSDA) mode, but not limited to. DSDS and DSDA are specified in TR 22.834.

[0035] DSDS: both SIMs (including a first SIM and a second SIM) may be used for idle-mode network connection, but when a radio connection is active the other connection is disabled. The SIMs in a DSDS device may share a single transceiver. Two radio connections may be maintained in idle mode through time multiplexing. When the UE is in-call on network for the first SIM, it is no longer possible to maintain a radio connection to the network of the second SIM. Therefore, the connection to the network of the second SIM is unavailable for the duration of the call. Registration to the second network may be maintained.

[0036] DSDA: both SIMs may be used in both idle and connected modes. Each SIM has a dedicated transceiver, meaning that there are no interdependencies on idle or connected mode operation at the modem level.

[0037] Based on the device implementation choices, several architectures for multi-SIM devices may coexist in the market to support DSDS or DSDA. The architectures for multi-SIM devices may include {single RX, single TX}, {dual RX, single TX} and {dual RX, dual TX}. RX may mean a reception antenna, a reception antenna panel, a reception antenna chain, or a reception antenna system. TX may mean a transmission antenna, a transmission antenna panel, a transmission antenna chain, or a transmission antenna system. Single RX may mean a single reception RF antenna

(panel/chain/system), single TX may mean a single transmission RF antenna (panel/chain/system), dual RX may mean two reception RF antennas (panels/chains/systems) used for two networks respectively, and dual TX may mean two transmission RF antennas (panels/chains/systems) used for two networks respectively. A single RX UE may not be capable of receiving traffic from two networks at the same time, while a dual RX UE may be able to receive traffic from two networks at the same time. Note that a single TX UE may not be capable of transmitting traffic to two networks at the same time, while a dual TX UE may be able to transmit traffic to two networks at the same time.

[0038] In Multi-SIM scenarios, a UE may be (pre)configured or installed with at least two USIM(s). A USIM may be a physical SIM or eSIM. In one implementation, the UE may be equipped with a first SIM card and a second SIM card. The UE operating in a multi-SIM mode (or a dual-SIM mode) may also be referred to as a multi-SIM UE (or a dual-SIM UE).

[0039] The USIMs of a UE may belong to the same operator or belong to different operators. An operator may be a public network operator (e.g., PLMN operator), or a non-public network (e.g., SNPN operator, PNI-NPN operator). The network of one USIM (e.g., associated with Network A) may be NR, LTE connected to 5GC, LTE connected EPC, multi-connectivity (e.g., EN-DC, NE-DC, NGEN-DC, NR-DC), but not limited to. For example, a UE with two USIMs may operate on Network A (e.g., NR or LTE) and Network B (e.g., NR or LTE). The core network of a Network A may be the same as the core network of a Network B. The core network of Network A may be different from the core network of Network B. For example, considering the case of LTE connected to EPC, Network A may refer to LTE and the core network of Network A may refer to EPC. For another example, considering the case of NR, Network A may refer to NR and the core network of Network A may refer to 5GC. The UE may be equipped with {single RX, single TX}, {dual RX, single TX}, or {dual RX, dual TX}.

[0040] **Resolving Paging Collision**

[0041] In some implementations, a UE with dual-SIM (or multi-SIM) and {single RX, single TX} may experience paging collision. The paging collision may be that the paging monitoring occasions for different SIMs (or the corresponding networks) are overlapping in time domain and may result in missing paging (e.g., a paging DCI or a paging message may be missed from the UE's perspective). FIG. 1 shows a schematic diagram of paging collision, in accordance with an implementation of the present disclosure. For example, as shown in FIG. 1, a UE with dual-SIM (or multi-SIM) and {single RX, single TX} may camp on a cell of PLMN A (or Network A) associated with a first SIM and camp on a cell of PLMN B (or Network B) associated with a second SIM. Based on the corresponding paging factors (or parameters) of PLMN A (or Network A), the UE may monitor paging occasion PO #11, PO #12, and the following paging occasions in time domain. Based on the corresponding paging factors (or parameters) of PLMN B (or Network B), the UE may monitor paging occasion PO #21 and the

following paging occasions in time domain. As result, PO #11 and PO #21 are overlapping in time domain and the UE may experience a paging collision accordingly. For example, based on the PF/PO formula with paging factors (or parameters) of PLMN A (or Network A), the UE may derive the time resource location and/or frequency resource location of PO #11. Based on the PF/PO formula with paging factors (or parameters) of PLMN B (or Network B), the UE may derive the time resource location and/or frequency resource location of PO#21. The PF/PO formula captured in 3GPP TS 38.304 or TS 36.304 may be applied. However, if the time and/or frequency resource location of PO#11 and the time and/or frequency resource location of PO#21 overlaps (e.g., partially overlaps or fully overlaps), the UE with single RX may not successfully receive and decode both the paging DCI (or the corresponding paging message) from the cell of Network A in PO#11 and the paging DCI (or the corresponding paging message) from the cell of Network B in PO#21. In some implementations, when PLMN A (or Network A/Network A cell) and PLMN B (or Network B/Network B cell) are operating on the same spectrum/frequency band/frequency carrier, a UE with dual-SIM (or multi-SIM) and {single RX, single TX} may not experience paging collision. In some implementations, when PLMN A (or Network A/Network A cell) and PLMN B (or Network B/Network B cell) are operating on the same spectrum/frequency band/frequency carrier, a UE with dual-SIM (or multi-SIM) and {single RX, single TX} may not perform any mechanism (e.g., initiate a paging collision resolution procedure) for paging collision resolution (e.g., omit monitoring a PO of one of the network or apply new paging parameters/factors of one of the networks).

[0042] In some implementations, a UE may consider a network as active if an associated SIM/USIM of the network is switched on/turned on/plugged in/installed. In some implementations, a UE may consider a network as active if the UE registers to the network or sign in the network. In some implementations, a UE may consider a network as active if one suitable cell of the network is (re)selected by the UE. In some implementations, a UE may consider a network as active if one acceptable cell of the network is (re)selected by the UE. In some implementations, a UE may consider a network as active if at least one suitable cell of the network or one acceptable cell of the network is (re)selected by the UE. Note that the cell selection/cell reselection mechanism for suitable cell(s) or acceptable cell(s) captured in 3GPP TS 38.304 or TS 36.304 may be applied. The definitions of suitable cell(s) or acceptable cell(s) captured in 3GPP Technical Specification (TS) 38.304 or TS 36.304 may be applied.

[0043] In some implementations, a UE may consider a network as inactive if an associated SIM/USIM of the network is switched off/turned off/unplugged/uninstalled. In some implementations, a UE may consider a network as inactive if the UE dese not register to the network or sign out the network. In some implementations, a UE may consider a network as inactive if no suitable cell of the

network is (re)selected by the UE. In some implementations, a UE may consider a network as inactive if no acceptable cell of the network is (re)selected by the UE. In some implementations, a UE may consider a network as inactive if neither one suitable cell of the network nor one acceptable cell of the network is (re)selected by the UE. Note that the cell selection/cell reselection mechanism for suitable cell(s) or acceptable cell(s) captured in 3GPP TS 38.304 or TS 36.304 may be applied. The definitions of suitable cell(s) or acceptable cell(s) captured in 3GPP TS 38.304 or TS 36.304 may be applied.

[0044] In some implementations, upper layers (e.g., NAS layer or Application layer) of a UE may inform lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated). For example, if a UE successfully registered to a first network associated with a first SIM and a second network associated with a second SIM, (upper layers of) a UE may determine that the multi-SIM operation (or dual-SIM operation) is on (or be activated). In another example, if the multi-SIM operation (or dual-SIM operation) is on (or be activated) but a UE deregistered to a first network associated with a first SIM, (upper layers of) a UE may determine that the multi-SIM operation (or dual-SIM operation) is off (or be deactivated).

[0045] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have a common upper layer (e.g., a NAS layer or an Application layer) and the common upper layer may inform lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated).

[0046] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with a first SIM and the other NAS layer for network B associated with a second SIM) and each of the individual upper layer may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated). For example, the UE's NAS layer of network A associated with the first SIM may inform the UE's RRC layer of network A that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated). The UE's NAS layer of network B associated with the second SIM may inform the UE's RRC layer of network B that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated).

[0047] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with a first SIM and the other NAS layer for network B associated with a second SIM) and only one of the individual upper layers may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated).

[0048] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with a first SIM and the other

NAS layer for network B associated with a second SIM) and only the individual upper layer of a selected network may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated). The selected network may be determined based on pre-defined rules, pre-configuration, policy (e.g., based on channel quality results and/or S-criteria and/or operating frequency band), or UE implementations (e.g., the network which is associated with a SIM/USIM which is plugged in/installed first or manual selected).

[0049] In some implementations, individual upper layers (e.g., the upper layers of the UE) may exchange the information about a network status (e.g., whether the associated network is active or inactive) (e.g., via core network signaling, via UE internal signaling). For example, assume that network A associated with the first SIM is firstly active (or turned on). Later, network B associated with the second SIM is also active (or turned on). The upper layer associated with the network B (or the second SIM) of the UE may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on. For example, assume that network A associated with the first SIM and network B associated with the second SIM are both active (or turned on). Later, network B associated with the second SIM is inactive (or turned off). The upper layer associated with the network B (or the second SIM) of the UE may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is off. In another example, assume that network A associated with the first SIM and network B associated with the second SIM are both active (or turned on). Later, network B associated with the second SIM is inactive (or turned off). The upper layer associated with the network A (or the first SIM) of the UE may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is off.

[0050] In some implementations, individual lower layers (e.g., RRC layers of the UE) may exchange the information about the network status (e.g., whether the associated network is active or inactive) (e.g., via core network signaling, via UE internal signaling). For example, RRC layer associated with network A of a UE and RRC layer associated with network B of the UE may exchange the information. In some implementations, individual upper layer associated with network A of a UE may inform lower layer associated with network B of the UE about the network status.

[0051] In some implementations, upper layers (e.g., NAS layer or Application layer) of a UE may inform lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is off and/or which network is active (or inactive). For example, assume that network A is associated with a first SIM and network B is associated with a second SIM. While the multi-SIM operation is on and turned off later (e.g., the second SIM is disabled), upper layers (e.g., NAS layer or Application layer) of a UE may inform lower layers (e.g., RRC layer) of the UE that network A is active (or network B is not active).

[0052] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have a common upper layer (e.g., a NAS layer or an Application layer) and the common upper layer may inform lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is off and/or which network is active (or inactive).

[0053] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with a first SIM and the other NAS layer for network B associated with a second SIM) and each of the individual upper layer may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is off and/or the associated network is active (or inactive).

[0054] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with a first SIM and the other NAS layer for network B associated with a second SIM) and only one of the individual upper layers may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is off and/or which network is active (or inactive).

[0055] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with a first SIM and the other NAS layer for network B associated with a second SIM) and only the individual upper layer of a selected network may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is off and/or which network is active (or inactive). The selected network may be determined based on pre-defined rules, pre-configuration, policy, or UE implementations (e.g., the network which is associated with a SIM/USIM which is plugged in/installed first or manual selected).

[0056] In some implementations, individual upper layers (e.g., the upper layers of the UE) may exchange the information about the network status (e.g., if the associated network is active or inactive). For example, assume that network A associated with the first SIM and network B associated with the second SIM are both active (or turned on). Later, network B associated with the second SIM is inactive (or turned off). The upper layer associated with the network B (or the second SIM) of the UE may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is off and the status of network B is inactive. For another example, assume that network A associated with the first SIM and network B associated with the second SIM are both active (or turned on). Later, network B associated with the second SIM is inactive (or turned off). The upper layer associated with the network B (or the second SIM) of the UE may inform the lower layers (e.g., RRC layer) associated with the network A of the UE that the multi-SIM operation (or dual-SIM operation) is off and/or the status of network B is inactive.

[0057] In some implementations, the priorities of each network (or the related PLMN) associated with each (active) SIM/USIM may be determined based on pre-defined rules, pre-configuration, policy, or UE implementations (e.g., the network which is associated with a SIM/USIM which is plugged in/installed first or manual selected).

[0058] In some implementations, the priorities of each network (or the related PLMN) associated with each (active) SIM/USIM may be determined based on the associated RRC state. For example, if a UE is in RRC_IDLE at network A and is in RRC_INACITVE state at network B, the priority of network B may be considered higher than the priority of network A.

[0059] In some implementations, the priorities of each network (or the related PLMN) associated with each (active) SIM/USIM may be determined based on network type (e.g., public network or private network). For example, if network A is a public network and network B is a private network (e.g., Standalone Non-Public Network/SNPN or closed access group/CAG), the priority of network B may be considered higher than the priority of network A.

[0060] In some implementations, the priorities of each network (or the related PLMN) associated with each (active) SIM/USIM may be determined based on the serving frequencies. For example, if network A is operating on a non-ITS (Intelligent Transport System) band and network B is operating on an ITS band, the priority of network B may be considered higher than the priority of network A.

[0061] In some implementations, the priorities of each network (or the related PLMN) associated with each (active) SIM/USIM may be determined based on the associated core network (e.g., EPC or 5GC). For example, if network A is associated with EPC and network B is associated with 5GC, the priority of network B may be considered higher than the priority of network A.

[0062] In some implementations, a UE may jointly consider different factors (e.g., RRC state, network type, serving frequency or core network type, but not limited to) to determine a priority of a network (or the related PLMN).

[0063] In some implementations, upper layers (e.g., NAS layer or Application layer) of a UE may inform lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated), and/or the priority of the network (which is associated with a respective SIM).

[0064] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with the first SIM and the other NAS layer for network B associated with the second SIM) and each individual upper layer may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated), and/or the priority of the network (which is associated with a respective SIM).

[0065] In some implementations, upper layers (e.g., NAS layer or Application layer) of a UE may inform lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated), and/or one of the networks (which is associated with a respective SIM) is with highest/higher priority (or lowest/lower priority). For example, assume that network A is associated with the first SIM and network B is associated with the second SIM. While the multi-SIM operation is on, network A may be indicated as the network with highest/higher priority.

[0066] In some implementations, upper layers (e.g., NAS layer or Application layer) of a UE may inform lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated), and/or one of the selected PLMNs (which is associated with a respective SIM or a network) is with highest/higher priority (or lowest/lower priority).

[0067] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have a common upper layer (e.g., a NAS layer or an Application layer) and the common upper layer may inform lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated), and/or one of the networks (which is associated with a respective SIM) is with highest/higher priority (or lowest/lower priority).

[0068] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with the first SIM and the other NAS layer for network B associated with the second SIM) and each of the individual upper layer may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated), and/or the associated network (which is associated with a respective SIM) is with highest/higher priority (or lowest/lower priority).

[0069] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with the first SIM and the other NAS layer for network B associated with the second SIM) and only one of the individual upper layers may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated), and/or one of the networks (which is associated with a respective SIM) is with highest/higher priority (or lowest/lower priority).

[0070] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with the first SIM and the other NAS layer for network B associated with the second SIM) and only the individual upper layer of a selected network may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on or off (or be activated/de-activated), and/or one of the networks (which is associated with a respective SIM) is with highest/higher priority (or lowest/lower priority). The selected network may be determined based on pre-defined rules, pre-configuration, policy, or UE

implementations (e.g., the network which is associated with a SIM/USIM which is plugged in/installed first or manual selected).

[0071] In some implementations, individual upper layers (e.g., the upper layers of the UE) may exchange the information about the network status (e.g., if the associated network is active or inactive). For example, assume that network A associated with the first SIM is first active (or turned on). Later, network B associated with the second SIM is also active (or turned on). The upper layer associated with the network B (or the second SIM) of the UE may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is on and network B is with highest/higher priority (or lowest/lower priority). For example, assume that network A associated with the first SIM and network B associated with the second SIM are both active (or turned on). Later, network B associated with the second SIM is inactive (or turned off). The upper layer associated with the network B (or the second SIM) of the UE may inform associated lower layers (e.g., RRC layer) of the UE that the multi-SIM operation (or dual-SIM operation) is off.

[0072] In some implementations, individual lower layers (e.g., RRC layers of the UE) may exchange the information about the network status (e.g., the priority of the related network) (e.g., via core network signaling, via UE internal signaling). For example, RRC layer associated with network A of a UE and RRC layer associated with network B of the UE may exchange the information.

[0073] In some implementations, individual upper layer associated with network A of a UE may inform lower layer associated with network B of the UE about the network status.

[0074] In some implementations, upper layers (e.g., NAS layer or Application layer) of a UE may inform lower layers (e.g., RRC layer) of the UE about the architecture for supporting multi-SIM operation/dual-SIM operation. For example, upper layers (e.g., NAS layer or Application layer) of a UE may report/inform/configure the architecture for supporting multi-SIM operation to be {single RX, single TX} to lower layers (e.g., RRC layer) of the UE. For example, upper layer (e.g., NAS layer or Application layer) of a UE may report/inform/configure the architecture for supporting multi-SIM operation to be {dual RX, single TX} to lower layers (e.g., RRC layer) of the UE.

[0075] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have a common upper layer (e.g., a NAS layer or an Application layer) and the common upper layer may inform lower layers (e.g., RRC layer) of the UE about the architecture for supporting multi-SIM/dual-SIM operation.

[0076] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with the first SIM and the other NAS layer for network B associated with the second SIM) and each of the individual upper layer may inform associated lower layers (e.g., RRC layer) of the UE about the architecture for supporting multi-

SIM/dual-SIM operation.

[0077] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with the first SIM and the other NAS layer for network B associated with the second SIM) and only one of the individual upper layers may inform associated lower layers (e.g., RRC layer) about the architecture for supporting multi-SIM/dual-SIM operation.

[0078] In some implementations, a multi-SIM capable UE (or a dual-SIM capable UE) may have individual upper layers (e.g., one NAS layer for network A associated with the first SIM and the other NAS layer for network B associated with the second SIM) and only the individual upper layer of a selected network may inform associated lower layers (e.g., RRC layer) of the UE about the architecture for supporting multi-SIM/dual-SIM operation. The selected network may be determined based on pre-defined rules, pre-configuration, policy, or UE implementations (e.g., the network which is associated with a SIM/USIM which is plugged in/installed first or manual selected).

[0079] **Paging collision resolution**

[0080] In some implementation, if the multi-SIM operation/dual-SIM operation of a UE is on, the UE may monitor at least one paging occasion (PO) per DRX cycle for per network which is associated with a respective SIM. Note that one Paging Frame (PF) is one Radio Frame and may contain one or multiple PO(s) or starting point of a PO. The UE may determine the paging frame(s) and paging occasion(s) for paging based on a pre-defined formula (e.g., the formula defined in TS 38.304 v16.0.0) based on the parameters (or factors) received from the respective network (or the cell). The UE may receive pages (e.g., paging DCI) based on the determined PO(s) (or PF(s)) of both networks. For example, if the multi-SIM operation/dual-SIM operation of a UE is on and network A is associated with the first SIM and network B is associated with the second SIM, the UE may determine the paging frame(s) and paging occasion(s) for paging from network A based on the parameters configured by network A (e.g., via broadcasting system information, via RRC message (e.g., RRC Release with suspend configuration, RRC Release without suspend configuration)) and the UE may also determine the paging frame(s) and paging occasion(s) for paging from network B based on the parameters configured by network B (e.g., via broadcasting system information, via RRC message (e.g., RRC Release with suspend configuration, RRC Release without suspend configuration)). The UE may monitor the determined PO(s) of network A for receiving pages (e.g., paging DCI). The UE may monitor the determined PO(s) of network B for receiving pages. In some implementations, based on the determination, a PO (or a PF) of network A may collide with a PO (of a PF) of a network B. In some implementations, if monitoring both collided POs (or PFs) for receiving pages (e.g., paging DCI) is possible (e.g., the architecture for supporting multi-SIM operation/dual-SIM operation is {dual RX,

single TX}), the UE may receive pages from both collided POs (or PFs).

[0081] **Solution #1**

[0082] In some implementations, if monitoring both collided POs (or PFs) for receiving pages (e.g., paging DCI) is not possible (e.g., the architecture for supporting multi-SIM operation/dual-SIM operation is {single RX, single TX}), the UE may monitor pages from one of the collided POs (or PFs). In some implementations, if monitoring both collided POs (or PFs) for receiving pages (e.g., paging DCI) is not possible (e.g., the architecture for supporting multi-SIM operation/dual-SIM operation is {single RX, single TX}), the UE may randomly select one of the collided POs (or PFs) and monitor the selected collided PO (or PF) for receiving pages (e.g., paging DCI). In some implementations, if monitoring both collided POs (or PFs) for receiving pages (e.g., paging DCI) is not possible (e.g., the architecture for supporting multi-SIM operation/dual-SIM operation is {single RX, single TX}), the UE may monitor the collided PO (or PF) of the network (or selected PLMN) with the highest/higher priority for receiving pages (e.g., paging DCI). The priority of a network (or PLMN) associated with a respective SIM may be pre-defined/per-configured or informed by upper layers (e.g., NAS layer or Application layer). In some implementations, if monitoring both collided POs (or PFs) for receiving pages (e.g., paging DCI) is not possible (e.g., the architecture for supporting multi-SIM operation/dual-SIM operation is {single RX, single TX}), the UE may monitor the collided PO (or PF) of the network (or selected PLMN) wherein the UE may just monitor another PO (or another PF) of the other network (or selected PLMN) before the current (collided) PO. For example, if a UE determines that there are collides PO(s) among network A and network B, the UE may first monitor a collided PO of network A and then monitor a next collided PO of network B.

[0083] In some implementations, if monitoring both collided POs (or PFs) for receiving pages (e.g., paging DCI) is not possible (e.g., the architecture for supporting multi-SIM operation/dual-SIM operation is {single RX, single TX}), the UE omit monitoring the collided PO (or PF) of the impacted network (or selected PLMN). In some implementations, in case of multi-SIM operation/dual-SIM operation is on and both a network associated with E-UTRA and a network associated with NR are active, a network associated with NR may be considered to be impacted if a PO (or a PF) determined based on its paging parameters collides with another PO (or another PF) determined based on the paging parameters of the network associated with E-UTRA. In some implementations, in case of multi-SIM operation/dual-SIM operation is on and both a network associated with E-UTRA and a network associated with NR are active, a network associated with E-UTRA may be considered to be impacted if a PO (or a PF) determined based on its paging parameters collides with another PO (or another PF) determined based on the paging parameters of the network associated with NR. In some implementations, in case of multi-SIM operation/dual-SIM operation is on and both networks are

associate with same Radio Access Technology/RAT (e.g., NR or LTE), if a PO (or a PF) determined based on the paging parameters of network A collides with another PO (or another PF) determined based on the paging parameters of network B, a UE may randomly select one network as the impacted network. In some implementations, in case of multi-SIM operation/dual-SIM operation is on and both networks are associated with same RAT (e.g., NR or LTE), if a PO (or a PF) determined based on the paging parameters of network A collides with another PO (or another PF) determined based on the paging parameters of network B, a UE may select one network with lowest/lower priority as the impacted network. In some implementations, in case of multi-SIM operation/dual-SIM operation is on and both networks are associate with same RAT (e.g., NR or LTE), if a PO (or a PF) determined based on the paging parameters of network A collides with another PO (or another PF) determined based on the paging parameters of network B, a UE may select one network as the impacted network based on the pre-defined rules/configuration/policy, UE implementations, or UE setting (e.g., based on the information provided by NAS layer or Application layer).

[0084] In some implementations, if the multi-SIM operation (or dual-SIM operation) is off and only one of the networks is active, the UE may keep monitoring PO(s) of the active network and stop monitoring PO(s) of the network which is not active. In some implementations, if the multi-SIM operation (or dual-SIM operation) is off and a network becomes inactive (or is turned off), the UE may keep the corresponding paging parameters (or paging factors) (e.g., PO offset, PF offset, or UE-ID offset used in paging formula) of the inactive network. In some implementations, if the multi-SIM operation (or dual-SIM operation) is off and a network becomes inactive (or is turned off), the UE may release the corresponding paging parameters (or paging factors) (e.g., PO offset, PF offset, or UE-ID offset used in paging formula) of the inactive network. In some implementations, if the multi-SIM operation (or dual-SIM operation) is off and only one of the networks is active, the UE may stop monitoring the paging occasion of the inactive network. For example, assume that network A associated with the first SIM and network B associated with the second SIM are both active (or turned on). Later, network B associated with the second SIM is inactive (or turned off). The UE may not monitor the paging occasion of network B. Instead, since network A is still active, the UE may keep monitoring the paging occasion of network A.

[0085] In some implementations, if at least one collided PO (or PF) is determined, the UE may omit monitor pages from one of the networks. For example, if the multi-SIM operation (or dual-SIM operation) of a UE is on and at least one collided PO (or PF) is determined by the UE based on the paging parameters (or factors) from network A and the paging parameters (or factors) from network B, the UE may omit monitoring (all) PO(s) of network B (e.g., network B is with lowest/lower priority or network B is selected based on pre-configuration/pre-defined rules/UE implementations).

[0086] In some implementations, as shown in FIG. 1, when PLMN A (or Network B/Network A cell) and PLMN B (or Network B/Network B cell) are operating on the same spectrum/frequency band/frequency carrier, a UE with dual-SIM (or multi-SIM) and {single RX, single TX} may not perform the related implementation of solution #1 for paging collision resolution.

[0087] **Solution #2**

[0088] In some implementations, if the determined collided PO(s)/PF(s) is equal to or below a collision rate, a UE may only apply the solution without NW involvement (e.g., the solution #1). In some implementations, if the determined collided PO(s)/PF(s) is equal to or above a collision rate, a UE may be allowed to apply the solution with NW involvement (e.g., the solution #2). In some implementation, a collision rate may be configurable or pre-defined. In some implementations, a collision rate may be provided via system information or via dedicated signaling. In some implementations, a collision rate may be the number of collided PO(s) (or the number of collided PF(s)) within a period. The period may be configurable or pre-defined. The period may be provided via system information or via dedicated signaling.

[0089] In some implementations, a network (or an associated base station/cell) may indicate (e.g., via broadcasting system information or dedicated signaling) whether paging collision resolution is supported. In some implementations, if paging collision resolution is indicated (or supported) and a UE encounters a problem of paging collision (e.g., a PO of network A may collide with a PO of a network B), a UE may initiate a paging collision resolution procedure. In some implementations, upon initiation a paging collision resolution procedure, a UE may inform a network (e.g., a network which is impacted or with lowest/lower priority or the network which is selected based on the pre-configuration/pre-defined rules/UE implementations) about the initiation of the paging collision resolution procedure or the intention to initiate the paging collision resolution procedure. Note that in case of multi-SIM operation/dual-SIM operation is on (i.e., both network A and network B are active (or turned on)), Network A may be considered to be impacted if a PO (or a PF) determined based on the paging parameters of network A collides with another PO (or another PF) determined based on the paging parameters of network B. In some implementations, in case of multi-SIM operation/dual-SIM operation is on and both a network associated with E-UTRA and a network associated with NR are active, a network associated with NR may be considered to be impacted if a PO (or a PF) determined based on its paging parameters collides with another PO (or another PF) determined based on the paging parameters of the network associated with E-UTRA. In some implementations, in case of multi-SIM operation/dual-SIM operation is on and both a network associated with E-UTRA and a network associated with NR are active, a network associated with E-UTRA may be considered to be impacted if a PO (or a PF) determined based on its paging parameters collides with another PO (or another PF)

determined based on the paging parameters of the network associated with NR. In some implementations, in case of multi-SIM operation/dual-SIM operation is on and both networks are associate with same RAT (e.g., NR or LTE), if a PO (or a PF) determined based on the paging parameters of network A collides with another PO (or another PF) determined based on the paging parameters of network B, a UE may randomly select one network as the impacted network. In some implementations, in case of multi-SIM operation/dual-SIM operation is on and both networks are associated with same RAT (e.g., NR or LTE), if a PO (or a PF) determined based on the paging parameters of network A collides with another PO (or another PF) determined based on the paging parameters of network B, a UE may select one network with lowest/lower priority as the impacted network. In some implementations, in case of multi-SIM operation/dual-SIM operation is on and both networks are associate with same RAT (e.g., NR or LTE), if a PO (or a PF) determined based on the paging parameters of network A collides with another PO (or another PF) determined based on the paging parameters of network B, a UE may select one network as the impacted network based on the pre-defined rules/configuration/policy, UE implementations, or UE setting (e.g., based on the information provided by NAS layer or Application layer).

[0090] In some implementations, a UE may provide an assistance information to a network for resolving paging collision. In some implementations, a UE may be allowed to initiate/apply a paging collision resolution procedure after receiving a NW command or response (e.g., the response from the NW after sending an information about the intention to initiate the paging collision resolution procedure). In some implementations, after initiating the paging collision resolution procedure/applying a paging collision resolution, if a collided PO (or PF) still happens, the UE may monitor the collided PO (or PF) of the network (or selected PLMN) with the highest/higher priority for receiving pages (e.g., paging DCI), monitor the collided PO (or PF) of the network/PLMN randomly selected by UE, or apply the corresponding implementations and designs (e.g., the implementations related to solution #1). In some implementations, after applying paging collision resolution of solution #2, if collided POs (or PFs) for receiving pages (e.g., paging DCI) still exist, the UE may apply paging collision resolution of solution #1.

[0091] In some implementations, a UE may apply pre-defined/pre-configured (or dummy) paging parameters to determine PO(s) or PF(s) of a network (or PLMN) (e.g., upon initiating/applying a paging collision resolution procedure or upon the NW response). Pre-defined/pre-configured (or dummy) paging parameters may be provided via system information or dedicated signaling. Pre-defined/pre-configured (or dummy) paging parameters may be pre-defined or specified. For example, if a UE determines that at least one PO (or a PF) of network A may collide with a PO (of a PF) of a network B, the UE may apply the pre-defined (or dummy) paging parameters to derive the new PO(s)

or PF(s) of network B to try to avoid paging collision. For example, if a UE determines that at least one PO (or a PF) of network A may collide with a PO (of a PF) of a network B, the UE may apply the pre-defined (or dummy) paging parameters to derive the new PO(s) or PF(s) for the network with lowest/lower priority (in comparison with the NW with the highest priority) or for the impacted network to try to avoid paging collision. Note that the priorities of each network associated with each active SIM/USIM may be determined based on pre-defined rules, pre-configuration, policy, or UE implementations (e.g., the network which is associated with a SIM/USIM which is plugged in/installed first or manual selected). For example, if a UE determines that at least one PO (or a PF) of network A may collide with a PO (of a PF) of a network B, the UE may apply the pre-defined (or dummy) paging parameters to derive the new PO(s) or PF(s) of a network selected by the UE or based on the pre-defined rules/configurations/policy to try to avoid paging collision. In some implementations, a UE may stop applying pre-defined (or dummy) paging parameters to determine PO(s) or PF(s) of a network (or PLMN) when the camped cell associated the impacted network (or PLMN) changes (e.g., due to cell reselection). In some implementations, a UE may stop applying pre-defined (or dummy) paging parameters to determine PO(s) or PF(s) of a network (or PLMN) when a camped cell of the network (or PLMN) changes (e.g., due to cell reselection). In some implementations, a UE may stop applying pre-defined (or dummy) paging parameters to determine PO(s) or PF(s) of a network (or PLMN) when the UE connects to the network (e.g., transition to RRC_CONNECTED state) or when the UE connects to another network (e.g., transition to RRC_CONNECTED state).

[0092] In some implementations, a UE may start monitoring reserved PO(s) or reserved PF(s) of a network for receiving pages (e.g., paging DCI) (e.g., upon initiating/applying a paging collision resolution procedure or upon the NW response). Reserved PO(s) or reserved PF(s) may be provided via system information or dedicated signaling. Reserved PO(s) or reserved PF(s) may be pre-defined or specified. For example, if a UE determines that at least one PO (or a PF) of network A may collide with a PO (of a PF) of a network B, the UE may start monitoring the reserved PO(s) or reserved PF(s) of a network with lowest/lower priority for receiving pages (e.g., paging DCI) or an impacted network to try to avoid paging collision. For example, if a UE determines that at least one PO (or a PF) of network A may collide with a PO (of a PF) of a network B, the UE may start monitoring the reserved PO(s) or reserved PF(s) of a network selected by the UE or selected based on the pre-defined rules/configurations/policy for receiving pages (e.g., paging DCI) to try to avoid paging collision. In some implementations, a UE may stop monitoring reserved PO(s) or reserved PF(s) of a network (or PLMN) when the camped cell associated the impacted network (or PLMN) changes (e.g., due to cell reselection). In some implementations, a UE may stop monitoring reserved PO(s) or reserved PF(s) of a network (or PLMN) when a camped cell of the network (or PLMN) changes (e.g., due to cell

reselection). In some implementations, a UE may stop monitoring reserved PO(s) or reserved PF(s) of a network (or PLMN) when the UE connects to the network (e.g., transition to RRC_CONNECTED state) or when the UE connects to another network (e.g., transition to RRC_CONNECTED state).

[0093] In some implementations, a UE may apply the new paging parameters or paging information (e.g., PO offset/PF offset) indicated in a NW command to derive/determine the new PO(s) or PF(s) to monitor for receiving pages (e.g., paging DCI) (e.g., upon initiating/applying a paging collision resolution procedure or upon the NW response). For example, if a UE determines that at least one PO (or a PF) of network A may collide with a PO (of a PF) of a network B, the UE may inform a network with lowest/lower priority or an impacted network to resolve paging collision. For example, if a UE determines that at least one PO (or a PF) of network A may collide with a PO (of a PF) of a network B, the UE may inform a network selected by the UE or selected based on the pre-defined rules/configurations/policy to resolve paging collision. The network being informed may provide the new paging parameters (e.g., based on the assistance information provided by the UE) to the UE to derive/determine the new PO(s) or PF(s) to monitor for receiving pages (e.g., paging DCI). In some implementations, a UE may stop applying the new paging parameters or paging information (e.g., PO offset/PF offset/UE-ID offset) indicated in a NW command of a network (or PLMN) when the camped cell associated the impacted network (or PLMN) changes (e.g., due to cell reselection). In some implementations, a UE may stop applying the new paging parameters or paging information (e.g., PO offset/PF offset/UE-ID offset) indicated in a NW command of a network (or PLMN) when a camped cell of the network (or PLMN) changes (e.g., due to cell reselection). In some implementations, a UE may stop applying the new paging parameters or paging information (e.g., PO offset/PF offset/UE-ID offset) indicated in a NW command of a network (or PLMN) when the UE connects to the network (e.g., transition to RRC_CONNECTED state) or when the UE connects to another network (e.g., transition to RRC_CONNECTED state). In some implementations, if the multi-SIM operation (or dual-SIM operation) is off and a network becomes inactive (or is turned off), the UE may keep the new paging parameters (or paging information) (e.g., PO offset, PF offset, or UE-ID offset used in paging formula) of the inactive network (if received before). In some implementations, if the multi-SIM operation (or dual-SIM operation) is off and a network becomes inactive (or is turned off), the UE may release the new paging parameters (or paging information) (e.g., PO offset, PF offset, or UE-ID offset used in paging formula) of the inactive network (if received before).

[0094] In some implementations, a UE may apply the suggested/assisted paging parameters or paging information (e.g., an offset for the current PO(s) or an offset for the current PF(s)) to derive/determine the new PO(s) or PF(s) to monitor for receiving pages (e.g., paging DCI) (e.g., upon transmitting assistance information related paging collision resolution to NW, upon initiating/applying

a paging collision resolution procedure or upon the NW response). For example, if an offset is received via a NW response and the offset is applied for an impacted NW, each PO of the impacted NW may be shifted based on the offset in time domain. For example, if a PO of the impacted NW is at time domain T1 (e.g., the starting point of the PO) and the offset is T2, the UE may monitor the PO at time domain T1+T2 (e.g., the new starting point of the PO). In some implementations, the suggested/assisted paging parameters or paging information may be pre-configured/configured via dedicated signaling or broadcasting system information from a network. In some implementations, a UE may apply the suggested/assisted paging parameters or paging information (e.g., an offset for the current PO(s)) to derive/determine the new PO(s) or PF(s) to monitor for receiving pages (e.g., paging DCI), while receiving a NW command. In some implementations, a UE may stop applying the suggested/assisted paging parameters or paging information of a network (or PLMN) when the camped cell associated the impacted network (or PLMN) changes (e.g., due to cell reselection). In some implementations, a UE may stop applying the suggested/assisted paging parameters or paging information of a network (or PLMN) when a camped cell of the network (or PLMN) changes (e.g., due to cell reselection). In some implementations, a UE may stop applying the suggested/assisted paging parameters or paging information of a network (or PLMN) when the UE connects to the network (e.g., transition to RRC_CONNECTED state) or when the UE connects to another network (e.g., transition to RRC_CONNECTED state).

[0095] In some implementations, as shown in FIG. 1, when PLMN A (or Network B/Network A cell) and PLMN B (or Network B/Network B cell) are operating on the same spectrum/frequency band/frequency carrier, a UE with dual-SIM (or multi-SIM) and {single RX, single TX} may not perform the related implementation of solution #2 for paging collision resolution.

[0096] **Solution #3**

[0097] In some implementations, if a first page (e.g., paging DCI, short message, or paging message) associated with a UE (e.g., a UE with dual-SIM (or multi-SIM) and/or {single RX, single TX}) is received, the UE may monitor the PO(s) (including collided PO and/or non-collided PO) of another network for a period to try to receive a second page associated with the UE.

[0098] In some implementations, if a first page associated with a UE (e.g., a UE with dual-SIM (or multi-SIM) and/or {single RX, single TX}) is received and the first page is with the highest priority (or high priority), the UE may NOT monitor the PO(s) (including collided PO and/or non-collided PO) of another network but perform the action (e.g., a RA procedure for RRC Connection Setup or RRC Connection Resume) in response to the first page. In some implementations, if a first page associated with a UE (e.g., a UE with dual-SIM (or multi-SIM) and/or {single RX, single TX}) is received and the first page is not with the highest priority (or high priority), the UE may monitor the PO(s) (including

collided PO and/or non-collided PO) of another network for a time period to try to receive a second page associated with the UE. If the second page associated with the UE is not received within the time period, the UE may perform the action (e.g., a RA procedure for RRC Connection Setup or RRC Connection Resume) in response to the first page. If the second page associated with the UE is received within the time period and the priority of the second page is higher than or equal to the priority of the first page, the UE may perform the action (e.g., a RA procedure for RRC Connection Setup or RRC Connection Resume) in response to the second page. If the second page associated with the UE is received within the time period and the priority of the second page is lower than or equal to the priority of the first page, the UE may perform the action (e.g., a RA procedure for RRC Connection Setup or RRC Connection Resume) in response to the first page. If the second page associated with the UE is received within the time period and the priority of the second page is equal to the priority of the first page, the UE may select one of the page to respond (e.g., based on pre-configuration/pre-defined rules/policy/UE implementations).

[0099] In some implementations, if a first page associated with a UE (e.g., a UE with dual-SIM (or multi-SIM) and/or {single RX, single TX}) is received at a network with lower priority, the UE may monitor the PO(s) (including collided PO and/or non-collided PO) of another network (with higher priority or same priority) for a time period to try to receive a second page associated with the UE. In some implementations, if a first page associated with a UE (e.g., a UE with dual-SIM (or multi-SIM) and/or {single RX, single TX}) is received at a network with higher priority, the UE may not monitor the PO(s) (including collided PO and/or non-collided PO) of another network but perform the action (e.g., a RA procedure for RRC Connection Setup or RRC Connection Resume) in response to the first page.

[00100] In some implementation, the time period may be configurable or pre-defined. In some implementations, the time period may be provided via system information or via dedicated signaling. For example, the time period for Network A may be provided by the Network A to the UE. For another example, the time period for Network A may be provided by the Network B to the UE. The time period may be configurable or pre-defined. The time period may be provided via system information or via dedicated signaling. In one implementation, the time period may be configured per NW individually (e.g., UE assume no timer if there is no valid stored configuration). In one implementation, the timer period may be determined based on a scaling factor and the factor may rely on number of SIM supported for Multi-SIM operation, number of TX/RX and so on.

[00101] In some implementations, if a first page associated with a UE (e.g., a UE with dual-SIM (or multi-SIM) and/or {single RX, single TX}) is received and the first page is NOT with the highest priority (or high priority), the UE may monitor the coming K PO(s) (including collided PO and/or non-

collided PO) of another network to try to receive a second page associated with the UE. If the second page associated with the UE is not received after monitoring the K PO(s) of the other network, the UE may perform the action (e.g., a RA procedure for RRC Connection Setup or RRC Connection Resume) in response to the first page. If the second page associated with the UE is received when monitoring the coming K PO(s) of the other network and the priority of the second page is higher than or equal to the priority of the first page, the UE may perform the action (e.g., a RA procedure for RRC Connection Setup or RRC Connection Resume) in response to the second page. If the second page associated with the UE is received when monitoring the coming K PO(s) of the other network and the priority of the second page is lower than or equal to the priority of the first page, the UE may perform the action (e.g., a RA procedure for RRC Connection Setup or RRC Connection Resume) in response to the first page. If the second page associated with the UE is received when monitoring the coming K PO(s) of the other network and the priority of the second page is equal to the priority of the first page, the UE may select one of the pages to respond (e.g., based on pre-configuration/pre-defined rules/policy/UE implementations).

[00102] In some implementations, if a first page associated with a UE (e.g., a UE with dual-SIM (or multi-SIM) and/or {single RX, single TX}) is received at a network with lower priority, the UE may monitor the coming K PO(s) (including collided PO and/or non-collided PO) of another network (with higher priority or same priority) to try to receive a second page associated with the UE. In some implementations, if a first page associated with a UE (e.g., a UE with dual-SIM (or multi-SIM) and/or {single RX, single TX}) is received at a network with higher priority, the UE may not monitor the PO(s) (including collided PO and/or non-collided PO) of another network but perform the action (e.g., a RA procedure for RRC Connection Setup or RRC Connection Resume) in response to the first page.

[00103] In some implementation, K may be configurable or pre-defined. In some implementations, K may be provided via system information or via dedicated signaling. For example, the K value for Network A may be provided by the Network A to the UE. For another example, the K value for Network A may be provided by the Network B to the UE. The K may be configurable or pre-defined. K may be provided via system information or via dedicated signaling. In one implementation, K may be configured per NW individually (e.g., UE assume no timer if there is no valid stored configuration). In one implementation, that K may be determined based on a scaling factor and the factor may rely on number of SIM supported for Multi-SIM operation, number of TX/RX and so on.

[00104] In some implementations, as shown in FIG. 1, when PLMN A (or Network B/Network A cell) and PLMN B (or Network B/Network B cell) are operating on the same spectrum/frequency band/frequency carrier, a UE with dual-SIM (or multi-SIM) and {single RX, single TX} may NOT

perform the related implementation of solution #3 for paging collision resolution.

[00105] The solution #1, solution #2, and solution #3 may be combined or partially combined and performed by the UE.

[00106] **Informing the network**

[00107] In some implementations, a UE may inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested. In some implementations, a UE may inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested via RA procedure (e.g., a 2-step RA procedure or a 4-step RA procedure). In some implementations, a UE may inform a network that a paging collision resolution procedure is initiated via RA procedure (e.g., a 2-step RA procedure or a 4-step RA procedure) without transiting to Connected state. For example, the UE may not include RRC Setup Request message or may not RRC Resume Request message in a msgA of a 2-step RA procedure or in a msg3 of a 4-step RA procedure. For example, the UE may include a paging collision resolution request or a paging collision resolution assistance information in a msgA of a 2-step RA procedure or in a msg3 of a 4-step RA procedure.

[00108] In some implementations, an RRC Inactive UE may inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested via 2-step RA procedure by including the corresponding cause/intention/collision information and/or associated I-RNTI (e.g., a full I-RNTI or a short I-RNTI) in msgA payload. In some implementations, an RRC Inactive UE may inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested via 4-step RA procedure by including corresponding cause/intention/collision information and/or the associated I-RNTI (e.g., a full I-RNTI or a short I-RNTI) in msg3.

[00109] In some implementations, an RRC IDLE UE may inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested via 2-step RA procedure by including corresponding cause/intention and/or the associated UE ID (e.g., 5G-S-TMSI or 5G-TMSI) in msgA payload. In some implementations, an RRC Inactive UE may inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested via 4-step RA procedure by including corresponding cause/intention/collision information and/or the associated I-RNTI (e.g., 5G-S-TMSI or 5G-TMSI) in msg3.

[00110] In some implementations, a UE may inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested via pre-configured uplink grant(s). In some implementations, a UE may inform a network that a paging collision resolution procedure is initiated via pre-configured uplink grant without transiting to Connected state. For example, the UE

may transmit a paging collision resolution request or a paging collision resolution assistance information in a pre-configured uplink grant.

[00111] In some implementations, an RRC Inactive UE may inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested by transmitting the corresponding cause/intention/collision information and/or the associated I-RNTI (e.g., a full I-RNTI or a short I-RNTI) via pre-configured uplink grant(s).

[00112] In some implementations, an RRC IDLE UE may inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested by transmitting the corresponding cause/intention/collision information and/or associated UE ID (e.g., 5G-S-TMSI or 5G-TMSI) via pre-configured uplink grant(s).

[00113] In some implementations, a UE (e.g., a UE whose multi-SIM operation/dual-SIM operation is on) may inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested when a camped cell of one of the associated networks changes.

[00114] In some implementations, a UE may inform a network that a paging collision resolution procedure is initiated. The network being informed may realize that the UE may monitor the new PO(s) or PF(s) (e.g., based on the pre-defined paging parameters or based on the preserved PO/PF).

[00115] In some implementations, a UE may provide an assistance information (e.g., suggested/assisted paging parameters/paging information or the paging factors of another network) for a network to resolve paging collision (e.g., via RRC Resume Request message, via RRC Setup Request message, via another RRC message, via a MAC CE or via NAS message). In some implementations, an assistance information may include a value of offset for the current determined PO(s). The offset may be in units of ms, subframe, or slot, but not limited to. In some implementations, an assistance information may include suggested paging parameters, e.g., DRX cycle, number of total paging frames in DRX cycle, number of paging occasions for a PF, offset used for PF determination, UE_ID, or offset to the current UE_ID, but not limited to. The UE_ID may be a permanent subscription identifier (e.g., IMSI) or a temporary identifier (e.g., 5G-S-TMSI).

[00116] In some implementations, the UE may inform the Network before/after the paging collision via MAC CE/ UCI/lower-layer signal (e.g., upon a UE detects the paging collision or upon a UE has expected the paging collision). The UE may transmit the MAC CE/UCI/lower-layer signal to the Network being impacted. The UE may transmit the MAC CE/UCI/lower-layer signal to the Primary/Prioritized Network, which would not be impacted.

[00117] **UE/NW Capability**

[00118] In some implementations, a UE may signal its capability of supporting paging collision resolution or paging collision resolution procedure to the network. In some implementations, a UE

may signal its capability of supporting paging collision resolution or paging collision resolution procedure in IDLE state and Inactive state to the network. In some implementations, a UE may signal its capability of supporting paging collision resolution or paging collision resolution procedure in IDLE state to the network. In some implementations, a UE may signal its capability of supporting paging collision resolution or paging collision resolution procedure in Inactive state. In some implementations, a UE may signal its capability of supporting paging collision resolution or paging collision resolution procedure in both NR-NR dual-SIM/multi-SIM operation and LTE-NR dual-SIM/multi-SIM operation. In some implementations, a UE may signal its capability of supporting paging collision resolution or paging collision resolution procedure in NR-NR dual-SIM/multi-SIM operation. In some implementations, a UE may signal its capability of supporting paging collision resolution or paging collision resolution procedure in NR-LTE dual-SIM/multi-SIM operation.

[00119] In some implementations, a base station may indicate whether it supports paging collision resolution or paging collision resolution procedure (e.g., via RRC signaling or NAS signaling). For example, a base station (or an associated cell) may broadcast an indication in system information to indicate the base station (or the cell) supports paging collision resolution or paging collision resolution procedure. For example, if an indication (e.g., in an RRC signaling or in a NAS signaling) to indicate the base station (or the cell) supports paging collision resolution or paging collision resolution procedure, a UE may be allowed to perform paging collision resolution or initiate paging collision resolution procedure. For example, if an indication to indicate the base station (or the cell) supports paging collision resolution or paging collision resolution procedure, a UE may be allowed to inform a network that a paging collision resolution procedure is initiated or a paging collision resolution is requested. For example, if an indication to indicate the base station (or the cell) supports paging collision resolution or paging collision resolution procedure, a UE may be allowed to transmit the assistance information related to paging collision resolution or paging collision resolution procedure.

[00120] In some implementations, a base station may indicate whether it supports paging collision resolution or paging collision resolution procedure in IDLE state and Inactive state. In some implementations, a base station may indicate whether it supports paging collision resolution or paging collision resolution procedure in IDLE state. In some implementations, a base station may indicate whether it supports paging collision resolution or paging collision resolution procedure in Inactive state. In some implementations, a base station may indicate whether it supports paging collision resolution or paging collision resolution procedure for a UE in both NR-NR dual-SIM/multi-SIM operation and LTE-NR dual-SIM/multi-SIM operation. In some implementations, a base station may indicate whether it supports paging collision resolution or paging collision resolution procedure for a UE in NR-NR dual-SIM/multi-SIM operation. In some implementations, a base station may indicate

whether it supports paging collision resolution or paging collision resolution procedure for a UE in LTE-NR dual-SIM/multi-SIM operation. In some implementations, a base station may indicate whether it supports paging collision resolution or paging collision resolution procedure for a UE in LTE-LTE dual-SIM/multi-SIM operation.

[00121] FIG. 2 is a flowchart illustrating a method 200 performed by a UE for the multi-SIM operation according to an example implementation of the present disclosure.

[00122] In action 202, the UE registers, to a first network associated with a first SIM and a second network associated with a second SIM. The UE may register to more than one network (e.g., the first network and the second network) from which the UE may receive pages from the more than one network (e.g., the first network and the second network).

[00123] In action 204, the UE determines, whether paging collision associated with the first network and the second network is detected after determining that the multi-SIM operation is activated. In one implementation, the upper layer (e.g. NAS layer or Application layer) of UE may transmit a status of the multi-SIM operation to the lower layer (e.g., RRC layer) of the UE to inform the lower layer of the UE that the multi-SIM operation is activated. In one implementation, the upper layer (e.g. NAS layer or Application layer) of UE may transmit architecture information to the lower layer (e.g., RRC layer) of the UE, the architecture information includes the number of receivers in the UE. In one implementation, when the paging occasions for the first network and the paging occasions for the second network are overlapping in time domain, the UE may determine that the paging collision associated with the first network and the second network is detected. In one implementation, when the paging occasions for the first network and the paging occasions for the second network are overlapping in time domain, the UE may determine that the paging collision event is detected.

In action 206, the UE initiates, a paging collision resolution procedure associated with a selected network to resolve the paging collision after determining that the paging collision is detected, the selected network is the first network or the second network. In one implementation, the selected network may be determined based on priorities of the first network and the second network. The priorities of the first network and the second network may be determined based on the pre-defined rules, pre-configuration, policy, UE implementations (e.g., the network which is associated with a SIM which is plugged in/installed first or manual selected), the associated RRC state, network type (e.g., public network or private network), the serving frequencies, or the associated core network.

In one implementation, the paging collision resolution procedure may include that the UE transmits assistance information to the selected network, and receives a command from the selected network after transmitting the assistance information. The command may include a new paging information associated with the selected network to calculate new paging occasions for the selected

network. In one implementation, the new paging information is an offset to UE identity (ID) of the UE. In one implementation, the paging collision resolution procedure may include that the UE omits monitoring a collided PO or a collied PF of the selected network.

[00124] FIG. 3 is a flowchart illustrating a method performed by a UE for the multi-SIM operation according to another example implementation of the present disclosure. Actions 302 and 304 correspond to actions 202 and 204 illustrated in FIG. 2.

[00125] In action 312, the UE initiates, a paging collision resolution procedure associated with a selected network to resolve the paging collision after determining that the selected network indicates supporting of the paging collision resolution procedure, the selected network is the first network or the second network. In one implementation, the selected network may be determined based on priorities of the first network and the second network. The priorities of the first network and the second network may be determined based on the pre-defined rules, pre-configuration, policy, UE implementations (e.g., the network which is associated with a SIM which is plugged in/installed first or manual selected), the associated RRC state, network type (e.g., public network or private network), the serving frequencies, or the associated core network. In another implementation, the selected network may be determined based on pre-defined rules, pre-configuration, policy, or UE implementations (e.g., the network which is associated with a SIM/USIM which is plugged in/installed first or manual selected).

[00126] In one implementation, the selected network may indicate whether paging collision resolution procedure is supported via system information or dedicated signaling. For example, the selected network may broadcast an indication in system information to indicate the selected network supports collision resolution procedure. For example, if an indication to indicate the selected network supports paging collision resolution procedure, the UE may be allowed to initiate paging collision resolution procedure.

[00127] FIG. 4 is a block diagram illustrating a node 400 for wireless communication in accordance with various aspects of the present disclosure. As illustrated in FIG. 4, a node 400 may include a transceiver 420, a processor 428, a memory 434, one or more presentation components 438, and at least one antenna 436. The node 400 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. 4).

[00128] Each of the components may directly or indirectly communicate with each other over one or more buses 440. The node 400 may be a UE or a BS that performs various functions disclosed with reference to FIGS. 2 and 3.

[00129] The transceiver 420 has a transmitter 422 (e.g., transmitting/transmission circuitry) and a

receiver 424 (e.g., receiving/reception circuitry) and may be configured to transmit and/or receive time and/or frequency resource partitioning information. The transceiver 420 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 420 may be configured to receive data and control channels.

[00130] The node 400 may include a variety of computer-readable media. Computer-readable media may be any available media that may be accessed by the node 400 and include volatile (and/or non-volatile) media and removable (and/or non-removable) media.

[00131] The computer-readable media may include computer-storage media and communication media. Computer-storage media may include both volatile (and/or non-volatile media), and removable (and/or non-removable) media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or data.

[00132] Computer-storage media may include RAM, ROM, EPROM, 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), etc. Computer-storage media may not include a propagated data signal. Communication media may 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 mechanisms and include any information delivery media.

[00133] The term "modulated data signal" may mean 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 may 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.

[00134] The memory 434 may include computer-storage media in the form of volatile and/or non-volatile memory. The memory 434 may be removable, non-removable, or a combination thereof. Example memory may include solid-state memory, hard drives, optical-disc drives, etc. As illustrated in FIG. 4, the memory 434 may store a computer-readable and/or computer-executable program 432 (e.g., software codes) that are configured to, when executed, cause the processor 428 to perform various functions disclosed herein, for example, with reference to FIGS. 2 and 3. Alternatively, the program 432 may not be directly executable by the processor 428 but may be configured to cause the node 400 (e.g., when compiled and executed) to perform various functions disclosed herein.

[00135] The processor 428 (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 428 may

include memory. The processor 428 may process the data 430 and the program 432 received from the memory 434, and information transmitted and received via the transceiver 420, the base band communications module, and/or the network communications module. The processor 428 may also process information to send to the transceiver 420 for transmission via the antenna 436 to the network communications module for transmission to a CN.

[00136] One or more presentation components 438 may present data indications to a person or another device. Examples of presentation components 438 may include a display device, a speaker, a printing component, a vibrating component, etc.

[00137] In view of the present disclosure, it is obvious that various techniques may be used for implementing the disclosed concepts 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 may 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 for multi-subscriber identity module (SIM) operation performed by a user equipment (UE), the method comprising:

registering, to a first network associated with a first Subscriber Identity Module (SIM) and a second network associated with a second SIM;

determining, whether paging collision associated with the first network and the second network is detected after determining that the multi-SIM operation is activated; and

initiating, a paging collision resolution procedure associated with a selected network to resolve the paging collision after determining that the paging collision is detected, the selected network being the first network or the second network.

2. The method according to claim 1, wherein NAS layer of the UE transmits a status of the multi-SIM operation to RRC layer of the UE to inform the RRC layer of the UE that the multi-SIM operation is activated.

3. The method according to claim 1, wherein NAS layer of the UE transmits architecture information to RRC layer of the UE, the architecture information includes the number of receivers in the UE.

4. The method according to claim 1, wherein initiating the paging collision resolution procedure associated with the selected network comprising:

transmitting, to the selected network, assistance information.

5. The method according to claim 4, further comprising:

receiving a command from the selected network after transmitting the assistance information.

6. The method according to claim 5, wherein the command includes a new paging information associated with the selected network to calculate new paging occasions for the selected network.

7. The method according to claim 6, wherein the new paging information is an offset to UE identity (ID) of the UE.

8. The method according to claim 1, wherein the selected network is determined based on priorities of the first network and the second network.

9. The method according to claim 1, wherein initiating the paging collision resolution procedure associated with the selected network comprising:

omitting monitoring a collided PO or a collied PF of the selected network.

10. The method according to claim 1, further comprising:

initiating, the paging collision resolution procedure associated with the selected network to resolve the paging collision after determining that the selected network indicates supporting of the paging collision resolution procedure.

11. A user equipment (UE) for multi-subscriber identity module (SIM) operation, comprising:

a processor; and

a memory coupled to the processor, wherein the memory stores a computer-executable program that when executed by the processor, causes the processor to perform the method of any of claims 1 to 10.

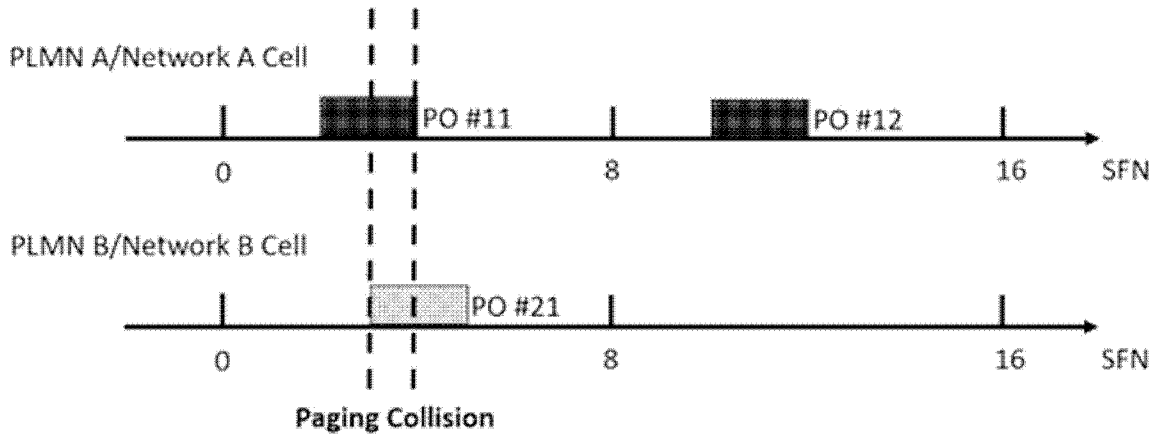

PLMN A/Network A Cell
PO #11
PO #12
0
8
16
SFN
PLMN B/Network B Cell
PO #21
0
8
16
SFN
Paging Collision

FIG. 1

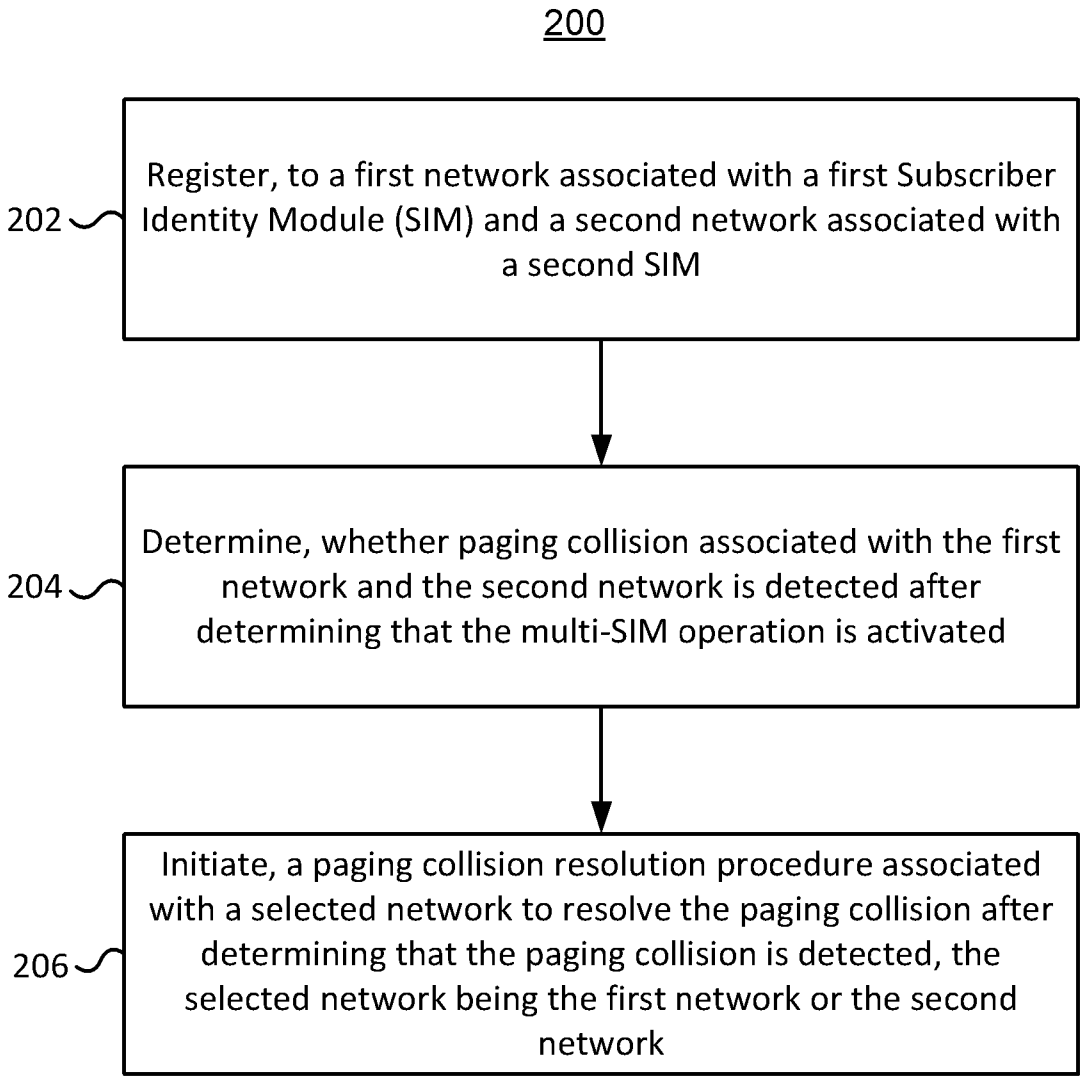

200
202
Register, to a first network associated with a first Subscriber Identity Module (SIM) and a second network associated with a second SIM
204
Determine, whether paging collision associated with the first network and the second network is detected after determining that the multi-SIM operation is activated
206
Initiate, a paging collision resolution procedure associated with a selected network to resolve the paging collision after determining that the paging collision is detected, the selected network being the first network or the second network

FIG. 2

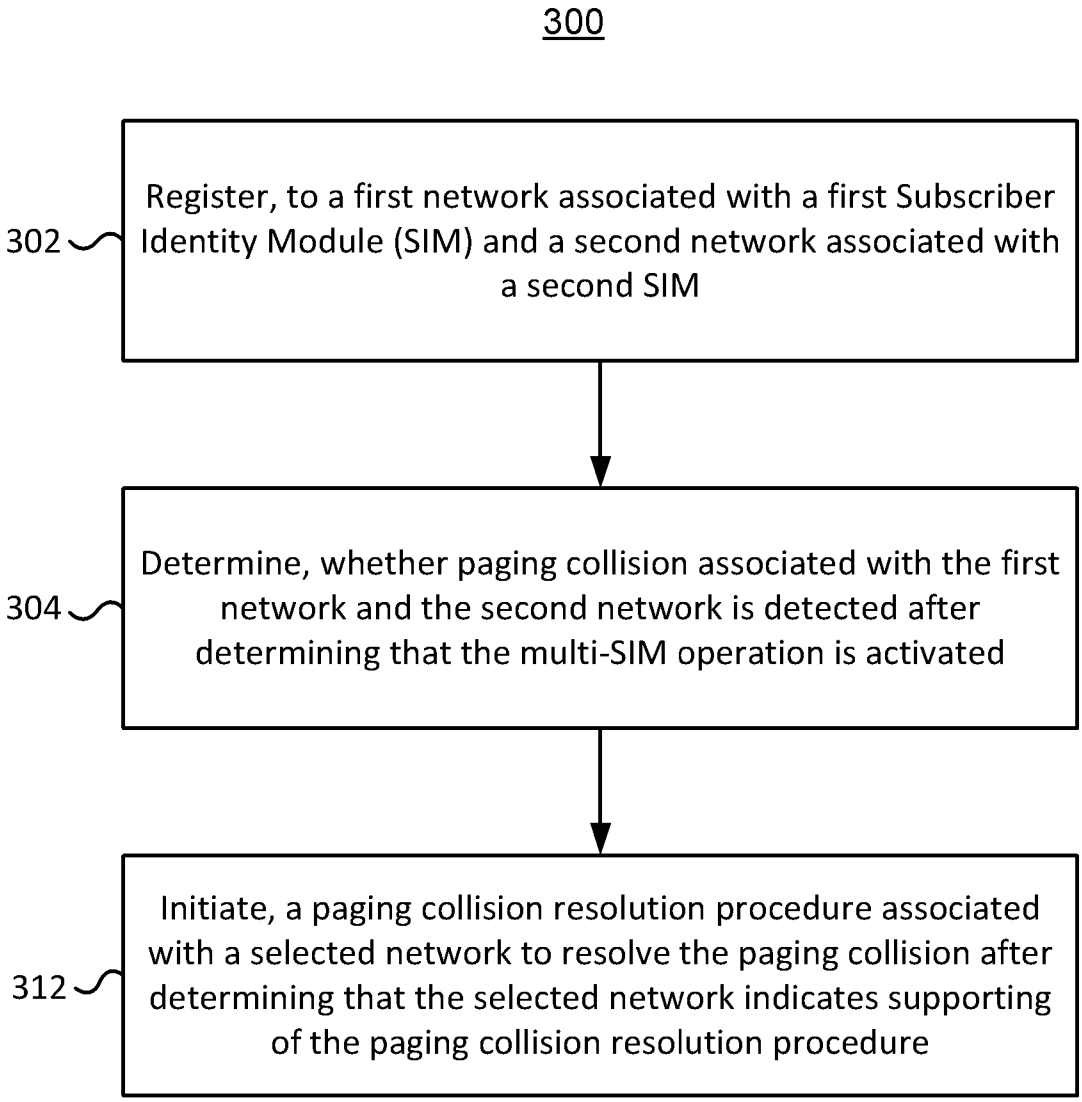

300
302
Register, to a first network associated with a first Subscriber Identity Module (SIM) and a second network associated with a second SIM
304
Determine, whether paging collision associated with the first network and the second network is detected after determining that the multi-SIM operation is activated
312
Initiate, a paging collision resolution procedure associated with a selected network to resolve the paging collision after determining that the selected network indicates supporting of the paging collision resolution procedure

FIG. 3

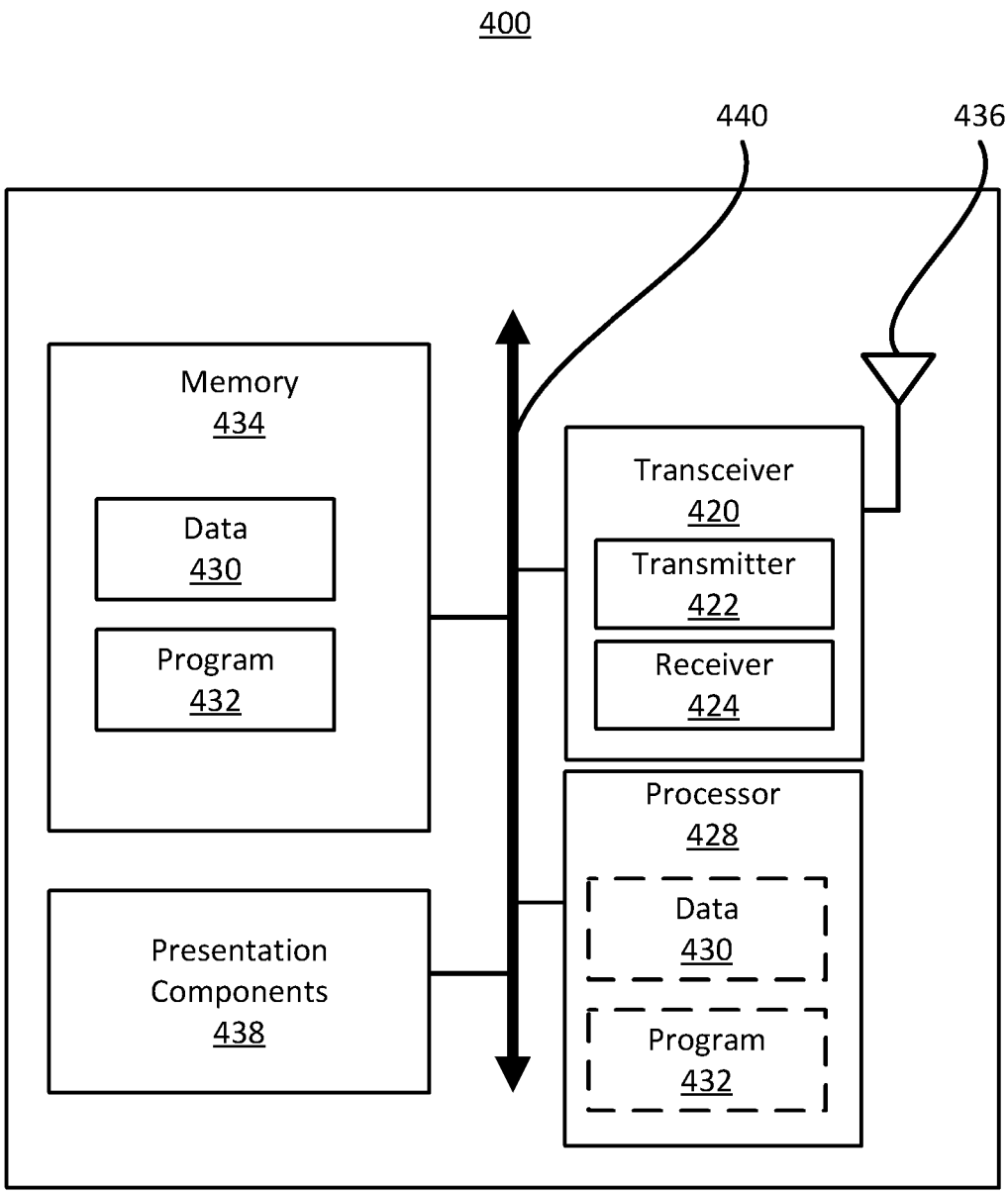

400
440
436
Memory
434
Data
430
Program
432
Transceiver
420
Transmitter
422
Receiver
424
Processor
428
Data
430
Program
432
Presentation
Components
438

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/093897

A. CLASSIFICATION OF SUBJECT MATTER

H04W 68/12(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)

EPODOC,WPI,CNKI,CNPAT,3GPP,IEEE:sim,paging collision,collide,conflict,resolving,avoidance,auxiliary,paging occasion, ID,identification, offset, priority, PO, PF, monitor, solution

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SONY. "KI2: Solution for Paging Reception with PO collision avoidance" *SA WG2 Meeting #S2-136AH S2-2000841,* 17 January 2020 (2020-01-17), section 6.X	1-11
X	INTEL, SONY, OPPO, INTERDIGITAL. "Solution for Paging Reception with PO collision avoidance" *SA WG2 Meeting #S2-136AH S2-2000164,* 17 January 2020 (2020-01-17), section 6.X	1-11
PX	WO 2020238127 A1 (GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.) 03 December 2020 (2020-12-03) description, paragraphs[0023]-[0064]	1-11
A	US 2013090137 A1 (QUALCOMM INCORPORATED) 11 April 2013 (2013-04-11) the whole document	1-11
A	US 2009215473 A1 (MEDIATEK INC.) 27 August 2009 (2009-08-27) the whole document	1-11
A	CN 101184291 A (SPREADTRUM COMMUNICATIONS SHANGHAI CO., LTD.) 21 May 2008 (2008-05-21) the whole document	1-11

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
20 July 2021	**12 August 2021**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer **HOU,Yanlan** Telephone No. **86-(10)-53961644**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/093897

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2020238127 A1	03 December 2020	None	
US 2013090137 A1	11 April 2013	WO 2013052868 A1	11 April 2013
US 2009215473 A1	27 August 2009	CN 101521959 A	02 September 2009
		TW 200937988 A	01 September 2009
CN 101184291 A	21 May 2008	None	