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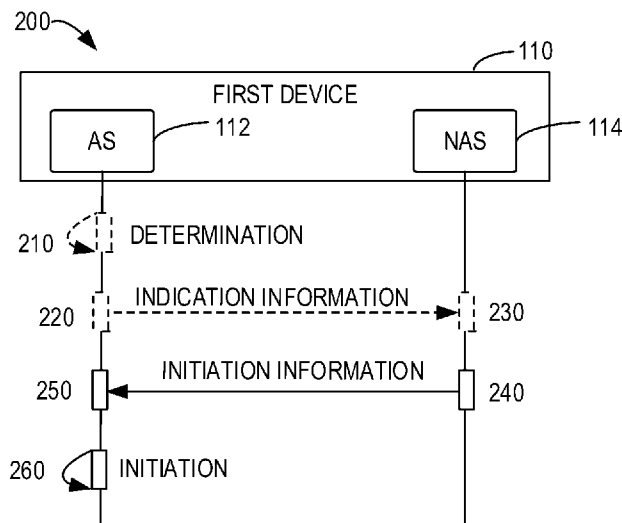


FIG. 2A

(57) Abstract: Embodiments of the present disclosure relate to devices, methods, apparatuses and computer readable storage media of high-priority service initiation during network energy saving (NES). In the method, a first device causes initiation information to be provided from a non-access stratum to an access stratum, the initiation information regarding a high-priority service to be initiated in a connected mode. The first device further causes, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum. In this way, the high-priority service can be initiated during the connected mode with NES activated.

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HIGH-PRIORITY SERVICE INITIATION DURING NETWORK ENERGY SAVING

FIELD

[0001] Embodiments of the present disclosure generally relate to the field of telecommunication and in particular to devices, methods, apparatuses and computer readable storage media of high-priority service (e.g., an emergency call or high priority data/signaling) initiation during network energy saving (NES).

BACKGROUND

[0002] Network energy saving is of great importance for environmental sustainability, to reduce environmental impact such as greenhouse gas emissions, and for operational cost savings. As 5th Generation Mobile Communication Technology (5G) is becoming pervasive across industries and geographical areas, handling more advanced services and applications requiring very high data rates (e.g., Extended Reality (XR)), networks are being denser and using more antennas, larger bandwidths, and more frequency bands. The environmental impact of 5G needs to stay under control. Network energy savings need to be developed and improved.

SUMMARY

[0003] In a first aspect, there is provided an apparatus. The apparatus comprises at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus at least to: cause initiation information to be provided from a non-access stratum to an access stratum, the initiation information regarding a high-priority service to be initiated in a connected mode; and cause, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum.

[0004] In a second aspect, there is provided an apparatus. The apparatus comprises at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus at least to: cause indication information to be provided from an access stratum to a non-access stratum, the indication information indicating at least one of: a network energy saving mode, or initiation information regarding a high-priority service to be initiated in a connected mode being required.

[0005] In a third aspect, there is provided a method. The method comprises causing, at a first device, initiation information to be provided from a non-access stratum to an access stratum, the initiation information regarding a high-priority service to be initiated in a connected mode. The method further comprises causing, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum.

[0006] In a fourth aspect, there is provided a method. The method comprises causing, at a first device, indication information to be provided from an access stratum to a non-access stratum, the indication information indicating at least one of: a network energy saving mode, or initiation information regarding a high-priority service to be initiated in a connected mode being required.

[0007] In a fifth aspect, there is provided an apparatus comprising means for causing initiation information to be provided from a non-access stratum to an access stratum, the initiation information regarding a high-priority service to be initiated in a connected mode; and means for causing, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum.

[0008] In a sixth aspect, there is provided an apparatus comprising means for causing indication information to be provided from an access stratum to a non-access stratum, the indication information indicating at least one of: a network energy saving mode, or initiation information regarding a high-priority service to be initiated in a connected mode being required.

[0009] In a seventh aspect, there is provided a computer readable medium having a computer program stored thereon which, when executed by at least one processor of an apparatus, causes the apparatus to carry out the method according to the third aspect or the fourth aspect.

[0010] Other features and advantages of the embodiments of the present disclosure will also be apparent from the following description of specific embodiments when read in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of embodiments of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Embodiments of the disclosure are presented in the sense of examples and their advantages are explained in greater detail below, with reference to the accompanying

drawings.

[0012] FIG. 1 illustrates an example environment in which example embodiments of the present disclosure may be implemented;

[0013] FIG. 2A shows a signaling flow illustrating an example of high-priority service initiation according to some example embodiments of the present disclosure;

[0014] FIG. 2B shows a signaling flow illustrating another example of high-priority service initiation according to some example embodiments of the present disclosure;

[0015] FIG. 3 shows a flowchart of an example method implemented by a first device according to some example embodiments of the present disclosure;

[0016] FIG. 4 shows a flowchart of another example method implemented by a first device according to some example embodiments of the present disclosure;

[0017] FIG. 5 shows a simplified block diagram of a device that is suitable for implementing example embodiments of the present disclosure; and

[0018] FIG. 6 shows a block diagram of an example computer readable medium in accordance with some embodiments of the present disclosure.

[0019] Throughout the drawings, the same or similar reference numerals may represent the same or similar element.

DETAILED DESCRIPTION

[0020] Principle of the present disclosure will now be described with reference to some example embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. Embodiments described herein may be implemented in various manners other than the ones described below.

[0021] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein may have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0022] References in the present disclosure to “one embodiment,” “an embodiment,” “an example embodiment,” and the like indicate that the embodiment described may include a

particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0023] It shall be understood that although the terms “first,” “second” and the like may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and similarly, a second element could be termed a first element, without departing from the scope of example embodiments. As used herein, the term “and/or” includes any and all combinations of one or more of the listed terms.

[0024] As used herein, “at least one of the following: <a list of two or more elements>” and “at least one of <a list of two or more elements>” and similar wording, where the list of two or more elements are joined by “and” or “or”, mean at least any one of the elements, or at least any two or more of the elements, or at least all the elements.

[0025] As used herein, unless stated explicitly, performing a step “in response to A” does not indicate that the step is performed immediately after “A” occurs and one or more intervening steps may be included.

[0026] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises”, “comprising”, “has”, “having”, “includes” and/or “including”, when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/or combinations thereof.

[0027] As used in this application, the term “circuitry” may refer to one or more or all of the following:

(a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and

(b) combinations of hardware circuits and software, such as (as applicable):

(i) a combination of analog and/or digital hardware circuit(s) with software/firmware and

(ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and

(c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation.

[0028] This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit or processor integrated circuit for a mobile device or a similar integrated circuit in server, a cellular network device, or other computing or network device.

[0029] As used herein, the term “communication network” refers to a network following any suitable communication standards, such as New Radio (NR), Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), Narrow Band Internet of Things (NB-IoT), an Enhanced Machine type communication (eMTC) and so on. Furthermore, the communications between a terminal device and a network device in the communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G), the sixth generation (6G) communication protocols, and/or any other protocols either currently known or to be developed in the future. Embodiments of the present disclosure may be applied in various communication systems. Given the rapid development in communications, there will of course also be future type communication technologies and systems with which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned system.

[0030] As used herein, the terms “network device”, “radio network device” and/or “radio

access network device” refers to a node in a communication network via which a terminal device accesses the network and receives services therefrom. The network device may refer to a base station (BS) or an access point (AP), for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), an NR NB (also referred to as a gNB), a Remote Radio Unit (RRU), a remote radio head (RRH), a relay, an Integrated Access and Backhaul (IAB) node, a low power node such as a femto, a pico, a non-terrestrial network (NTN) or non-ground network device such as a satellite network device, a low earth orbit (LEO) satellite and a geosynchronous earth orbit (GEO) satellite, an aircraft network device, and so forth, depending on the applied terminology and technology. In some example embodiments, low earth orbit (LEO) split architecture includes a Centralized Unit (CU) and a Distributed Unit (DU). In some other example embodiments, part of the radio access network device or full of the radio access network device may be embarked on an airborne or space-borne NTN vehicle.

[0031] The term “terminal device” refers to any end device that may be capable of wireless communication. By way of example rather than limitation, a terminal device may also be referred to as a communication device, user equipment (UE), a Subscriber Station (SS), a Portable Subscriber Station, a Mobile Station (MS), or an Access Terminal (AT). The terminal device may include, but not limited to, a mobile phone, a cellular phone, a smart phone, voice over IP (VoIP) phones, wireless local loop phones, a tablet, a wearable terminal device, a personal digital assistant (PDA), portable computers, desktop computer, image capture terminal devices such as digital cameras, gaming terminal devices, music storage and playback appliances, vehicle-mounted wireless terminal devices, wireless endpoints, mobile stations, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), USB dongles, smart devices, wireless customer-premises equipment (CPE), an Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device and applications (e.g., remote surgery), an industrial device and applications (e.g., a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless networks, and the like. The terminal device may also correspond to a Mobile Termination (MT) part of an IAB node (e.g., a relay node). In the following description, the terms “terminal device”, “communication device”, “terminal”, “user equipment” and “UE” may be used interchangeably.

[0032] As used herein, the term “resource,” “transmission resource,” “resource block,” “physical resource block” (PRB), “uplink resource,” or “downlink resource” may refer to any

resource for performing a communication, for example, a communication between a terminal device and a network device, such as a resource in time domain, a resource in frequency domain, a resource in space domain, a resource in code domain, or any other resource enabling a communication, and the like. In the following, unless explicitly stated, a resource in both frequency domain and time domain will be used as an example of a transmission resource for describing some example embodiments of the present disclosure. It is noted that example embodiments of the present disclosure are equally applicable to other resources in other domains.

[0033] FIG. 1 illustrates an example communication environment 100 in which example embodiments of the present disclosure can be implemented. As shown in FIG. 1, the communication environment 100 includes a first device 110. In the example of FIG. 1, the first device 110 may include a terminal device such as a UE.

[0034] The communication environment 100 may further include a second device 120 communicating with the first device 110. In one example, the second device 120 may include a network device such as gNB or eNodeB serving the first device 110. For example, the serving area of the second device 120 may be called as a cell (not shown).

[0035] In some example embodiments, the communication environment 100 may further include a further device such as a core network device (not shown) communicating with the first device 110 and/or the second device 120. Alternatively, or in addition, in some example embodiments, the second device 120 and the core network device may be combined into a single network device, which supports both access stratum (AS) function and non-access stratum (NAS) function.

[0036] The first device 110 may be configured with a plurality of signaling layers, including an AS 112 (also referred to as an AS layer or a lower signaling layer), and a NAS 114 (also referred to as a NAS layer or a higher signaling layer). In some example embodiments, the AS 112 may support communications between the first device 110 and a radio access network (RAN) such as the second device 120 or the AS function of a device via a radio frequency (RF) channel. The NAS 114 may support non-radio signaling traffic between the first device 110 and a core network device (also referred to as a core network) or a NAS function of a device. For example, the core network may include a mobility management entity (MME) for LTE or access and mobility management function (AMF).

[0037] In some example embodiments, interactions between the AS 112 and NAS 114 are

supported. For example, the AS 112 may provide information or message(s) to the NAS 114. The NAS 114 may also provide information or message(s) to the AS 112.

[0038] It is to be understood that the number of devices and their connections shown in FIG. 1 are only for the purpose of illustration without suggesting any limitation. The communication environment 100 may include any suitable number of devices configured to implementing example embodiments of the present disclosure.

[0039] In the following, for the purpose of illustration, some example embodiments are described with the first device 110 operating as a terminal device and the second device 120 operating as a network device. However, in some example embodiments, operations described in connection with a terminal device may be implemented at a network device or other device, and operations described in connection with a network device may be implemented at a terminal device or other device.

[0040] In some example embodiments, if the first device 110 is a terminal device and the second device 120 is a network device, a link from the second device 120 to the first device 110 is referred to as a downlink (DL), while a link from the first device 110 to the second device 120 is referred to as an uplink (UL). In DL, the second device 120 is a transmitting (TX) device (or a transmitter) and the first device 110 is a receiving (RX) device (or a receiver). In UL, the first device 110 is a TX device (or a transmitter) and the second device 120 is a RX device (or a receiver).

[0041] Communications in the communication environment 100 may be implemented according to any proper communication protocol(s), comprising, but not limited to, cellular communication protocols of the first generation (1G), the second generation (2G), the third generation (3G), the fourth generation (4G), the fifth generation (5G), the sixth generation (6G), and the like, wireless local network communication protocols such as Institute for Electrical and Electronics Engineers (IEEE) 802.11 and the like, and/or any other protocols currently known or to be developed in the future. Moreover, the communication may utilize any proper wireless communication technology, comprising but not limited to: Code Division Multiple Access (CDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Frequency Division Duplex (FDD), Time Division Duplex (TDD), Multiple-Input Multiple-Output (MIMO), Orthogonal Frequency Division Multiple (OFDM), Discrete Fourier Transform spread OFDM (DFT-s-OFDM) and/or any other technologies currently known or to be developed in the future.

[0042] As described above, the study associated with the NES has been discussed in 5G NR for environmental sustainability and for operational cost savings. Recently, energy consumption has become a key part of the operators' operating expenses (OPEX). The energy cost on mobile networks accounts for up to 23% of the total operator cost. Most of the energy consumption comes from the RAN and in particular from the active antenna unit (AAU), with data centres and fibre transport accounting for a smaller share. The power consumption of a radio access may be split into two parts. One part is a dynamic part which is consumed when data transmission/reception is ongoing. Another part is a static part which is consumed all the time to maintain the necessary operation of the radio access devices, even if the data transmission/reception is not on-going.

[0043] In some embodiments, it is expected to specify synchronization signal block (SSB)-less secondary cell (SCell) operation for inter-band carrier aggregation (CA) for FR1 and co-located cells, if found feasible by RAN4 study, where a UE measures SSB transmitted on primary cell (PCell) or another SCell for an SCell's time/frequency synchronization (including downlink automatic gain control (AGC)), and layer 1 (L1)/layer 3 (L3) measurements, including potential enhancement on SCell activation procedures if necessary.

[0044] In some embodiments, it is expected to specify enhancement on cell discontinuous transmission (DTX)/discontinuous reception (DRX) mechanism including the alignment of cell DTX/DRX and UE DRX in radio resource control (RRC)_CONNECTED mode, and inter-node information exchange on cell DTX/DRX. In some embodiments, there is no change for SSB transmission due to cell DTX/DRX. In some embodiments, the impact to IDLE/INACTIVE UEs due to the above enhancement should be avoided.

[0045] In some embodiments, as for techniques in spatial and power domains, it is expected to specify necessary enhancements on channel state information (CSI) and beam management related procedures including measurement and report and signaling to enable efficient adaptation of spatial elements (e.g., antenna ports, active transceiver chains).

[0046] In some embodiments, as for techniques in spatial and power domains, it is expected to specify necessary enhancements on CSI related procedures including measurement and report and signaling to enable efficient adaptation of power offset values between physical downlink shared channel (PDSCH) and CSI reference signal (CSI-RS). The above example embodiments are only for UE specific channels/signals. In some embodiments, legacy UE CSI/CSI-RS capabilities applies when considering total number of CSI reports and

requirements.

[0047] In some embodiments, it is expected to specify mechanism(s) to prevent legacy UEs camping on cells adopting the release 18 NES techniques, if necessary.

[0048] In some embodiments, it is expected to specify Conditional Handover (CHO) procedure enhancement(s) in case source/target cell is in NES mode.

[0049] In some embodiments, it is expected to specify inter-node beam activation and enhancements on restricting paging in a limited area.

[0050] In some embodiments, it is expected to specify the corresponding radio resource management (RRM)/radio frequency (RF) core requirements, if necessary, for the above features.

[0051] For the DTX/DRX mechanism, the following operations may be implemented. In some embodiments, UE doesn't monitor Semi-persistent Scheduling (SPS) occasions during Cell DTX non-active period. As baseline, gNB is assumed to be not transmitting PDSCH to that UE on such SPS occasions during the Cell DTX non-active period.

[0052] In some embodiments, UE does not transmit on configured grant (CG) occasions during Cell DRX non-active periods.

[0053] In some embodiments, UE does not transmit scheduling request (SR) occasions overlapping with Cell DRX non-active periods, e.g., SR transmissions are dropped during the non-active period.

[0054] In some embodiments, (for the SRs that will be dropped) if SR is not to be transmitted on a physical uplink control channel (PUCCH) occasion during Cell DRX non-active time, the UE keep the SR pending, i.e., the UE delays the SR transmission till the Cell DRX active period without triggering random access channel (RACH).

[0055] In some embodiments, the understanding for the gNB scheduling behaviour for new transmissions during Cell DTX non-active period is that the gNB does not schedule UE-specific dynamic grants/assignments, even if the UE is in Connected DRX (C-DRX) Active Time. The UE doesn't monitor physical downlink control channel (PDCCH) for dynamic grants/assignments for new transmissions during Cell DTX non-active period, even if the UE is in C-DRX Active time.

[0056] However, by far, it is unclear how a high-priority service such as an emergency call or a high-priority data transmission can be supported if a cell is in NES mode such as cell

DTX/DRX. NES may be violated if the network needs to monitor for SR and respond to SR during cell DTX/DRX inactive period. It might cause unacceptable delay for emergency call if not being able to send SR due to cell DTX/DRX inactive period.

[0057] In some mechanisms, if the UE is in a connected mode such as RRC connected mode, the emergency call and/or cause for connection may not be seen by the AS. For example, the NAS will not provide related information to the AS. Therefore, the AS cannot be informed of the emergency call or any other high-priority service.

[0058] In order to solve at least part of the above problems or other potential problems, a solution on high-priority service initiation during NES is proposed. According to embodiments of the present disclosure, initiation information regarding a high-priority service to be initiated in a connected mode is provided from a non-access stratum to an access stratum. For example, in the connected mode, NES may be activated. An initiation of the high-priority service is performed at the access stratum based on the initiation information. In this way, the high-priority service can be initiated during the connected mode with NES activated.

[0059] Example embodiments of the present disclosure will be described in detail below with reference to the accompanying drawings. Reference is now made to FIG. 2A, which illustrates a signaling flow 200 for high-priority service initiation during NES according to some example embodiments of the present disclosure. For the purposes of discussion, the signaling flow 200 will be discussed with reference to FIG. 1, for example, by using the AS 112 and NAS 114 of the first device 110. In the example of FIG. 2A, it is assumed that the first device 110 is in a connected mode such as a RRC connected mode.

[0060] In operation, the first device 110 causes initiation information regarding a high-priority service to be initiated in a connected mode to be provided from the NAS 114 to the AS 112. As illustrated, the NAS 114 provides (240) the initiation information to the AS 112. The AS 112 obtains (250) the initiation information.

[0061] As used herein, providing information or message from the NAS 114 to the AS 112, or providing information or message from the AS 112 to the NAS 114 is caused by the first device 110. The information or message providing by the AS 112 or the NAS 114 and obtaining at the NAS 114 or the AS 112 may be referred to as “interaction(s) between the AS 112 and the NAS 114”. The interaction(s) may be internal operations of the first device 110.

[0062] As used herein, the term “high-priority service” may refer a service or a traffic which

is emergent, critical, important, or with a higher priority. The term “high-priority service” may also be referred to as “high-priority traffic”.

[0063] By way of example, the high-priority service may include an emergency call. Further examples of the high-priority service may include, but not limited to signaling or data of a mission critical service, signaling or data belonging to a certain or predefined access category or access categories, signaling or data belonging to a certain or predefined access identity, signaling or data with a priority above a threshold priority, high priority data or signaling such as ultra-reliable and low latency communications (URLLC), or the like. The threshold priority may be predefined or configured. In one example, the threshold priority may be considered as a priority classification, so that certain one or more of highest-priority access categories may be considered to deliver the high priority data.

[0064] It is to be understood that these example high-priority services are only for the purpose of illustration, without suggesting any limitation. In some other example embodiments, the high-priority service may be other high priority transmissions, traffics or services. Scope of the present disclosure is not limited in this regard.

[0065] With the initiation information, the first device 110 causes an initiation of the high-priority service to be performed at the AS 112. For example, the AS 112 performs (260) the initiation of the high-priority service such as the emergency call based on the initiation information.

[0066] In one example, the AS 112 may perform (260) the initiation of the high-priority service by initiating a random access procedure. In another example, the AS 112 may perform (260) the initiation of the high-priority service by transmitting a SR to the second device 120. In a further example, the AS 112 may perform (260) the initiation of the high-priority service by indicating a radio link failure (RLF). That is, the AS 112 may declare RLF. In a still further example, the AS 112 may perform (260) the initiation of the high-priority service by initiating a RRC reestablishment procedure. In a still further example, the AS 112 may perform (260) the initiation of the high-priority service by switching to an idle mode and performing a RRC establishment procedure. The initiation of the high-priority service may be performed during the NES mode of the cell to which the AS 112 is currently connected.

[0067] In other words, the NAS 114 may inform the AS 112 when the high-priority service such as the emergency call needs to be initiated. Based on this information, the AS 112 can

state the high-priority initiation by starting random access procedure or by transmitting SR or by declaring RLF or starting RRC reestablishment procedure or going via the idle mode. It is to be understood that these example procedures for initiating the high-priority service are only for the purpose of illustration, without suggesting any limitation. Any suitable procedure for initiating the high-priority service may be applied. Scope of the present disclosure is not limited in this regard.

[0068] Examples regarding initiating the high-priority service based on the initiation information interaction between the AS 112 and NAS 114 have been described. In this way, the high-priority service can be initiated by the AS in the connected mode.

[0069] In some example embodiments, the first device 110 may cause the initiation information to be provided (240) based on a certain condition. For example, the first device 110 may cause indication information to be provided from the AS 112 to the NAS 114. In one example, the indication information indicates that the initiation information regarding the high-priority service to be initiated in the connected mode is required. In another example, the indication information indicates a network energy saving (NES) mode. For example, the indication information may indicate that the NES mode is configured or activated for the AS 112. The AS 112 may provide (220) the indication information to the NAS 114. The NAS 114 may obtain (230) the indication information. In this manner, the AS 112 may switch the provision of the initiation information from a disabled state to an enabled state.

[0070] In some example embodiments, if the NAS 114 obtains (230) the indication information, the NAS 114 may provide (240) the initiation information to the AS 112 if the high-priority service such as the emergency call needs to be initiated.

[0071] As discussed, the first device 110 may communicate with the second device 120. In some example embodiments, the second device 120 or the serving cell of the second device 120 may be in an energy saving mode (also referred to as a NES mode). If the second device 120 is operated in the NES mode, the power consumption may be reduced compared with the power consumption in a non-energy saving mode. One example NES mode may be a cell discontinuous transmission (DTX). Another example NES mode may be a cell discontinuous reception (DRX). Other example NES mode may be a spatial domain energy saving mode or a power domain energy saving mode.

[0072] It is to be understood that the above example NES modes are only for the purpose of illustration without suggesting any limitations. In the other example embodiments, the

NES mode may be any suitable existing energy saving mode or any newly introduced energy saving mode. The present discourse is not limited in this regard.

[0073] In some example embodiments associated with the NES, the network energy consumption model for the BS may be defined including the reference configurations for frequency range 1 (FR1) time division duplexing (TDD)/ frequency division duplexing (FDD) and frequency range 2 (FR2). The network energy consumption model for the BS may also be defined including the deep/light/micro sleep power states with corresponding relative power, transition time and energy consumption among different power states based on two types of BS categories, and the scaling rules for the active DL/UL power states considering BS power split by a static part of power and a dynamic part of power. The dynamic part of power reflects the dynamic power consumption with respect to transmission/reception resource configurations in time, frequency, spatial and power domains.

[0074] In addition, evaluation methodology and assumptions may be achieved to study and evaluate the network energy saving gains for potential techniques with respect to other key performance indicator (KPI) including user perceived throughput (UPT), access delay, UE power consumption, etc.

[0075] Based on the agreed BS energy consumption model, and the evaluation methodology and assumptions, potential network energy saving techniques in various domains may be evaluated with respect to the energy saving gains and the corresponding performance impact considering the above KPIs. The techniques are classified into time, frequency, spatial and power domains, and the technical descriptions as well as the legacy UE and specification impacts are summarized in a technical report.

[0076] The techniques in time and frequency domains mainly aim to reduce the power consumption for dynamic part by trying to shut down more symbols on one or more carriers to achieve BS micro sleep, and even the static power part by enlarging the interval between the contiguous active transmission/reception occasions to achieve BS light/deep sleep.

[0077] The techniques in spatial and power domains mainly aim to reduce the power consumption of the transceiver (TRX) chains and power amplifiers (PAs) by trying to shut down more spatial elements and/or reduce transmission power/power spectrum density or increase the PA efficiency.

[0078] If the second device 120 serving the first device 110 is in the NES mode, the first device 110 may be referred to as being in a cell in the NES mode, or in a NES cell. As used

herein, the first device 110 in the NES cell may be referred to as the first device 110 in the NES mode or the first device 110 in a connected mode with NES activated. The AS 112 of the first device 110 may be referred to as the AS 112 in the NES mode.

[0079] If the AS 112 is in the NES mode, the indication information obtained (230) at the NAS 114 may indicate that the AS 112 is in the NES mode. If the indication information indicates the NES mode, the NAS 114 may be informed that the initiation information of the high-priority service is needed. That is, the AS 112 may inform the NAS 114 about the NES mode. Based on such information, the NAS 114 may know that the AS 112 needs to be informed about the high-priority service such as emergency call initiation in the connected mode and/or in the NES mode.

[0080] In some example embodiments, if the NES mode is configured or activated for the AS 112, the AS 112 may provide (220) the indication information to the NAS 114. In this manner, the AS 112 may allow the NAS 114 to wake up the AS 112 from the NES mode in order to initiate the high-priority service in an expedited manner. For example, a NES mode configuration such as a periodic cell DTX/DRX configuration may be explicitly signalled to the first device 110, to configure the NES mode for the AS 112. If the NES mode is configured, or when the NES mode is configured, the AS 112 may provide (220) the indication information to the NAS 114.

[0081] In one example, a periodic cell DTX/DRX pattern may be configured by a RRC signaling specific for the first device 110. By way of example, the cell DTX/DRX configuration may contain at least: periodicity, start slot/offset, on duration.

[0082] In some example embodiments, the NES mode such as the cell DTX/DRX may be activated/deactivated implicitly by RRC signaling. That is, the cell DTX/DRX may be activated immediately once configured by RRC and deactivated once the RRC configuration is released. For example, L1 signaling for cell DTX/DRX activation/deactivation may be used. In some example embodiments, if the NES mode is activated, or when the NES mode is activated, the AS 112 may provide (220) the indication information to the NAS 114.

[0083] In this way, with the interactions between the AS 112 and NAS 114 such as the indication information interaction and the initiation information interaction, the high-priority service such as the emergency call can be initiated. That is, the high-priority service such as the emergency call can be initiated by the first device 110 which is in the NES mode. In addition, there is no delay in the connected mode due to NES. Thus, the indication from the

NAS to AS when any high-priority service may be done although the first device 110 is in the connected state from NAS 114 point of view.

[0084] In some example embodiments, the AS 112 may provide (220) the indication information to the NAS 114 if one or more conditions is met. That is, the AS 112 may determine (210) whether at least one condition is met. In one example, if the AS 112 determines (210) that the AS 112 is in the NES mode or using a specific NES method, the AS 112 may provide (220) the indication information to the NAS 114. In another example, if the AS 112 determines (210) that a periodicity of DTX/DRX is longer than a threshold periodicity, the AS 112 may provide (220) the indication information to the NAS 114. The threshold periodicity may be predefined or configured. The determination (210) may be based on the indication information the NAS 114 has obtained (230) from the AS 112, or based on monitoring the mode of the AS 112.

[0085] Alternatively, or in addition, in some example embodiments, if the AS 112 is not in the NES mode, or if the periodicity of DTX/DRX is shorter than or equal to the threshold periodicity, the AS 112 may not provide (220) the indication information to the NAS 114. That is, if the AS 112 is in a specific state, for example using the specific NES method, or the cell DTX/DRX periodicity longer than the threshold periodicity, the AS 112 may need to inform this state to the NAS 114.

[0086] Examples regarding initiating the high-priority service based on interactions between the AS 112 and the NAS 114 have been described. FIG. 2B illustrates another signaling flow 270 for high-priority service initiation during NES according to some example embodiments of the present disclosure. For the purposes of discussion, the signaling flow 270 will be discussed with reference to FIG. 1, for example, by using the AS 112 and NAS 114 of the first device 110. In the example of FIG. 2B, it is assumed that the first device 110 is in a connected mode such as a RRC connected mode.

[0087] In operation, the first device 110 causes indication information to be provided from the AS 112 to the NAS 114. In one example, the indication information indicates that the initiation information regarding the high-priority service to be initiated in the connected mode is required. In another example, the indication information indicates a NES mode. For example, the indication information may indicate that the NES mode is configured or activated for the AS 112. The AS 112 provides (220) the indication information to the NAS 114. The NAS 114 obtains (230) the indication information.

[0088] In some example embodiments, the first device 110 or the AS 112 of the first device 110 may be in the NES mode, such as the cell DRX/DTX. If the AS 112 is in the NES mode, the indication information obtained (230) at the NAS 114 may indicate that the AS 112 is in the NES mode. If the indication information indicates the NES mode, the NAS 114 may be informed that the initiation information of the high-priority service is needed. That is, the AS 112 may inform the NAS 114 about the NES mode. Based on such information, the NAS 114 may know that the AS 112 needs to be informed about the high-priority service such as emergency call initiation in the connected mode and/or in the NES mode.

[0089] In some example embodiments, if the NES mode is configured or activated for the AS 112, the AS 112 may provide (220) the indication information to the NAS 114. For example, a NES mode configuration such as a periodic cell DTX/DRX configuration may be explicitly signalled to the first device 110, to configure the NES mode for the AS 112. If the NES mode is configured, or when the NES mode is configured, the AS 112 may provide (220) the indication information to the NAS 114.

[0090] In some example embodiments, the NES mode such as the cell DTX/DRX may be activated/deactivated implicitly by RRC signaling. That is, the cell DTX/DRX may be activated immediately once configured by RRC and deactivated once the RRC configuration is released. For example, L1 signaling for cell DTX/DRX activation/deactivation may be used. In some example embodiments, if the NES mode is activated, or when the NES mode is activated, the AS 112 may provide (220) the indication information to the NAS 114.

[0091] In this way, with the interactions between the AS 112 and NAS 114 such as the indication information interaction and the initiation information interaction, the high-priority service such as the emergency call can be initiated. That is, the high-priority service such as the emergency call can be initiated by the first device 110 which is in the NES mode. In addition, there is no delay in the connected mode due to NES. Thus, the indication from the NAS to AS when any high-priority service may be done although the first device 110 is in the connected state from NAS 114 point of view.

[0092] In some example embodiments, the AS 112 may provide (220) the indication information to the NAS 114 if one or more conditions is met. That is, the AS 112 may determine (210) whether at least one condition is met. In one example, if the AS 112 determines (210) that the AS 112 is in the NES mode or using a specific NES method, the AS 112 may provide (220) the indication information to the NAS 114. In another example,

if the AS 112 determines (210) that a periodicity of DTX/DRX is longer than a threshold periodicity, the AS 112 may provide (220) the indication information to the NAS 114. The threshold periodicity may be predefined or configured.

[0093] Alternatively, or in addition, in some example embodiments, if the AS 112 is not in the NES mode, or if the periodicity of DTX/DRX is shorter than or equal to the threshold periodicity, the AS 112 may not provide (220) the indication information to the NAS 114. That is, if the AS 112 is in a specific state, for example using the specific NES method, or the cell DTX/DRX periodicity longer than the threshold periodicity, the AS 112 may need to inform this state to the NAS 114.

[0094] In the example embodiments of FIG. 2A, if the NAS 114 obtains (230) the indication information, the NAS 114 may provide (240) the initiation information to the AS 112 if the high-priority service such as the emergency call needs to be initiated. Different with FIG. 2A, in the example of FIG. 2B, if the NAS 114 obtains (230) the indication information, the NAS 114 may perform different actions.

[0095] In some example embodiments, the NAS 114 may store (280) the indication information for later usage. For example, if the NAS 114 determines that a high-priority service such as an emergency call needs to be initiated, the NAS 114 may determine whether the indication information is stored (280) at the NAS 114. If the NAS 114 has stored (280) the indication information, the NAS 114 may for example provide (240) the initiation information to the AS 112, or perform any other suitable actions to aid the AS 112 to initiate the high-priority service.

[0096] In some example embodiments, the NAS 114 may stop using the stored (280) indication information if the connection such as RRC connection ends. For example, the NAS 114 may remove or delete the indication information without sending the initiation information to the AS 112. Alternatively, or in addition, in some example embodiments, a timer for the indication information may be predefined or configured. The stored (280) indication information may be valid until the timer expires. That is, if the NAS 114 determines that a high-priority service such as an emergency call needs to be initiated before the expiry of the timer, the NAS 114 may for example provide (240) the initiation information to the AS 112, or perform any other suitable actions to aid the AS 112 to initiate the high-priority service. If the timer expires, the NAS 114 may set the indication information as invalid, or remove or delete the indication information.

[0097] In some example embodiments, the NAS 114 may replace or delete the stored (280) indication information for example after a handover (HO). For example, after the HO, the situation or status on a new cell may be different. The NAS 114 may replace the stored (280) indication information based on the situation or status of the new cell.

[0098] In this way, the NAS 114 may use the stored (280) indication information for high-priority service initiation. The NAS 114 may also update or remove the indication information if the connected mode or NES mode has changed. By performing these different actions, the high-priority service triggered in the NES cell can be well handled.

[0099] Examples regarding high-priority service initiation have been described with respect to FIG. 2A and FIG. 2B. In some example embodiments, embodiments described with reference to the above signaling flow 200 and signaling 270 may be combined. By using these signaling flows 200 and 270, the high-priority service triggered in the NES cell can be well handled.

[00100] FIG. 3 shows a flowchart of an example method 300 of high-priority service initiation during NES according to some example embodiments of the present disclosure. The method 300 may be implemented at a first device such as the first device 110 in FIG. 1. For the purpose of discussion, the method 300 will be described from the perspective of the first device 110 in FIG. 1.

[00101] At 310, the first device 110 causes initiation information to be provided from a non-access stratum such as the NAS 114 to an access stratum such as the AS 112, the initiation information regarding a high-priority service to be initiated in a connected mode. At block 320, the first device 110 causes, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum.

[00102] In some example embodiments, the initiation of the high-priority service is performed by at least one of: initiating a random access procedure; transmitting a scheduling request to a network device; indicating a radio link failure; initiating a radio resource control reestablishment procedure; or switching to an idle mode.

[00103] In some example embodiments, the method 300 further comprises: causing indication information to be provided from the access stratum to the non-access stratum. In one example, the indication information indicates that the initiation information regarding the high-priority service to be initiated in the connected mode is required. In another example, the indication information indicates a network energy saving mode. For example, the

indication information may indicate that the network energy saving mode is configured or activated for the AS. In this manner, the access stratum may switch the provision of the initiation information from a disabled state to an enabled state.

[00104] In some example embodiments, the method 300 further comprises: in response to a network energy saving mode being configured or activated for the access stratum, causing the indication information to be provided from the access stratum to the non-access stratum. In this manner, the access stratum may allow the non-access stratum to wake up the access stratum from the NES mode in order to initiate the high-priority service in an expedited manner.

[00105] In some example embodiments, the method 300 further comprises: in accordance with a determination that the access stratum is in a network energy saving mode, causing the indication information to be provided from the access stratum to the non-access stratum. The determination may be based on the indication information the non-access stratum has received from the access stratum, or based on monitoring the mode of the access stratum.

[00106] In some example embodiments, the method 300 further comprises: in accordance with a determination that a periodicity of cell discontinuous reception or discontinuous transmission is longer than a threshold periodicity, causing the indication information to be provided from the access stratum to the non-access stratum.

[00107] In some example embodiments, the indication information further indicates that the access stratum is in the network energy saving mode.

[00108] In some example embodiments, the high-priority service comprises at least one of: an emergency call, signaling or data of a mission critical service, signaling or data belonging to an access category, signaling or data belonging to an access identity, signaling or data with a priority above a threshold priority, or high priority data or signaling.

[00109] FIG. 4 shows a flowchart of an example method 400 of AS and NAS interactions during NES according to some example embodiments of the present disclosure. The method 400 may be implemented at a first device such as the first device 110 in FIG. 1. For the purpose of discussion, the method 400 will be described from the perspective of the first device 110 in FIG. 1.

[00110] At 410, the first device 110 causes indication information to be provided from an access stratum such as the AS 112 to a non-access stratum such as the NAS 114. In one example, the indication information indicates that initiation information regarding a high-

priority service to be initiated in a connected mode is required. Alternatively, or in addition, in another example, the indication information indicates a network energy saving mode. For example, the indication information may indicate that the network energy saving mode is configured or activated for the AS.

[00111] In some example embodiments, the method 400 further comprises: causing the initiation information to be provided from the non-access stratum to the access stratum; and causing, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum.

[00112] In some example embodiments, the initiation of the high-priority service is performed by at least one of: initiating a random access procedure; transmitting a scheduling request to a network device; indicating a radio link failure; initiating a radio resource control reestablishment procedure; or switching to an idled mode.

[00113] In some example embodiments, the method 400 further comprises: in response to a network energy saving mode being configured or activated for the access stratum, causing the indication information to be provided from the access stratum to the non-access stratum.

[00114] In some example embodiments, the method 400 further comprises: in accordance with a determination that the access stratum is in a network energy saving mode, causing the indication information to be provided from the access stratum to the non-access stratum.

[00115] In some example embodiments, the method 400 further comprises: in accordance with a determination that a periodicity of cell discontinuous reception or discontinuous transmission is longer than a threshold periodicity, causing the indication information to be provided from the access stratum to the non-access stratum.

[00116] In some example embodiments, the indication information further indicates that the access stratum is in the network energy saving mode.

[00117] In some example embodiments, the high-priority service comprises at least one of: an emergency call, signaling or data of a mission critical service, signaling or data belonging to an access category, signaling or data belonging to an access identity, signaling or data with a priority above a threshold priority, or high priority data or signaling.

[00118] In some example embodiments, a first apparatus capable of performing any of the method 300 (for example, the first device 110 in FIG. 1) may comprise means for performing the respective operations of the method 300. The means may be implemented in any suitable

form. For example, the means may be implemented in a circuitry or software module. The first apparatus may be implemented as or included in the first device 110 in FIG. 1.

[00119] In some example embodiments, the first apparatus comprises means for causing initiation information to be provided from a non-access stratum to an access stratum, the initiation information regarding a high-priority service to be initiated in a connected mode; and means for causing, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum.

[00120] In some example embodiments, the initiation of the high-priority service is performed by at least one of: initiating a random access procedure; transmitting a scheduling request to a network device; indicating a radio link failure; initiating a radio resource control reestablishment procedure; or switching to an idle mode.

[00121] In some example embodiments, the first apparatus further comprises: means for causing indication information to be provided from the access stratum to the non-access stratum, the indication information indicating at least one of: a network energy saving mode, or that the initiation information regarding the high-priority service to be initiated in the connected mode is required.

[00122] In some example embodiments, the first apparatus further comprises: means for in response to a network energy saving mode being configured or activated for the access stratum, causing the indication information to be provided from the access stratum to the non-access stratum.

[00123] In some example embodiments, the first apparatus further comprises: means for causing in accordance with a determination that the access stratum is in a network energy saving mode, causing the indication information to be provided from the access stratum to the non-access stratum.

[00124] In some example embodiments, the first apparatus further comprises: means for causing in accordance with a determination that a periodicity of cell discontinuous reception or discontinuous transmission is longer than a threshold periodicity, causing the indication information to be provided from the access stratum to the non-access stratum.

[00125] In some example embodiments, the indication information further indicates that the access stratum is in the network energy saving mode.

[00126] In some example embodiments, the high-priority service comprises at least one of:

an emergency call, signaling or data of a mission critical service, signaling or data belonging to an access category, signaling or data belonging to an access identity, signaling or data with a priority above a threshold priority, or high priority data or signaling.

[00127] In some example embodiments, the first apparatus further comprises means for performing other operations in some example embodiments of the method 300 or the first device 110. In some example embodiments, the means comprises at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the performance of the first apparatus.

[00128] In some example embodiments, a second apparatus capable of performing any of the method 400 (for example, the first device 110 in FIG. 1) may comprise means for performing the respective operations of the method 400. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module. The second apparatus may be implemented as or included in the first device 110 in FIG. 1.

[00129] In some example embodiments, the second apparatus comprises means for causing indication information to be provided from an access stratum to a non-access stratum, the indication information indicating at least one of: a network energy saving mode, or that initiation information regarding a high-priority service to be initiated in a connected mode is required.

[00130] In some example embodiments, the second apparatus further comprises: means for causing the initiation information to be provided from the non-access stratum to the access stratum; and means for causing, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum.

[00131] In some example embodiments, the initiation of the high-priority service is performed by at least one of: initiating a random access procedure; transmitting a scheduling request to a network device; indicating a radio link failure; initiating a radio resource control reestablishment procedure; or switching to an idled mode.

[00132] In some example embodiments, the second apparatus further comprises: means for in response to a network energy saving mode being configured or activated for the access stratum, causing the indication information to be provided from the access stratum to the non-access stratum.

[00133] In some example embodiments, the second apparatus further comprises: means for

in accordance with a determination that the access stratum is in a network energy saving mode, causing the indication information to be provided from the access stratum to the non-access stratum.

[00134] In some example embodiments, the second apparatus further comprises: means for in accordance with a determination that a periodicity of cell discontinuous reception or discontinuous transmission is longer than a threshold periodicity, causing the indication information to be provided from the access stratum to the non-access stratum.

[00135] In some example embodiments, the indication information further indicates that the access stratum is in the network energy saving mode.

[00136] In some example embodiments, the high-priority service comprises at least one of: an emergency call, signaling or data of a mission critical service, signaling or data belonging to an access category, means for signaling or data belonging to an access identity, signaling or data with a priority above a threshold priority, or high priority data or signaling.

[00137] In some example embodiments, the second apparatus further comprises means for performing other operations in some example embodiments of the method 400 or the first device 110. In some example embodiments, the means comprises at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the performance of the second apparatus.

[00138] FIG. 5 is a simplified block diagram of a device 500 that is suitable for implementing example embodiments of the present disclosure. The device 500 may be provided to implement a communication device, for example, the first device 110 or the second device 120 as shown in FIG. 1. As shown, the device 500 includes one or more processors 510, one or more memories 520 coupled to the processor 510, and one or more communication modules 540 coupled to the processor 510.

[00139] The communication module 540 is for bidirectional communications. The communication module 540 has one or more communication interfaces to facilitate communication with one or more other modules or devices. The communication interfaces may represent any interface that is necessary for communication with other network elements. In some example embodiments, the communication module 540 may include at least one antenna.

[00140] The processor 510 may be of any type suitable to the local technical network and may include one or more of the following: general purpose computers, special purpose

computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 500 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[00141] The memory 520 may include one or more non-volatile memories and one or more volatile memories. Examples of the non-volatile memories include, but are not limited to, a Read Only Memory (ROM) 524, an electrically programmable read only memory (EPROM), a flash memory, a hard disk, a compact disc (CD), a digital video disk (DVD), an optical disk, a laser disk, and other magnetic storage and/or optical storage. Examples of the volatile memories include, but are not limited to, a random access memory (RAM) 522 and other volatile memories that will not last in the power-down duration.

[00142] A computer program 530 includes computer executable instructions that are executed by the associated processor 510. The instructions of the program 530 may include instructions for performing operations/acts of some example embodiments of the present disclosure. The program 530 may be stored in the memory, e.g., the ROM 524. The processor 510 may perform any suitable actions and processing by loading the program 530 into the RAM 522.

[00143] The example embodiments of the present disclosure may be implemented by means of the program 530 so that the device 500 may perform any process of the disclosure as discussed with reference to FIG. 2A to FIG. 4. The example embodiments of the present disclosure may also be implemented by hardware or by a combination of software and hardware.

[00144] In some example embodiments, the program 530 may be tangibly contained in a computer readable medium which may be included in the device 500 (such as in the memory 520) or other storage devices that are accessible by the device 500. The device 500 may load the program 530 from the computer readable medium to the RAM 522 for execution. In some example embodiments, the computer readable medium may include any types of non-transitory storage medium, such as ROM, EPROM, a flash memory, a hard disk, CD, DVD, and the like. The term “non-transitory,” as used herein, is a limitation of the medium itself (i.e., tangible, not a signal) as opposed to a limitation on data storage persistency (e.g., RAM vs. ROM).

[00145] FIG. 6 shows an example of the computer readable medium 600 which may be in

form of CD, DVD or other optical storage disk. The computer readable medium 600 has the program 530 stored thereon.

[00146] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. While various aspects of embodiments of the present disclosure are illustrated and described as block diagrams, flowcharts, or using some other pictorial representations, it is to be understood that the block, apparatus, system, technique or method described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00147] Some example embodiments of the present disclosure also provide at least one computer program product tangibly stored on a computer readable medium, such as a non-transitory computer readable medium. The computer program product includes computer-executable instructions, such as those included in program modules, being executed in a device on a target physical or virtual processor, to carry out any of the methods as described above. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data types. The functionality of the program modules may be combined or split between program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or distributed device. In a distributed device, program modules may be located in both local and remote storage media.

[00148] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. The program code may be provided to a processor or controller of a general purpose computer, special purpose computer, or other programmable data processing apparatus, such that the program code, when executed by the processor or controller, cause the functions/operations specified in the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on the machine and partly on a remote machine or entirely on the remote machine or server.

[00149] In the context of the present disclosure, the computer program code or related data

may be carried by any suitable carrier to enable the device, apparatus or processor to perform various processes and operations as described above. Examples of the carrier include a signal, computer readable medium, and the like.

[00150] The computer readable medium may be a computer readable signal medium or a computer readable storage medium. A computer readable medium may include but not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the computer readable storage medium would include an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[00151] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, while several specific implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the present disclosure, but rather as descriptions of features that may be specific to particular embodiments. Unless explicitly stated, certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, unless explicitly stated, various features that are described in the context of a single embodiment may also be implemented in a plurality of embodiments separately or in any suitable sub-combination.

[00152] Although the present disclosure has been described in languages specific to structural features and/or methodological acts, it is to be understood that the present disclosure defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

WHAT IS CLAIMED IS:

1. An apparatus comprising:
at least one processor; and
at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus at least to:
cause initiation information to be provided from a non-access stratum to an access stratum, the initiation information regarding a high-priority service to be initiated in a connected mode; and
cause, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum.
2. The apparatus of claim 1, wherein the initiation of the high-priority service is performed by at least one of:
initiating a random access procedure;
transmitting a scheduling request to a network device;
indicating a radio link failure;
initiating a radio resource control reestablishment procedure; or
switching to an idle mode.
3. The apparatus of claim 1 or claim 2, wherein the apparatus is further caused to:
cause indication information to be provided from the access stratum to the non-access stratum, the indication information indicating at least one of:
a network energy saving mode, or
the initiation information regarding the high-priority service to be initiated in the connected mode being required.
4. The apparatus of claim 3, wherein the apparatus is further caused to:
in response to the network energy saving mode being configured or activated for the access stratum, cause the indication information to be provided from the access stratum to the non-access stratum.
5. The apparatus of claim 3 or claim 4, wherein the apparatus is further caused to:
in accordance with a determination that the access stratum is in a network energy

saving mode, cause the indication information to be provided from the access stratum to the non-access stratum.

6. The apparatus of any of claims 3 to 5, wherein the apparatus is further caused to:
in accordance with a determination that a periodicity of cell discontinuous reception or discontinuous transmission is longer than a threshold periodicity, cause the indication information to be provided from the access stratum to the non-access stratum.

7. The apparatus of any of claims 3 to 6, wherein the indication information further indicates that the access stratum is in the network energy saving mode.

8. The apparatus of any of claims 1 to 7, wherein the high-priority service comprises at least one of:

- an emergency call,
- signaling or data of a mission critical service,
- signaling or data belonging to an access category,
- signaling or data belonging to an access identity,
- signaling or data with a priority above a threshold priority, or
- high priority data or signaling.

9. An apparatus comprising:

- at least one processor; and

- at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus at least to:

- cause indication information to be provided from an access stratum to a non-access stratum, the indication information indicating at least one of:

- a network energy saving mode, or

- initiation information regarding a high-priority service to be initiated in a connected mode being required.

10. The apparatus of claim 9, wherein the apparatus is further caused to:

- cause the initiation information to be provided from the non-access stratum to the access stratum; and

- cause, based on the initiation information, an initiation of the high-priority service to

be performed at the access stratum.

11. The apparatus of claim 10, wherein the initiation of the high-priority service is performed by at least one of:

- initiating a random access procedure;
- transmitting a scheduling request to a network device;
- indicating a radio link failure;
- initiating a radio resource control reestablishment procedure; or
- switching to an idled mode.

12. The apparatus of any of claims 9 to 11, wherein the apparatus is further caused to: in response to a network energy saving mode being configured or activated for the access stratum, cause the indication information to be provided from the access stratum to the non-access stratum.

13. The apparatus of any of claims 9 to 12, wherein the apparatus is further caused to: in accordance with a determination that the access stratum is in a network energy saving mode, cause the indication information to be provided from the access stratum to the non-access stratum.

14. The apparatus of any of claims 9 to 13, wherein the apparatus is further caused to: in accordance with a determination that a periodicity of cell discontinuous reception or discontinuous transmission is longer than a threshold periodicity, cause the indication information to be provided from the access stratum to the non-access stratum.

15. The apparatus of any of claims 9 to 14, wherein the indication information further indicates that the access stratum is in the network energy saving mode.

16. The apparatus of any of claims 9 to 15, wherein the high-priority service comprises at least one of:

- an emergency call,
- signaling or data of a mission critical service,
- signaling or data belonging to an access category,
- signaling or data belonging to an access identity,

signaling or data with a priority above a threshold priority, or high priority data or signaling.

17. A method comprising:

causing, at a first device, initiation information to be provided from a non-access stratum to an access stratum, the initiation information regarding a high-priority service to be initiated in a connected mode; and

causing, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum.

18. A method comprising:

causing, at a first device, indication information to be provided from an access stratum to a non-access stratum, the indication information indicating at least one of:

a network energy saving mode, or

initiation information regarding a high-priority service to be initiated in a connected mode being required.

19. An apparatus comprising:

means for causing initiation information to be provided from a non-access stratum to an access stratum, the initiation information regarding a high-priority service to be initiated in a connected mode; and

means for causing, based on the initiation information, an initiation of the high-priority service to be performed at the access stratum.

20. An apparatus comprising:

means for causing indication information to be provided from an access stratum to a non-access stratum, the indication information indicating at least one of:

a network energy saving mode, or

initiation information regarding a high-priority service to be initiated in a connected mode being required.

21. A computer readable medium comprising instructions which, when executed by an apparatus, cause the apparatus to perform at least the method of claim 17 or the method of claim 18.

DRAWINGS

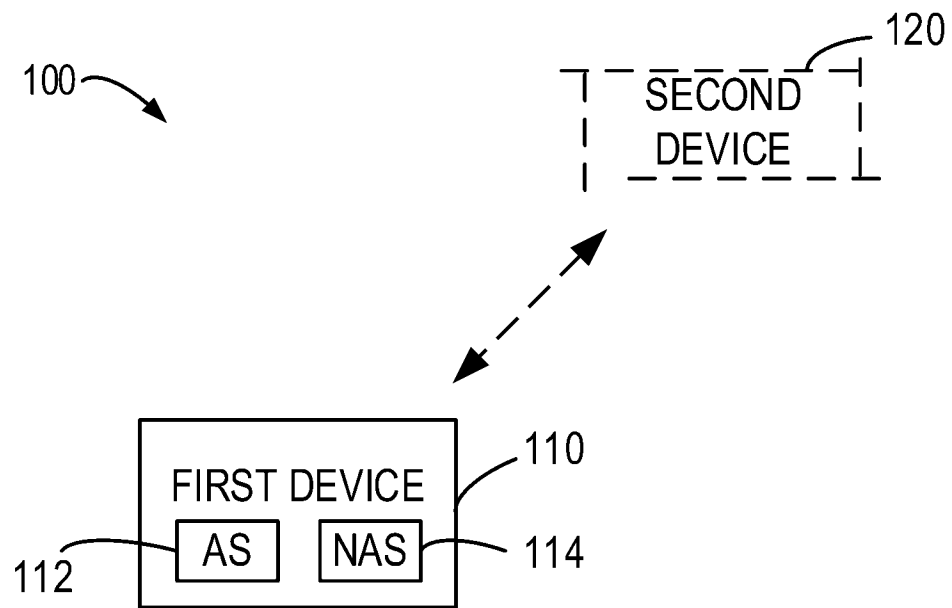


FIG. 1

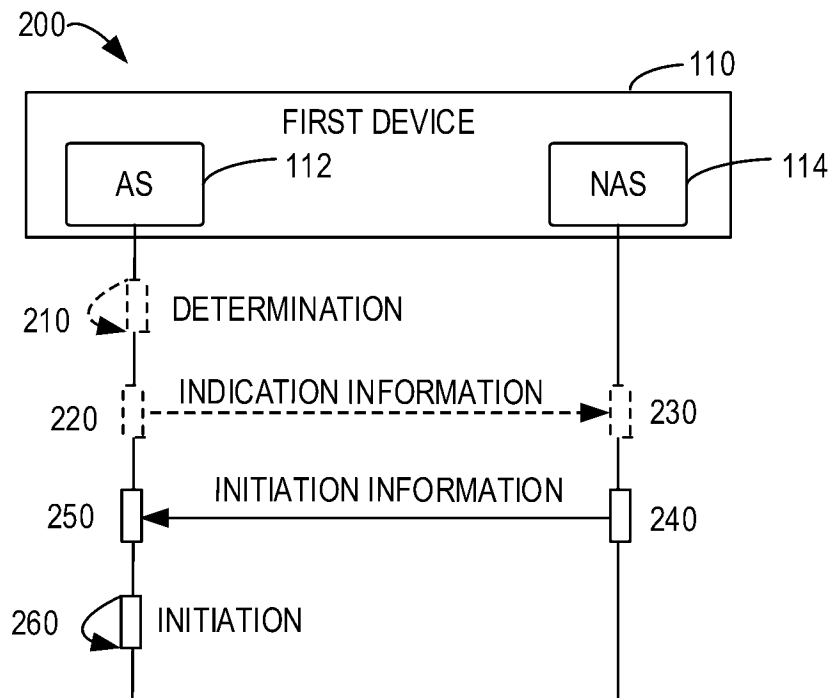


FIG. 2A

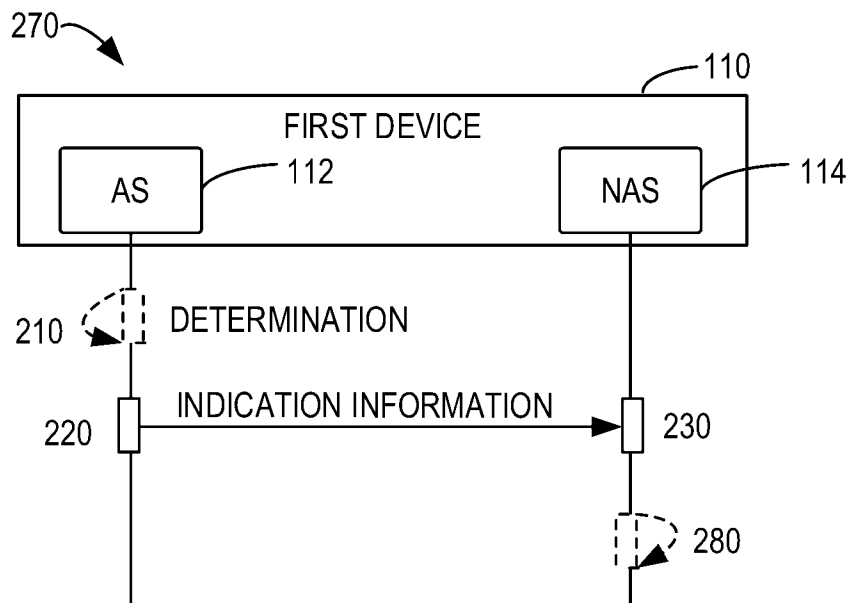
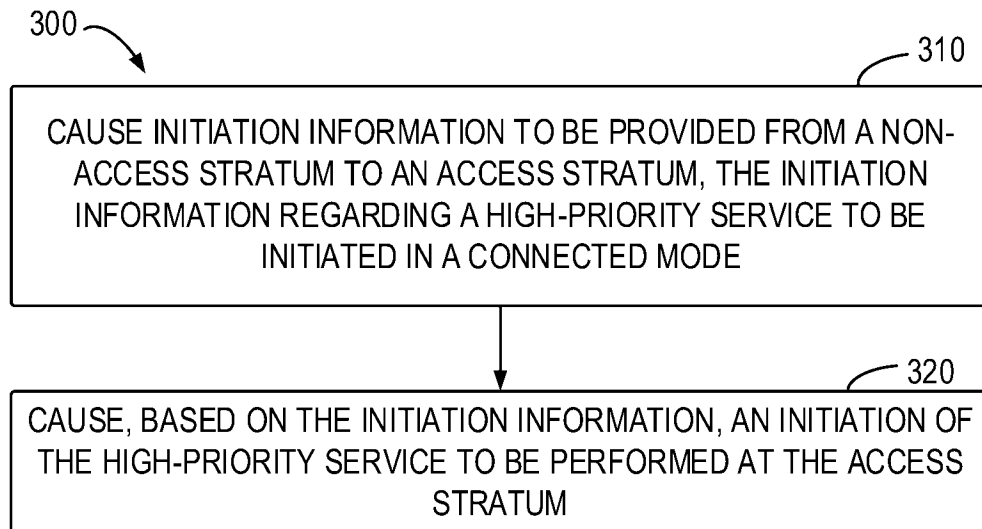
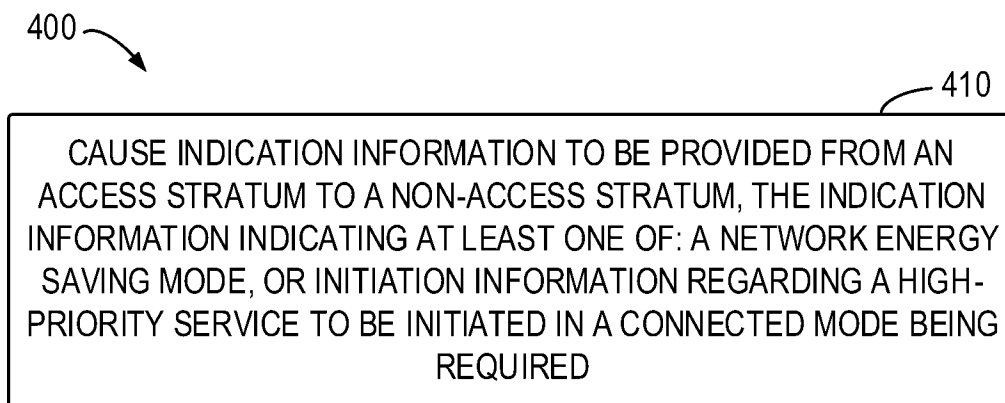


FIG. 2B

**FIG. 3****FIG. 4**

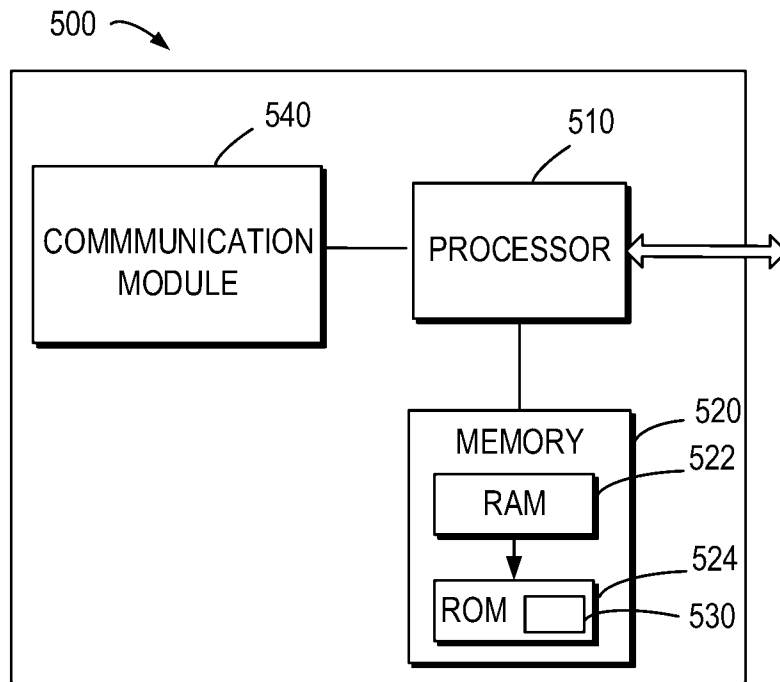


FIG. 5

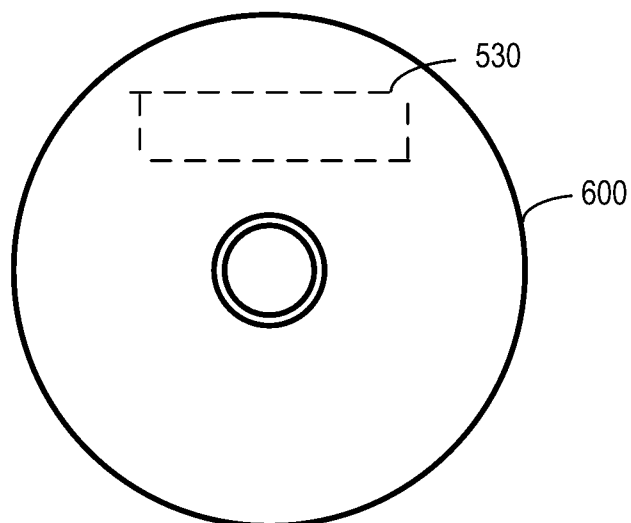


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/098717

A. CLASSIFICATION OF SUBJECT MATTER

H04W52/02(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)

IPC:H04W,H04Q,H04L

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

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

CNABS,CNTXT,WPABSC,ENTXTC,VEN,3GPP: NAS, AS, access stratum, non, priority, high, emergency, service, call, NES, network energy saving, connect, mode, initiation, RA, SR, RLF, RRC+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2503838 A2 (HTC CORPORATION) 26 September 2012 (2012-09-26) description, paragraphs [0018]-[0022], figures 2A-2B	1-2,8,17,19,21
Y	EP 2503838 A2 (HTC CORPORATION) 26 September 2012 (2012-09-26) description, paragraphs [0018]-[0022], figures 2A-2B	3-7,9-16,18,20
Y	WO 2009117588 A1 (INTERDIGITAL PATENT HOLDINGS, INC.) 24 September 2009 (2009-09-24) claims 1-11	3-7,9-16,18,20
A	CN 109891919 A (LG ELECTRONICS INC.) 14 June 2019 (2019-06-14) the whole document	1-21
A	HUAWEI et al. "No suppress of NAS signalling transmission for purpose of emergency services R17" 3GPP TSG-CT WG1 Meeting #139 C1-226682, 18 November 2022 (2022-11-18), the whole document	1-21



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"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

17 October 2023

Date of mailing of the international search report

24 October 2023

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2023/098717

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				US	2019246318	A1	08 August 2019