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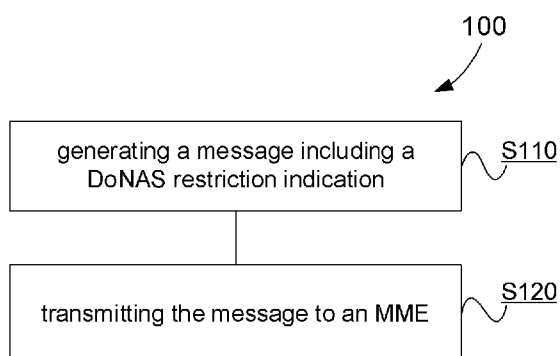


FIG. 1

(57) Abstract: A method in a network device is provided. The method comprises generating a message including a DoNAS restriction indication if it is determined that usage of signaling radio bearer resources in a cell reaches a threshold. The method further comprises transmitting the message to a Mobility Management Entity, MME. Other devices and methods are also provided.



DEVICES AND METHODS FOR DATA TRANSFER IN WIRELESS NETWORK**TECHNICAL FIELD**

- 5 [0001] The disclosure relates generally to wireless communications, and more particularly, to devices and methods for data transfer in a wireless network.

BACKGROUND

- [0002] According to 3GPP standard, Control Plane CioT EPS optimization (i.e.
10 DoNAS, Data over Non-Access Stratum) is designed to increase data transfer efficiency. Generally, DoNAS is used for infrequent small data transfer to avoid overuse of signaling radio bearer resources for data transfer. When DoNAS is used for data transfer, a User Equipment, UE, or a Mobility Management Entity, MME, can decide to switch to S1-U data transfer based on e.g. data size. For
15 example, UE and MME can trigger the switching from Control Plane CioT EPS optimization (i.e. DoNAS) to S1-U data transfer (refer to section 5.3.4B.4 of 3GPP TS23.401) if both UE and the network support S1-U data transfer.

SUMMARY

- 20 [0003] The summary is provided to introduce a selection of concepts in a simplified form that are further described below in detailed description. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.
- 25 [0004] Nevertheless, the UE or MME does not have knowledge of overall usage of signaling radio bearer resources in a cell and cannot perform the switching to S1-U data transfer timely and automatically. Therefore, it is difficult to protect the signaling radio bearer resources in a cell from being overused.
- 30 [0005] The disclosure proposes to provide an instruction by a network device (such as eNB), which has the knowledge of the usage of signaling radio bearer resources in a cell, to the MME so as to perform the switching from DoNAS to

S1-U data transfer.

[0006] In an aspect of the disclosure, a method in a network device is provided. The method comprises generating a message including a DoNAS restriction indication if it is determined that usage of signaling radio bearer resources in a cell reaches a threshold. The method further comprises transmitting the message to a Mobility Management Entity, MME.

[0007] In an embodiment, the DoNAS restriction indication may indicate that usage of DoNAS for data transfer is not preferred. Alternatively, the DoNAS restriction indication may indicate that usage of DoNAS for data transfer is restricted.

[0008] In an embodiment, the network device may receive, during NAS connection establishment, a NAS message from a User Equipment, UE. The NAS message may comprise a Control Plane Service Request, an Attach Request, or a TAU Request, etc. The network device may generate an S1-AP message by combining the NAS message with the DoNAS restriction indication.

[0009] In an embodiment, the network device may directly generate an S1-AP message including the DoNAS restriction indication when DoNAS is being used for data transfer. For example, the S1-AP message may comprise an Initial UE message, an Uplink NAS Transport message, a NAS Non Delivery Indication message or a NAS Delivery Indication message, etc.

[0010] In another aspect of the disclosure, a method in a Mobility Management Entity, MME, is provided. The method comprises receiving a message including a DoNAS restriction indication. The method further comprises performing operations associated with data transfer based at least upon the DoNAS restriction indication. Preferably, the message may comprise an Initial UE message, an Uplink NAS Transport message, a NAS Non Delivery Indication message or a NAS Delivery Indication message, etc.

[0011] In an embodiment, the DoNAS restriction indication may indicate that DoNAS is not preferred. In this situation, user plane bearers may be established if both the UE and the MME support S1-U data transfer. Otherwise, usage of DoNAS for data transfer may be maintained.

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[0012] In an embodiment, the DoNAS restriction indication may indicate that DoNAS is restricted. In this situation, usage of DoNAS for data transfer may be restricted, and user plane bearers may be established if both the UE and the MME support S1-U data transfer.

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[0013] In an embodiment, user plane bearers may be established by setting up S1-U bearers and data radio bearers. Usage of DoNAS may be inhibited by rejecting a NAS message from the UE and triggering S1 release procedure, or triggering S1 release procedure.

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[0014] In a further aspect of the disclosure, a network device is provided which comprises a processor and a memory. The memory contains instructions executable by the processor whereby the network device is operative to perform the methods in accordance with the aspects of the disclosure.

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[0015] In a further aspect of the disclosure, a Mobility Management Entity, MME, is provided which comprises a processor and a memory. The memory contains instructions executable by the processor whereby the MME is operative to perform the methods in accordance with the aspects of the disclosure.

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[0016] In a further aspect of the disclosure, a computer program comprising computer program code means is provided. The computer program code means may cause, when executed by at least one processor, the at least one processor to perform the methods in accordance with the aspects of the disclosure.

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[0017] In a further aspect of the disclosure, a computer readable medium is provided. The computer readable medium has stored thereon the computer program in accordance with the aspects of the disclosure.

[0018] With the proposed schemes of the disclosure, the switching from DoNAS to S1-U data transfer can be performed automatically according to usage of signaling radio bearer resources, and thus the signaling radio bearer resources can be protected from being overused.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The above and other objects, features and advantages will be more apparent from the following description of embodiments with reference to the figures, in which:

Fig. 1 is a flowchart illustrating a method in a network device according to an embodiment of the disclosure;

Fig. 2 is a flowchart illustrating a method in an MME according to an embodiment of the disclosure;

Fig. 3 is a schematic diagram showing signaling among a plurality of network nodes during NAS connection establishment;

Fig. 4 is a schematic diagram showing signaling among a plurality of network nodes when DoNAS is being used;

Fig. 5 is a block diagram of a network device according to an embodiment of the disclosure;

Fig. 6 is a block diagram of an MME according to an embodiment of the disclosure;

Fig. 7 is a block diagram of a computer readable medium having stored thereon a computer program comprising computer program code means according to an embodiment of the disclosure.

DETAILED DESCRIPTION

[0020] In the discussion that follows, specific details of particular embodiments of the present disclosure are set forth for purposes of explanation and not limitation.

It will be appreciated by those skilled in the art that other embodiments may be employed apart from these specific details. Furthermore, in some instances detailed descriptions of well-known methods, nodes, interfaces, circuits, and devices are omitted so as not to obscure the description with unnecessary detail.

Those skilled in the art will appreciate that the functions described may be implemented in one or several nodes.

[0021] As used herein, the term "wireless communication network" refers to a network following any suitable communication standards, such as LTE-Advanced (LTE-A), LTE, Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), and so on. Furthermore, the communications between a terminal device and a network device in the wireless 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 future fifth generation (5G) communication protocols, and/or any other protocols either currently known or to be developed in the future.

[0022] The term "device" refers to a network device or a terminal device in a wireless communication network.

[0023] The term "network device" refers to a device in a wireless communication network via which a terminal device accesses the network and receives services therefrom. The network device refers a base station (BS), an access point (AP), a Mobile Management Entity (MME), Multi-cell/Multicast Coordination Entity (MCE), a gateway, a server, a controller or any other suitable device in the wireless communication network. The BS may be, for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a gNB, a Remote Radio Unit (RRU), a radio header (RH), a remote radio head (RRH), a relay, a low power node such as a femto, a pico, and so forth.

[0024] Yet further examples of network device include multi-standard radio (MSR) radio equipment such as MSR BSs, network controllers such as radio network controllers (RNCs) or base station controllers (BSCs), base transceiver stations (BTSs), transmission points, transmission nodes, Multi-cell/multicast Coordination Entities (MCEs), core network nodes (e.g., MSCs, MMEs), O&M nodes, OSS

nodes, SON nodes, positioning nodes (e.g., E-SMLCs), and/or MDTs. More generally, however, network device may represent any suitable device (or group of devices) capable, configured, arranged, and/or operable to enable and/or provide a terminal device access to the wireless communication network or to
5 provide some service to a terminal device that has accessed the wireless communication network.

[0025] The term "terminal device" refers to any end device that can access a wireless communication network and receive services therefrom. By way of
10 example and not limitation, the terminal device refers to a mobile terminal, UE, or other suitable device. The UE may be, for example, 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, portable computers, image capture terminal devices such as digital cameras, gaming terminal devices, music
15 storage and playback appliances, a mobile phone, a cellular phone, a smart phone, a tablet, a wearable device, a personal digital assistant (PDA), a vehicle, and the like.

20 [0026] The terminal device may support device-to-device (D2D) communication, for example by implementing a 3GPP standard for sidelink communication, and may in this case be referred to as a D2D communication device.

[0027] As yet another specific example, in an Internet of Things (IOT) scenario, a
25 terminal device may represent a machine or other device that performs monitoring and/or measurements, and transmits the results of such monitoring and/or measurements to another terminal device and/or a network equipment. The terminal device may in this case be a machine-to-machine (M2M) device, which may in a 3GPP context be referred to as a machine-type communication
30 (MTC) device. As one particular example, the terminal device may be a UE implementing the 3GPP narrow band internet of things (NB-IoT) standard. Particular examples of such machines or devices are sensors, metering devices such as power meters, industrial machinery, or home or personal appliances, e.g.

refrigerators, televisions, personal wearables such as watches etc. In other scenarios, a terminal device may represent a vehicle or other equipment that is capable of monitoring and/or reporting on its operational status or other functions associated with its operation.

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[0028] Now some exemplary embodiments of the present disclosure will be described below with reference to the figures. Reference is first made to Fig. 1 which is a flowchart illustrating a method 100 in a network device (for example, an eNB) according to an embodiment of the disclosure. The method 100 as shown in Fig. 1 includes the following blocks.

10

[0029] At block S110, the network device determines, based upon knowledge of usage of signaling radio bearer resources in a cell, whether the usage of signaling radio bearer resources in the cell reaches a threshold. If so, the network device may generate a message including a Data over Non-Access Stratum, DoNAS, restriction indication. The DoNAS restriction indication may indicate that usage of DoNAS for data transfer is not preferred or is restricted.

15

[0030] In an example, the network device may receive, during NAS connection establishment, a NAS message from a User Equipment, UE. The NAS message may comprise a Control Plane Service Request, an Attach Request, or a TAU Request, etc. The network device may generate an S1-AP message by combining the received NAS message with the DoNAS restriction indication.

20

[0031] In another example, when DoNAS is being used for data transfer, the network device may directly generate an S1-AP message including the DoNAS restriction indication. For example, the S1-AP message may comprise an Initial UE message, an Uplink NAS Transport message, a NAS Non Delivery Indication message or a NAS Delivery Indication message, to name a few.

25

[0032] At block S120, the network device transmitted the message generated at block 110 to a Mobility Management Entity, MME. Thus the MME may perform the switching from DoNAS to S1-U data transfer.

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[0033] For S1-C interface (between MME and eNB), new information element DoNAS Restriction Indication may be added in messages such as Initial UE Message, an Uplink NAS Transport message, a NAS Non Delivery Indication message or a NAS Delivery Indication message, to name a few. Several
5 examples of messages incorporating the element DoNAS Restriction Indication are given below.

[0034] (1). Initial UE Message incorporating DoNAS Restriction Indication

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.1.1		YES	ignore
eNB UE STAP ID	M		9.2.3.4		YES	reject
NAS-PDU	M		9.2.3.6		YES	reject
TAI	M		9.2.3.16	Indicating the Tracking Area from which the UE has sent the NAS message.	YES	reject
E-UTRAN CGI	M		9.2.1.38	Indicating the E-UTRAN CGI from which the UE has sent the NAS message.	YES	ignore
RRC Establishment Cause	M		9.2.1.3a		YES	ignore
S-TMSI	O		9.2.3.6		YES	reject
CSG ID	O		9.2.1.62		YES	reject
GUMMEI	O		9.2.3.9		YES	reject
Cell Access Mode	O		9.2.1.74		YES	reject
GW Transport Layer Address	O		Transport Layer Address 9.2.2.1	Indicating GW Transport Layer Address if the GW is collocated with eNB.	YES	ignore
Relay Node Indicator	O		9.2.1.79	Indicating a relay node.	YES	reject
GUMMEI Type	O		ENUMERATED (native, mapped, ...)		YES	ignore
Tunnel Information for BBF	O		Tunnel Information 9.2.2.3	Indicating HeNB's Local IP Address assigned by the broadband access provider, UDP port Number.	YES	ignore
SIP TO L-GW Transport Layer Address	O		Transport Layer Address 9.2.2.1	Indicating SIP TO L-GW Transport Layer Address if the SIP TO L-GW is collocated with eNB.	YES	ignore
LHN ID	O		9.2.1.92		YES	ignore
MME Group ID	O		9.2.3.44		YES	ignore
UE Usage Type	O		INTEGER (0..255)		YES	ignore
CE-mode-B Support Indicator	O		9.2.1.118		YES	ignore
DCN ID	O		INTEGER (0..65535)		YES	ignore
Coverage Level	O		ENUMERATED (extended coverage, ...)		YES	ignore
DoNAS Restriction Indication	O		ENUMERATED (not preferred, restricted, ...)	Indicating whether DoNAS is not preferred or restricted for this connection	YES	ignore

[0035] (2). Uplink NAS Transport message incorporating DoNAS Restriction Indication

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.1.1		YES	ignore
MME UE STAP ID	M		9.2.3.3		YES	reject
eNB UE STAP ID	M		9.2.3.4		YES	reject
NAS-PDU	M		9.2.3.5		YES	reject
E-UTRAN CGI	M		9.2.1.38		YES	ignore
TAI	M		9.2.3.16		YES	ignore
GW Transport Layer Address	O		Transport Layer Address 9.2.2.1	Indicating GW Transport Layer Address if the GW is collocated with eNB	YES	ignore
SIPTO L-GW Transport Layer Address	O		Transport Layer Address 9.2.2.1	Indicating SIPTO L-GW Transport Layer Address if the SIPTO L-GW is collocated with eNB	YES	ignore
LHN ID	O		9.2.1.92		YES	ignore
DoNAS Restriction Indication	O		ENUMERATED (not preferred, restricted, ...)	Indicating whether DoNAS is not preferred or restricted for this connection	YES	ignore

[0036] (3). NAS Non Delivery Indication message incorporating DoNAS Restriction Indication

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IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.1.1		YES	ignore
MME UE STAP ID	M		9.2.3.3		YES	reject
eNB UE STAP ID	M		9.2.3.4		YES	reject
NAS-PDU	M		9.2.3.5		YES	ignore
Cause	M		9.2.1.3		YES	ignore
DoNAS Restriction Indication	O		ENUMERATED (not preferred, restricted, ...)	Indicating whether DoNAS is not preferred or restricted for this connection	YES	ignore

[0037] (4). NAS Delivery Indication message incorporating DoNAS Restriction Indication

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IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.1.1		YES	ignore
MME UE STAP ID	M		9.2.3.3		YES	reject
eNB UE STAP ID	M		9.2.3.4		YES	reject
DoNAS Restriction Indication	O		ENUMERATED (not preferred, restricted, ...)	Indicating whether DoNAS is not preferred or restricted for this connection	YES	ignore

[0038] Fig. 2 is a flowchart illustrating a method 200 in an MME according to an embodiment of the disclosure. The method 200 as shown in Fig. 2 includes the following blocks.

5 [0039] At block S210, the MME receives a message including a DoNAS restriction indication from, e.g., a network device (such as an eNB). The DoNAS restriction indication may indicate that usage of DoNAS for data transfer is not preferred or restricted. The message may be one of an Initial UE message, an Uplink NAS Transport message, a NAS Non Delivery Indication message or a
10 NAS Delivery Indication message, etc.

[0040] At block S220, the MME performs operations associated with data transfer based at least upon the received DoNAS restriction indication. For example, if the DoNAS restriction indication indicates that DoNAS is not preferred,
15 user plane bearers may be established if both the UE and the MME support S1-U data transfer. Otherwise, usage of DoNAS for data transfer may be maintained. For example, user plane bearers may be established by setting up S1-U bearers and data radio bearers.

20 [0041] On the other hand, if the DoNAS restriction indication indicates that DoNAS is restricted, usage of DoNAS for data transfer may be restricted and user plane bearers may be established if both the UE and the MME support S1-U data transfer. For example, usage of DoNAS may be inhibited by rejecting a NAS message from the UE and triggering S1 release procedure during NAS
25 connection establishment, or triggering S1 release procedure when DoNAS is being used.

[0042] In an example, if S1 connection should be released according to Release Assistance Information after the delivery of the uplink data contained in the NAS
30 ESM Data Transport message carried in S1-AP message, MME releases the S1 connection after uplink data delivery without additional action based on DoNAS Restriction Indication. Otherwise,

- If DoNAS Restriction Indication indicates that DoNAS is not preferred:
 - i. if both UE and MME support S1-U data transfer, MME establishes user plane bearers regardless of the UE's preference on DoNAS; otherwise,
 - 5 ii. DoNAS is used or kept.
- If DoNAS Restriction Indication indicates that DoNAS is restricted:
 - i. If both UE and MME support S1-U data transfer, MME establishes user plane bearers; otherwise,
 - 10 ii. MME rejects the Control Plane Service Request or MME releases the existing S1 connection.

[0043] It is noted that the above description is based on SGI PDN. The person skilled in the art would understand that similar principles apply to SCEF associated PDN except that S1-U data transfer is not supported in SCEF associated PDN.

[0044] With the methods shown in Figs. 1-2, a network device which has the knowledge of the usage of signaling radio bearer resources in a cell may provide an instruction to the MME so as to perform the switching from DoNAS to S1-U data transfer. As such, the switching from DoNAS to S1-U data transfer can be performed automatically according to usage of signaling radio bearer resources, and thus the signaling radio bearer resources can be protected from being overused.

[0045] In the next, more details of the proposed principles will be given in connection with Fig. 3 and Fig. 4.

[0046] Fig. 3 is a schematic diagram showing signaling among a plurality of network nodes during NAS connection establishment. In particular, Fig. 3 illustrates that an eNB instructs switching to S1-U data transfer by providing DoNAS Restriction Indication during NAS connection establishment.

[0047] Block 1: The UE establishes a RRC connection.

5 [0048] Block 2: If eNB determines that signaling radio bearer resource needs to be protected, it includes DoNAS Restriction Indication in an S1-AP Initial UE Message and sends the message to MME. It is noted that If UE sends Service Request for the NAS connection setup, then MME just establishes user plane bearers without checking the DoNAS Restriction Indication.

10 [0049] Block 3: MME decides whether to establish user plane bearers or use DoNAS or reject the Control Plane Service Request based on DoNAS Restriction Indication and other parameters, as have been described above with reference to Fig. 2. Blocks 4a-4c will be selectively performed based upon the determination of the MME. However, if S1 connection should be released according to Release
15 Assistance Information after the delivery of the uplink data contained in the NAS ESM Data Transport message carried in Initial UE message, MME would release the S1 connection after uplink data delivery and the following blocks 4a-4c and 5 will not be performed.

20 [0050] Blocks 4a: If MME decides to establish user plane bearers, S1-U and radio bearer can be setup.

[0051] Block 4b: If MME decides to use DoNAS for data transfer, S11-U tunnel can be setup.

25

[0052] Block 4c: If MME decides to reject Control Plane Service Request, a Service Reject can be sent to UE and S1 connection is released.

30 [0053] Block 5: The uplink and downlink data may be transferred using S1-U data transfer or DoNAS if service request is not rejected.

[0054] Fig. 4 is a schematic diagram showing signaling among a plurality of network nodes when DoNAS is being used. In particular, Fig. 4 illustrates that an

eNB instructs switching to S1-U data transfer by providing DoNAS Restriction Indication when DoNAS is being used.

5 [0055] Block 1: The uplink and downlink data is being transferred using DoNAS.

[0056] Block 2: If eNB determines that signaling radio bearer resource needs to be protected, it includes DoNAS Restriction Indication in an S1-AP Initial UE Message and sends the message to MME which is used for uplink data delivery or for downlink data delivery report. The S1-AP message may be one of UPLINK NAS TRANSPORT, NAS NON DELIVERY INDICATION or NAS DELIVERY INDICATION, etc.

15 [0057] Block 3: MME decides whether to establish user plane bearers or keep DoNAS or release S1 connection based on DoNAS Restriction Indication and other parameters, as have been described above with reference to Fig. 2. Blocks 4a-4b will be selectively performed based upon the determination of the MME (no extra action is needed if MME decides to keep DoNAS). However, if S1 connection should be released according to Release Assistance Information after the delivery of the uplink data contained in the NAS ESM Data Transport message carried in the S1-AP message, MME would release the S1 connection after uplink data delivery and the following blocks 4a-4b and 5 will not be performed.

25 [0058] Block 4a: If MME decides to establish user plane bearers, S1-U and radio bearer can be setup.

[0059] Block 4b: If MME decides to release S1 connection, S1 release procedure is triggered.

30

[0060] Block 5: Uplink and downlink data is transferred using S1-U data transfer or DoNAS if S1 connection is not released.

[0061] Fig. 5 is a block diagram of a network device according to an embodiment of the disclosure. As shown in Fig. 5, the network device 500 comprises a processor 510 and a memory 520 storing instructions executable by the processor 510. The processor 510 may be implemented by a CPU (Central processing unit), and could also be implemented by other types of components. Various embodiments of the present disclosure may be implemented by computer program executable by one or more of the processors 510, software, firmware, hardware or in a combination thereof. For example, the processor 510 may be implemented by general purpose microprocessors, instruction set processors and/or special purpose microprocessors such as Application Specific Integrated Circuit (ASICs) and processors based on multicore processor architecture, as non-limiting examples.

[0062] Fig. 6 is a block diagram of an MME according to an embodiment of the disclosure. As shown in Fig. 6, the MME 600 comprises a processor 610 and a memory 620 storing instructions executable by the processor 610. The processor 610 may be implemented by a CPU (Central processing unit), and could also be implemented by other types of components. Various embodiments of the present disclosure may be implemented by computer program executable by one or more of the processors 610, software, firmware, hardware or in a combination thereof. For example, the processor 610 may be implemented by general purpose microprocessors, instruction set processors and/or special purpose microprocessors such as Application Specific Integrated Circuit (ASICs) and processors based on multicore processor architecture, as non-limiting examples.

[0063] Fig. 7 is a block diagram of a computer readable medium having stored thereon a computer program comprising computer program code means according to an embodiment of the disclosure. As shown in Fig. 7, a computer readable medium 702 has stored thereon a computer program 701. The computer program 701 comprises computer program code means 700 for performing, when executed by at least one processor, the methods according to the disclosure as mentioned above. The computer readable medium 702 may have the form of a non-volatile or volatile memory, e.g., an Electrically Erasable

Programmable Read-Only Memory (EEPROM), a flash memory, a floppy disk, and a hard drive, etc. The computer program code means 700 may include codes/computer readable instructions in any format.

- 5 [0064] The techniques described herein may be implemented by various means so that an apparatus implementing one or more functions of a corresponding apparatus described with an embodiment includes not only prior art means, but also means for implementing the one or more functions of the corresponding apparatus described with the embodiment and it may include separate means for
- 10 each separate function, or means that may be configured to perform two or more functions. For example, these techniques may be implemented in hardware (one or more apparatuses), firmware (one or more apparatuses), software (one or more modules), or combinations thereof. For a firmware or software, implementation may be made through modules (e.g., procedures, functions, and
- 15 so on) that perform the functions described herein.

- [0065] Example embodiments herein have been described above with reference to block diagrams and flowchart illustrations of methods and apparatuses. It will
- 20 be understood that each block of the block diagrams and flowchart illustrations, and combinations of blocks in the block diagrams and flowchart illustrations, respectively, can be implemented by various means including hardware, software, firmware, and a combination thereof. For example, in one embodiment, each block of the block diagrams and flowchart illustrations, and combinations of
- 25 blocks in the block diagrams and flowchart illustrations can be implemented by computer program instructions. These computer program instructions may be loaded onto a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions which execute on the computer or other programmable data
- 30 processing apparatus create means for implementing the functions specified in the flowchart block or blocks.

[0066] 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

5 implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the subject matter described herein, but rather as descriptions of features that may be specific to particular embodiments. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a

10 single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be

15 excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.

[0067] Conditional language used herein, such as "can," "might," "may," "e.g.," and the like, unless specifically stated otherwise, or otherwise understood within

20 the context as used, is generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or states. Thus, such conditional language is not generally intended to imply that features, elements and/or states are in any way required for one or more

25 embodiments or that one or more embodiments necessarily include logic for deciding, with or without author input or prompting, whether these features, elements and/or states are included or are to be performed in any particular embodiment. The terms "comprises," "comprising," "including," "includes," "having," and the like are synonymous and are used inclusively, in an open-ended fashion, and do not exclude additional elements, features, acts, operations,

30 and so forth. Also, the term "or" is used in its inclusive sense (and not in its exclusive sense) so that when used, for example, to connect a list of elements, the term "or" means one, some, or all of the elements in the list. Further, the term "each," as used herein, in addition to having its ordinary meaning, can mean any

subset of a set of elements to which the term "each" is applied.

[0068] The terms "first" and "second" refer to different elements. The singular forms "a" and "an" are intended to include the plural forms as well, unless the context clearly indicates otherwise. The term "based on" is to be read as "based at least in part on." The term "one embodiment" and "an embodiment" are to be read as "at least one embodiment." The term "another embodiment" is to be read as "at least one other embodiment." Other definitions, explicit and implicit, may be included below.

[0069] In addition, language such as the phrase "at least one of X, Y and Z," unless specifically stated otherwise, is to be understood with the context as used in general to convey that an item, term, etc. may be either X, Y, or Z, or a combination thereof. Unless otherwise explicitly stated, articles such as "a" or "an" should generally be interpreted to include one or more described items. Accordingly, phrases such as "a device configured to" are intended to include one or more recited devices. Such one or more recited devices can also be collectively configured to carry out the stated recitations.

[0070] The disclosure has been described with reference to embodiments and drawings. It should be understood that various modifications, alternations and additions can be made by those skilled in the art without departing from the spirits and scope of the disclosure. Such modifications, alternations and additions are considered to be within the scope of the disclosure and the appended claims. Therefore, the scope of the disclosure is not limited to the above particular embodiments but only defined by the claims as attached and equivalents thereof.

CLAIMS

1. A method (100) in a network device, the method comprising:
generating (S110) a message including a Data over Non-Access Stratum,
5 DoNAS, restriction indication if it is determined that usage of signaling radio
bearer resources in a cell reaches a threshold; and
transmitting (S120) the message to a Mobility Management Entity, MME.
2. The method (100) according to claim 1, wherein the DoNAS restriction
10 indication indicates that usage of DoNAS for data transfer is not preferred.
3. The method (100) according to claim 1, wherein the DoNAS restriction
indication indicates that usage of DoNAS for data transfer is restricted.
- 15 4. The method (100) according to claim 1, wherein generating (S110) the
message comprises receiving a NAS connection request message from a User
Equipment, UE, and generating an S1-AP message by combining the NAS
connection request message with the DoNAS restriction indication.
- 20 5. The method (100) according to claim 1, wherein generating (S110) the
message comprises generating an S1-AP message including the DoNAS
restriction indication.
6. The method (100) according to claim 4, wherein the NAS connection
25 request message comprises any of a Control Plane Service Request, an Attach
Request, or a TAU Request.
7. The method (100) according to claim 5, wherein the S1-AP message
comprises any of an Initial UE message, Uplink NAS Transport message, a NAS
30 Non Delivery Indication message or a NAS Delivery Indication message.
8. A method (200) in a Mobility Management Entity, MME, the method
comprising:

receiving (S210) a message including a Data over Non-Access Stratum, DoNAS, restriction indication; and

performing (S220) operations associated with data transfer based at least upon the DoNAS restriction indication.

5

9. The method (200) according to claim 8, wherein the DoNAS restriction indication indicates that DoNAS is not preferred, and wherein performing (S220) operations associated with data transfer comprises:

10 establishing user plane bearers if both the UE and the MME support S1-U data transfer; or
maintaining usage of DoNAS for data transfer.

10. The method (200) according to claim 8, wherein the DoNAS restriction indication indicates that DoNAS is restricted, and wherein performing (S220) operations associated with data transfer comprises:
15 restricting usage of DoNAS for data transfer; or
establishing user plane bearers if both the UE and the MME support S1-U data transfer.

20 11. The method (200) according to claim 9 or claim 10, wherein establishing user plane bearers comprises setting up S1-U bearers and data radio bearers.

12. The method (200) according to claim 10, wherein restricting usage of DoNAS comprises:
25 rejecting a NAS message from the UE and triggering S1 release procedure;
or
triggering S1 release procedure.

13. The method (200) according to claim 8, wherein the message comprises
30 any of an Initial UE message, Uplink NAS Transport message, a NAS Non Delivery Indication message or a NAS Delivery Indication message.

14. A network device (500), comprising:

a processor (510); and

a memory (520) containing instructions executable by the processor (510)

whereby said network device (500) is operative to perform the method (100) according to any one of claim 1-7.

5

15. A Mobility Management Entity (600), MME, comprising:

a processor (610); and

a memory (620) containing instructions executable by the processor (610)

whereby said MME (600) is operative to perform the method (200) according to

10 any one of claim 8-13.

16. A computer program (701) comprising computer program code means (700) which, when executed on at least one processor, cause the at least one processor to carry out the method (100, 200) according to any one of claims 1-13.

15

17. A computer readable medium (702) having stored thereon a computer program (701) according to claim 16.

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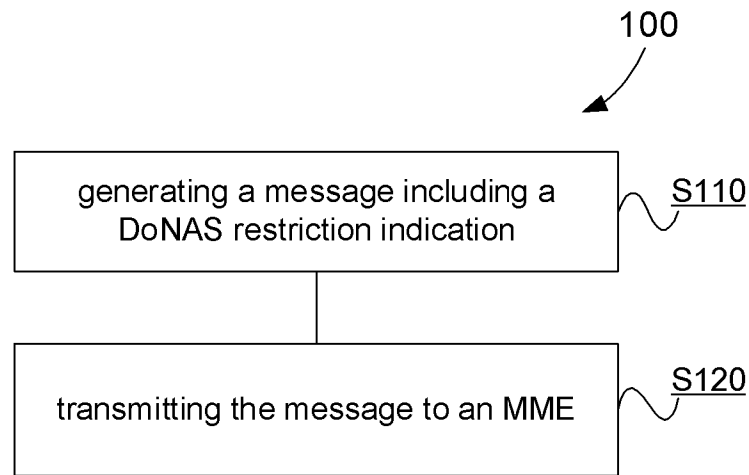


FIG. 1

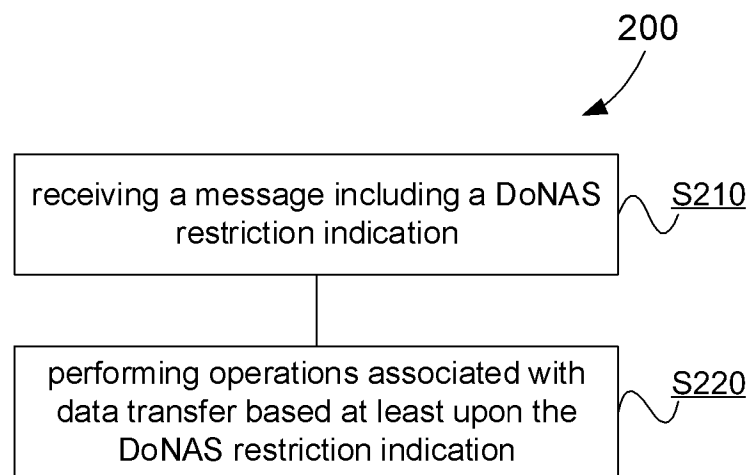


FIG. 2

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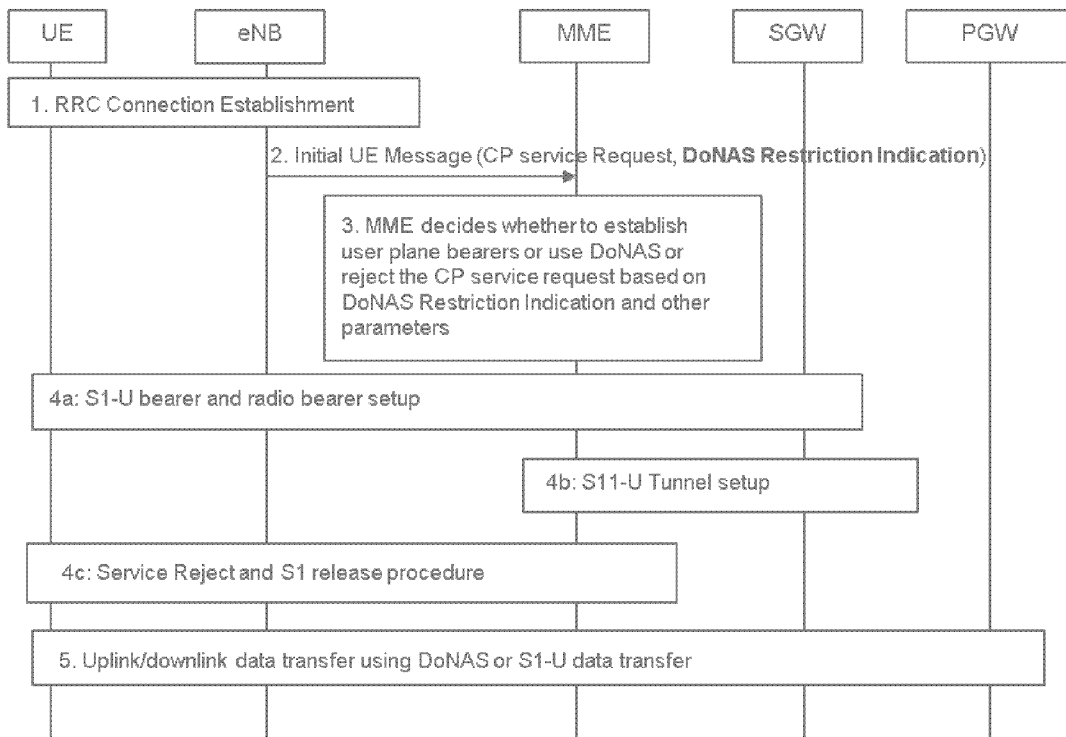


FIG. 3

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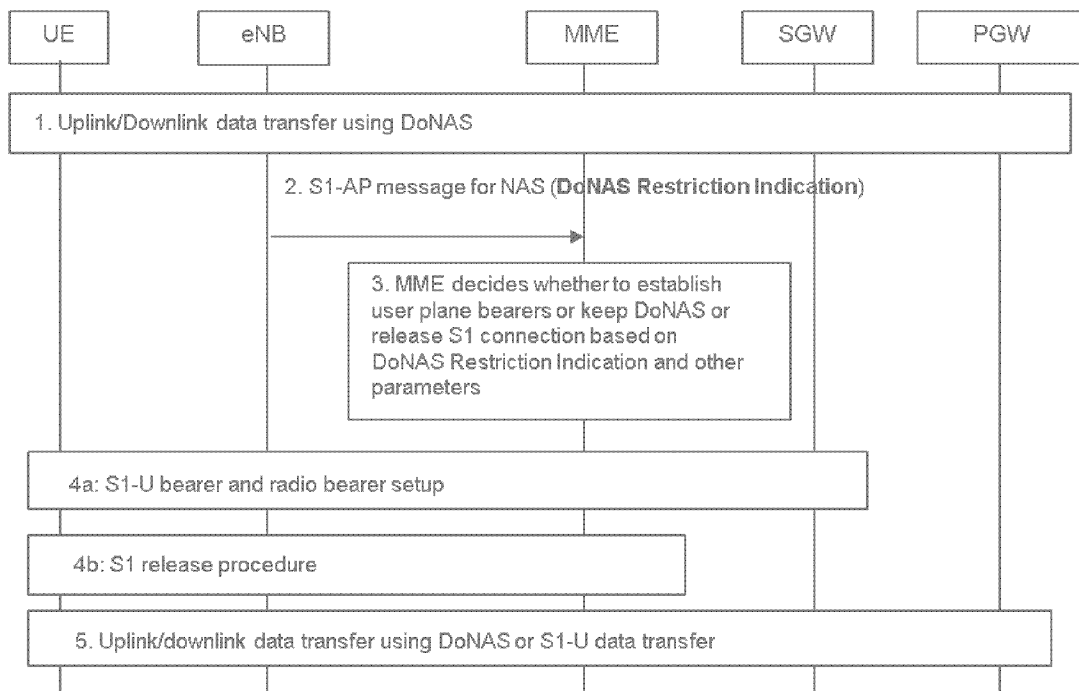


FIG. 4

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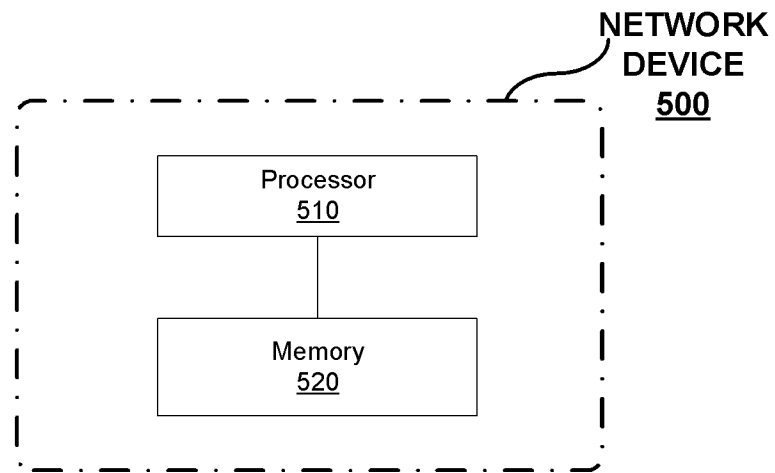


FIG. 5

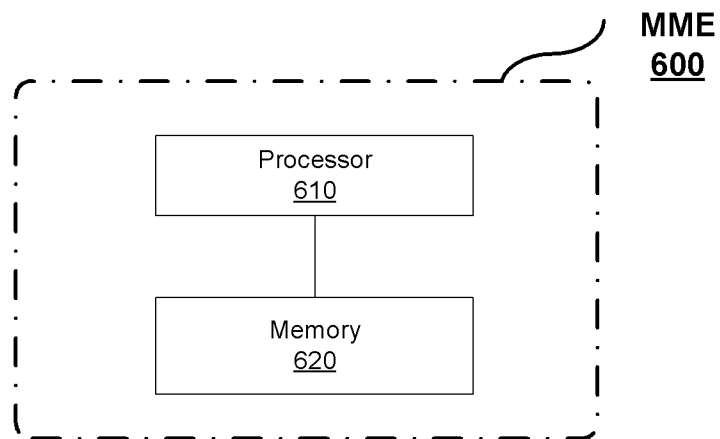


FIG. 6

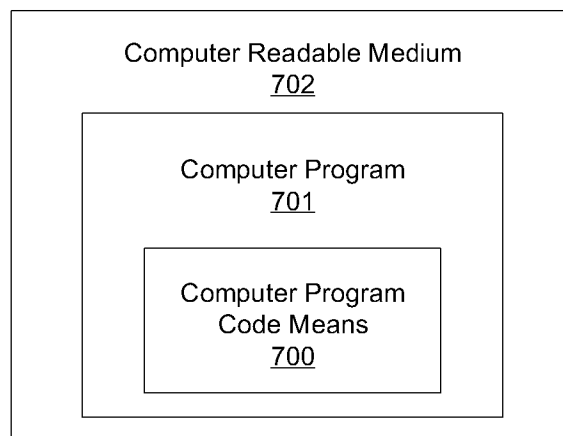


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2017/109270

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(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; 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)

CNPAT, CNKI, EPODOC, WPI, 3GPP: small, data, packet, switch, transition, select, DRB, SRB, NAS, DONAS, UP, CP, user plane, control plane, U-plane, C-plane, overload, congest, overuse, exceed, threshold, load, MME, eNb

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015103766 A1 (TELEFONAKTIEBOLAGET L M ERICSSONPUBL) 16 April 2015 (2015-04-16) description, paragraphs [0077]-[0078], [0156]-[0161]	1-17
A	EP 2911443 A1 (ZTE CORPORATION) 26 August 2015 (2015-08-26) the whole document	1-17
A	CN 102387495 A (CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY) 21 March 2012 (2012-03-21) the whole document	1-17
A	WO 2016004301 A1 (CONVIDA WIRELESS, LLC) 07 January 2016 (2016-01-07) the whole document	1-17
A	ZTE. "R3-160230, Solution2 and Solution18 selection and switching" 3GPP TSG-RAN WG3 #91, 19 February 2016 (2016-02-19), the whole document	1-17
A	ZTE. "R2-160415, RRC aspects for NB-IoT signaling optimization solution" 3GPP TSG-RAN WG2 NB-IOT AH, 21 January 2016 (2016-01-21), the whole document	1-17

☒ 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

05 June 2018

Date of mailing of the international search report

27 June 2018

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2017/109270

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	NEC. "S2-161566, CIoT Control Plane Load Control" SA WG2 Meeting #1134, 26 February 2016 (2016-02-26), the whole document	1-17

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2017/109270

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
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				WO	2012028076	A1	08 March 2012
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				US	2017150332	A1	25 May 2017
				EP	3165008	A1	10 May 2017
				JP	2017529810	A	05 October 2017
				KR	20180014197	A	07 February 2018
				CN	106576217	A	19 April 2017