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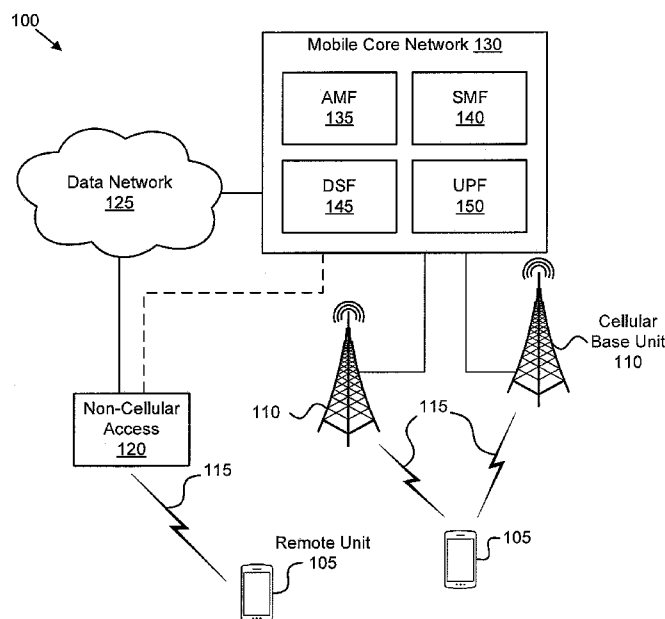


FIG. 1

(57) Abstract: Apparatuses, methods, and systems are disclosed for storing UE context and providing a UE context identification. One apparatus 900 includes a transmitter 930 that sends 1105 a storage request to store user equipment ("UE") context. Here, the storage request includes UE context for a served UE 205. The apparatus 900 includes a receiver 935 that receives 1110 a storage response message. Here, the storage response message includes a first context identification corresponding to the UE context. The first context identification allows for retrieval of the UE context. The apparatus 900 also includes a processor 905 that stores 1115 mapping information in response to the storage response message. Here, the mapping information associates the first context identification with a UE identifier of the served UE 205.

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UE CONTEXT STORAGE AND CONTEXT IDENTIFICATION

FIELD

[0001] The subject matter disclosed herein relates generally to wireless communications and more particularly relates to UE-specific associations in the network functions.

BACKGROUND

[0002] The following abbreviations are herewith defined, at least some of which are referred to within the following description.

[0003] 3GPP Third Generation Partnership Project

[0004] 5G Fifth Generation

[0005] AN Access Network

[0006] CP Control Plane

[0007] DHCP Dynamic Host Configuration Protocol

[0008] DNS Domain Name System

[0009] DL Downlink

[0010] eNB Evolved Node B

[0011] EPC Evolved Packet Core

[0012] E-UTRAN Evolved Universal Terrestrial Radio Access

[0013] gNB Next Generation Node B

[0014] IMS IP Multimedia Subsystem

[0015] IP Internet Protocol

[0016] LAN Local Area Network

[0017] LTE-A Long Term Evolution Advanced

[0018] PDU Packet Data Unit

[0019] PLMN Public Land Mobile Network

[0020] RAN Radio Access Network

[0021] SMF Session Management Function

[0022] SSDP Simple Service Discovery Protocol

[0023] UE User Entity/Equipment (Mobile Terminal)

[0024] UL Uplink

[0025] UPF User Plane Function

[0026] WiMAX Worldwide Interoperability for Microwave Access

[0027] WLAN Wireless Local Area Network

[0028] WPAD Web Proxy Auto-Discovery

[0029] In 5G networks (e.g., next generation networks), a 5G UE accesses the core network via an access network (“AN”), such as a 5G radio access network (“RAN”), and is served within the control plane (“CP”) by an Access and Mobility Management Function (“AMF”) which maintains a UE context for the served UE. In certain embodiments, the current
5 AMF may decide not to remain the serving function for the UE anymore (e.g., due to a long connected state), and another AMF needs to be selected for the UE. This decision may be taken by AMF after a certain procedure is complete, based on OA&M trigger, maintenance reasons and this is implementation specific decision. One problem that arises is the persistence of UE associations when AMF reselection is needed, which unnecessarily ties up network function
10 resources.

BRIEF SUMMARY

[0030] Methods for storing UE context and providing a UE context identification are disclosed. Apparatuses and systems also perform the functions of the methods. The methods may also be embodied in one or more computer program products comprising executable code.

15 [0031] In one embodiment, a method for storing UE context and providing a UE context identification includes receiving a storage request to store UE context. Here, the storage request includes UE context for a first UE. The method includes storing the UE context in a memory and generating a first context identification corresponding to the stored UE context. The method also includes transmitting a storage response message in response to storing the UE context.
20 Here, the storage response message includes the first context identification. The first context identification allows for retrieval of stored UE context for the first UE.

[0032] In certain embodiments, the method includes receiving a retrieval request to retrieve UE context, the retrieval request including a second context identification, determining from the second context identification whether the memory stores the requested UE context, and
25 returning the requested UE context in response to memory storing the requested UE context. If the memory does not store the requested UE context, the method includes forwarding the retrieval request to a data storage function and receiving the requested UE context from the data storage function

[0033] Another method for storing UE context and providing a UE context identification
30 includes transmitting a storage request to store UE context. Here, the storage request includes UE context for a first UE served by a network function. The method also includes receiving a storage response message. Here, the storage response message includes a first context identification corresponding to the stored UE context. A network function may use the first

context identification to later retrieve the UE context from the data storage function. The method further includes storing mapping information in response to receiving the storage response message. Here, the mapping information associates the first context identification with a UE identifier of the first UE.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] A more particular description of the embodiments briefly described above will be rendered by reference to specific embodiments that are illustrated in the appended drawings. Understanding that these drawings depict only some embodiments and are not therefore to be considered to be limiting of scope, the embodiments will be described and explained with additional specificity and detail through the use of the accompanying drawings, in which:

[0035] Figure 1 is a schematic block diagram illustrating one embodiment of a wireless communication system for storing UE context and providing a UE context identification;

[0036] Figure 2 illustrates one embodiment of a network architecture for storing UE context and providing a UE context identification;

[0037] Figure 3 illustrates one embodiment of a procedure for storing UE context and providing a UE context identification;

[0038] Figure 4 illustrates one embodiment of a procedure for storing UE context and providing a UE context identification;

[0039] Figure 5 illustrates one embodiment of a procedure for storing UE context and providing a UE context identification when the UE is in a connected state;

[0040] Figure 6 illustrates one embodiment of a procedure for storing UE context and providing a UE context identification when the UE is in an idle state;

[0041] Figure 7 illustrates another embodiment of a procedure for storing UE context and providing a UE context identification when the UE is in an idle state;

[0042] Figure 8 is a schematic block diagram illustrating one embodiment of an apparatus for storing UE context and providing a UE context identification;

[0043] Figure 9 is a schematic block diagram illustrating another embodiment of an apparatus for storing UE context and providing a UE context identification;

[0044] Figure 10 is a schematic flow chart diagram illustrating one embodiment of a method for storing UE context and providing a UE context identification;

[0045] Figure 11 is a schematic flow chart diagram illustrating another embodiment of a method for storing UE context and providing a UE context identification; and

[0046] Figure 12 is a schematic flow chart diagram illustrating one embodiment of a method for receiving a UE context identification and retrieving UE context.

DETAILED DESCRIPTION

[0047] As will be appreciated by one skilled in the art, aspects of the embodiments may be embodied as a system, apparatus, method, or program product. Accordingly, embodiments may take the form of an entirely hardware embodiment, an entirely software embodiment (including firmware, resident software, micro-code, etc.) or an embodiment combining software and hardware aspects.

[0048] For example, the disclosed embodiments may be implemented as a hardware circuit comprising custom very-large-scale integration ("VLSI") circuits or gate arrays, off-the-shelf semiconductors such as logic chips, transistors, or other discrete components. The disclosed embodiments may also be implemented in programmable hardware devices such as field programmable gate arrays, programmable array logic, programmable logic devices, or the like. As another example, the disclosed embodiments may include one or more physical or logical blocks of executable code which may, for instance, be organized as an object, procedure, or function.

[0049] Furthermore, embodiments may take the form of a program product embodied in one or more computer readable storage devices storing machine readable code, computer readable code, and/or program code, referred hereafter as code. The storage devices may be tangible, non-transitory, and/or non-transmission. The storage devices may not embody signals. In a certain embodiment, the storage devices only employ signals for accessing code.

[0050] Any combination of one or more computer readable medium may be utilized. The computer readable medium may be a computer readable storage medium. The computer readable storage medium may be a storage device storing the code. The storage device may be, for example, but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, holographic, micromechanical, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing.

[0051] More specific examples (a non-exhaustive list) of the storage device would include the following: 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), a portable compact disc read-only memory ("CD-ROM"), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing. In the context of this document, a computer readable

storage medium may be any tangible medium that can contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device.

[0052] Reference throughout this specification to “one embodiment,” “an embodiment,” or similar language means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, appearances of the phrases “in one embodiment,” “in an embodiment,” and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment, but mean “one or more but not all embodiments” unless expressly specified otherwise. The terms “including,” “comprising,” “having,” and variations thereof mean “including but not limited to,” unless expressly specified otherwise. An enumerated listing of items does not imply that any or all of the items are mutually exclusive, unless expressly specified otherwise. The terms “a,” “an,” and “the” also refer to “one or more” unless expressly specified otherwise.

[0053] Furthermore, the described features, structures, or characteristics of the embodiments may be combined in any suitable manner. In the following description, numerous specific details are provided, such as examples of programming, software modules, user selections, network transactions, database queries, database structures, hardware modules, hardware circuits, hardware chips, etc., to provide a thorough understanding of embodiments. One skilled in the relevant art will recognize, however, that embodiments may be practiced without one or more of the specific details, or with other methods, components, materials, and so forth. In other instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring aspects of an embodiment.

[0054] Aspects of the embodiments are described below with reference to schematic flowchart diagrams and/or schematic block diagrams of methods, apparatuses, systems, and program products according to embodiments. It will be understood that each block of the schematic flowchart diagrams and/or schematic block diagrams, and combinations of blocks in the schematic flowchart diagrams and/or schematic block diagrams, can be implemented by code. This code may be provided to a processor of a general-purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the schematic flowchart diagrams and/or schematic block diagrams.

[0055] The code may also be stored in a storage device that can direct a computer, other programmable data processing apparatus, or other devices to function in a particular manner, such that the instructions stored in the storage device produce an article of manufacture including

instructions which implement the function/act specified in the schematic flowchart diagrams and/or schematic block diagrams.

[0056] The code may also be loaded onto a computer, other programmable data processing apparatus, or other devices to cause a series of operational steps to be performed on the computer, other programmable apparatus, or other devices to produce a computer implemented process such that the code which execute on the computer or other programmable apparatus provide processes for implementing the functions/acts specified in the schematic flowchart diagrams and/or schematic block diagram.

[0057] The schematic flowchart diagrams and/or schematic block diagrams in the Figures illustrate the architecture, functionality, and operation of possible implementations of apparatuses, systems, methods, and program products according to various embodiments. In this regard, each block in the schematic flowchart diagrams and/or schematic block diagrams may represent a module, segment, or portion of code, which includes one or more executable instructions of the code for implementing the specified logical function(s).

[0058] It should also be noted that, in some alternative implementations, the functions noted in the block may occur out of the order noted in the Figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. Other steps and methods may be conceived that are equivalent in function, logic, or effect to one or more blocks, or portions thereof, of the illustrated Figures.

[0059] The description of elements in each figure may refer to elements of proceeding figures. Like numbers refer to like elements in all figures, including alternate embodiments of like elements.

[0060] In order to solve the above described problem of undesired persistence of UE-specific association among network functions ("NF"), a data storage function ("DSF") is used to store the UE context when a current AMF determines to no longer serve a UE. When the AMF can no longer serve the UE, it stored the UE's context in a DSF. Another AMF is reselected as a new serving AMF for the UE and retrieves the UE's context from the Data Storage. Beneficially, this approach avoids signaling the UE, thus reducing NAS signaling overhead. For a UE in CM-IDLE state, this approach eliminates both the need to page the UE and the interaction between the AMF and other network functions.

[0061] The DSF storing the UE's context creates a context identification, such as a temporary context ID, which is used to identify the location of the UE's context within the Data Storage. When the old AMF decides not to serve the UE any more, it stores the UE's context

information in the DSF and the DSF sends the context identification to the old AMF. Upon receiving the context identification, the old AMF maps the context identification to a UE identifier, such as the UE's temporary identity or permanent identity, and deletes the UE's context. The reselected AMF will fetch the UE's context from the Data Storage function based on the UE's context identification.

[0062] Figure 1 depicts a wireless communication system 100 for storing UE context and providing a UE context identification, according to embodiments of the disclosure. In one embodiment, the wireless communication system 100 includes remote units 105, cellular base units 110, and communication links 115. In certain embodiments, the wireless communication system 100 may include a non-cellular access 120. Even though a specific number of remote units 105, cellular base units 110, communication links 115, and non-cellular accesses 120 are depicted in Figure 1, one of skill in the art will recognize that any number of remote units 105, cellular base units 110, communication links 115, and non-cellular accesses 120 may be included in the wireless communication system 100.

[0063] In one implementation, the wireless communication system 100 is compliant with the 5G system specified in the 3GPP specifications. More generally, however, the wireless communication system 100 may implement some other open or proprietary communication network, for example, LTE-A or WiMAX, among other networks. The present disclosure is not intended to be limited to the implementation of any particular wireless communication system architecture or protocol.

[0064] In one embodiment, the remote units 105 may include computing devices, such as desktop computers, laptop computers, personal digital assistants ("PDAs"), tablet computers, smart phones, smart televisions (*e.g.*, televisions connected to the Internet), smart appliances (*e.g.*, appliances connected to the Internet), set-top boxes, game consoles, security systems (including security cameras), vehicle on-board computers, network devices (*e.g.*, routers, switches, modems), or the like. In some embodiments, the remote units 105 include wearable devices, such as smart watches, fitness bands, optical head-mounted displays, or the like. Moreover, the remote units 105 may be referred to as subscriber units, mobiles, mobile stations, users, terminals, mobile terminals, fixed terminals, subscriber stations, user equipment ("UE"), user terminals, a device, or by other terminology used in the art. The remote units 105 may communicate directly with one or more of the cellular base units 110 via uplink ("UL") and downlink ("DL") communication signals. Furthermore, the UL and DL communication signals may be carried over the communication links 115. In certain embodiments, a remote unit may communicate with the non-cellular access 120 instead of or in addition to the cellular base unit

110. Here, the remote unit sends UL communication signal and received DL communication signals via the non-cellular access 120. In certain embodiments, the non-cellular access 120 may employ radio communication links 115. Examples of non-cellular access 120 include, but are not limited to, WLAN access networks, WLAN access point, a WiMAX network, and the like.

5 [0065] The cellular base units 110 may be distributed over a geographic region. In certain embodiments, a cellular base unit 110 may also be referred to as an access terminal, a base, a base station, a Node-B, an eNB, a gNB, a Home Node-B, a relay node, a device, or by any other terminology used in the art. The cellular base units 110 are generally part of a radio access network (“RAN”) that may include one or more controllers communicably coupled to one
10 or more corresponding cellular base units 110. The RAN is generally communicably coupled to one or more core networks, which in turn may be coupled to other networks, like the Internet and public switched telephone networks, among other networks. These and other elements of radio access and core networks are not illustrated but are well known generally by those having ordinary skill in the art. The cellular base units 110 connect to the mobile core network 130 via
15 the RAN.

[0066] The cellular base units 110 may serve a number of remote units 105 within a serving area, for example, a cell or a cell sector via a wireless communication link. The cellular base units 110 may communicate directly with one or more of the remote units 105 via communication signals. Generally, the cellular base units 110 transmit downlink (“DL”) communication signals to serve the remote units 105 in the time, frequency, and/or spatial
20 domain. Furthermore, the DL communication signals may be carried over the communication links 115. The communication links 115 may be any suitable carrier in licensed or unlicensed radio spectrum. The communication links 115 facilitate communication between one or more of the remote units 105 and/or one or more of the cellular base units 110.

25 [0067] In one embodiment, the mobile core network 130 is a 5G core (“5GC”) or the evolved packet core (“EPC”), which may be coupled to other data network 125, like the Internet and private data networks, among other data networks. Each mobile core network 130 belongs to a single public land mobile network (“PLMN”). The present disclosure is not intended to be limited to the implementation of any particular wireless communication system architecture or
30 protocol.

[0068] The mobile core network 130 includes several network functions (“NFs”). As depicted, the mobile core network 130 includes an access and mobility management function (“AMF”) 135, a session management function (“SMF”) 140, a data storage function (“DSF”) 145, and a user plane function (“UPF”) 150. Although a specific number of AMFs 135, SMFs

140, DSFs 145, and UPFs 150 are depicted in Figure 1, one of skill in the art will recognize that any number of AMFs 135, SMFs 140, DSFs 145, and UPFs 150 may be included in the mobile core network 130. The AMF 135, SMF 140, and UPF 150 are all examples of NFs in the mobile core network 130.

5 [0069] The AMF 135 provides services such as UE registration, UE connection management, and UE mobility management. The SMF 140 manages the data sessions of the remote units 105, such as a PDU session. The AMF 135 and SMF 140 are examples of control plane NFs within the mobile core network 130. The UPF 150 provides user plane (*e.g.*, data) services to the remote units 105. A data connection between the remote unit 105 and a data
10 network 125 is managed by a UPF 150. The DSF 145 provides data storage to NFs in the mobile core network 130. The various NFs maintain UE contexts. As discussed below, the DSF 145 allows NFs to store, retrieve, and share remote unit 105 contexts with each other.

[0070] As discussed in greater detail below, an AMF 135 may determine that it is no longer able to serve a remote unit 105. Here, the AMF 135 store the UE context belonging to the
15 remote unit 105 in a DSF 145 associated with the AMF 135. A new AMF 135 may then be selected to serve the remote unit 105. The new AMF 135 uses a context identifier to retrieve the UE context belonging to the remote unit 105 from the DSF 145.

[0071] Figure 2 depicts a network architecture 200 used for storing UE context and providing a UE context identification, according to embodiments of the disclosure. The network
20 architecture 200 may be implemented by a wireless communication system, such as the wireless communication system 100 discussed above. The network architecture 200 includes a UE 205, a 5G-(R)AN 210, and a plurality of NF groups. Here, the network architecture 200 depicts a first NF group 215 and a second NF group 220 (labeled “NF Group 1” and “NF Group 2”, respectively). The UE 205 is a 5G UE and may be one embodiment of the remote unit 105
25 discussed above. The 5G-(R)AN 210 is an access network connecting the UE to a core network (*e.g.*, containing the first NF group 215 and the second NF group 220).

[0072] Each NF group includes a data storage and a plurality of control plane NFs. Here, the first NF group 215 includes a first data storage 225, a first AMF 235, a second AMF 240, a third AMF 245, and a first SMF 260. The second NF group 220 is communicatively coupled to
30 the first NF group 215. The second NF group 220 includes a second data storage 230, a fourth AMF 250, a fifth AMF 255, and a second SMF 265. The data storages 225-230 may be embodiments of the DSF 145 discussed above. The AMFs 235-245 may be embodiments of the AMF 135 discussed above. The SMFs 260-265 maybe embodiments of the SMF 140 discussed

above. While not shown in Figure 2, the NF groups 215-220 may each include additional AMFs 135, additional SMFs 140, or other control plane NFs.

[0073] As depicted, the UE 205 communicates with the 5G-(R)AN 210 using the “Uu” interface, the 5G-(R)AN 210 communicates with the various AMFs 235-255 using the N2 interface, the AMFs 235-255 communicate with the SMFs 260-265 using an N11 interface, and one of the AMF 235-255 may communicate with another of the AMFs 235-255 using an N14 interface. Although not depicted, each NF in the NF groups 215-220 may be communicatively coupled to the data storages 225-230. Further, the first data storage 225 is communicatively coupled to the second data storage 230 in order to share UE context data, as discussed below.

[0074] In the network architecture 200, several control plane NFs (e.g., the AMFs 235-245 and first SMF 260) share the same data storage (e.g., first data storage 225) based on their location or topology. The location information of the data storage is configured in the connected NFs. In certain embodiments, the NF groups may also be referred to as data storage groups. Here, NFs belonging to the same Data Storage can store, retrieve and share the UE context of the UE 205 with each other.

[0075] As discussed above, if an AMF (e.g., the first AMF 235) can’t serve the UE 205 anymore, it stores the UE’s context in its associated data storage (here the first data storage 225) without any extra signaling with the UE 205. The associated data storage (e.g., the first data storage 225) generates a context identifier for the stored UE context and returns it to the AMF. This context identifier is then used to retrieve the UE context for the UE 205. The old AMF (e.g., the first AMF 235) maintains the UE’s context identification. There is no interaction with UE 205 due to AMF change. In one embodiment, the context identifier is a temporary context identification. For example, the first data storage 225 may store the UE context of the UE 205 either until the UE context is retrieved (e.g., by the new serving AMF) or until the UE context expires. Thereafter, the first data storage may reuse the context identifier.

[0076] In one embodiment, a new AMF is selected from the same NF group as the old AMF. For example, the second AMF 240 may be reselected as the new serving AMF for the UE 205. In one embodiment, the old AMF (e.g., the first AMF 235) selects the new AMF (e.g., the second AMF 240), for example based on information received in NF discovery request/response as discussed below with reference to Figure 3. In another embodiment, the 5G-(R)AN 210, first SMF 260, or second SMF 265 may select the new AMF, for example based on AMF selection criteria as discussed below with reference to Figure 4. If the new AMF belongs to a different data storage group (e.g., NF group) than the old AMF, the new AMF’s data storage (e.g., the second data storage 230) will retrieve the UE’s context from the old AMF’s data storage. Here,

the second AMF 240 (upon selection) retrieves the UE's context from the first data storage 225. To do so, the second AMF 240 receives the context identifier upon being selected as the new serving AMF for the UE 205 and provides the context identifier to the first data storage 225 in a retrieval request. In some scenarios, the second AMF 240 receives the context identifier from the first AMF 235 directly. In other scenarios, the second AMF 240 receives the context identifier from the first AMF via an intermediate entity, as discussed below.

[0077] However, in another embodiment the new AMF may be selected from outside the NF group of the old AMF. For example, the fourth AMF 250 may be reselected as the new serving AMF for the UE 205 in response to the first AMF 235 determining that it can no longer serve the UE 205. Here, the fourth AMF 250 requests the UE context from its data storage, the second data storage 230. However, because the first AMF 235 did not store the UE context for the UE 205 in the second data storage 230, the second data storage 230 determines that the first data storage 225 has the desired UE context, retrieves the desired UE context from the first data storage 225, and provides the UE context for the UE 205 to the fourth AMF 250.

[0078] In certain embodiments, the context identifier includes information identifying the data storage where the UE context is stored. The context identifier may also include an internal identity indicating where in the data storage the context is held, such as a memory address or a pointer to a memory address where the UE context is located. The internal identity is also referred to herein as a storage location indicator. Thus, the second data storage 230 may examine the context identifier to determine that the first data storage 225 has the UE context and the first data storage may retrieve the UE context from a location indicated by the context identifier.

[0079] Figure 3 depicts a first procedure 300 for storing UE context and providing a UE context identification when using a first AMF reselection option (e.g., direct reroute option), according to embodiments of the disclosure. The first procedure 300 involves the 5G-(R)AN 210, an initial AMF 305, a target AMF 310, a network repository function ("NRF") 315, a data storage function ("DSF") 320, a unified data management entity ("UDM") 325, and a SMF 330. Here, the initial AMF 305 and target AMF 310 are each embodiments of the AMF 135 and AMFs 235-255, discussed above. The DSF 320 may be one embodiment of the DSF 145 and the data storages 225-230, discussed above. The SMF 330 may be one embodiment of the SMF 140 and the SMF 260-265, discussed above.

[0080] The second procedure 400 begins when the initial AMF 305 decides to stop serving a UE (see block 335). Here, the UE (e.g., the UE 205) may be in a long connected state and initial AMF 305 may decide to stop serving the UE based on a OA&M (operations,

administration, and management) trigger, for maintenance reasons, or the like. After deciding to stop serving the UE, the initial AMF 305 stores the UE's context to the DSF 320 (see transaction 340). Here, the initial AMF 305 sends a UE context storage request and receives a response from the DSF 320. The UE context storage request includes the UE context. In certain
5 embodiments, the context storage request also includes a UE identifier for the UE, such as a temporary or permanent UE identification. The DSF 320 stores the UE context and returns a context identification. As discussed above, the context identification may be a temporary context identification associated with the UE context.

[0081] Optionally, the initial AMF 305 may send a NF discovery request to the NRF 315
10 and receive a NF discovery response (see transaction 345). Here, the NF discovery request allows the initial AMF 305 to discover a proper target AMF 310 which has required NF capabilities to serve the UE. The NRF 315 replies with a set of potential target AMFs and their capabilities. Based on the information in the response, the initial AMF 305 may select the target AMF 310.

[0082] When using the first AMF reselection option, the initial AMF 305 reroutes a NAS
15 message to the target AMF 310 (see transaction 350). Here, the initial AMF 305 includes a context identification received from the DSF 320. The target AMF 310 then retrieves the UE context from the DSF 320 (see transaction 355). Here, the target AMF 310 may transmit a UE context retrieval request to the DSF 320, the context retrieval request including the context
20 identification created when the DSF 320 stored the UE context. In certain embodiments, the context identification identifies the DSF 320 from among a plurality of DSFs. If the target AMF 310 belongs to a different data storage group than the initial AMF 305, then target AMF's data storage will retrieve the UE's context from the initial AMF's data storage.

[0083] After retrieving the UE context, the target AMF 310 performs an N2 connection
25 reestablishment procedure to the 5G-(R)AN 210 (see transaction 360). Here, the target AMF 310 may identify the UE to be served during the N2 connection reestablishment procedure. The target AMF 310 also performs a location update procedure with the UDM 325 (see transaction 365). In response to performing the N2 connection reestablishment procedure, the 5G-(R)AN 210 sends a N2 connection release message to the initial AMF 305 (see transaction 370).

[0084] Optionally, the target AMF 310 initiates an N11 connection re-establishment
30 procedure with the SMF 330 (see transaction 375). The SMF 330 may then send a N11 connection release message to the initial AMF 305 (see transaction 380).

[0085] Figure 4 depicts a second procedure 400 for storing UE context and providing a UE context identification when using a second AMF reselection option (e.g., (R)AN-based AMF

reselection), according to embodiments of the disclosure. The second procedure 400 also involves the 5G-(R)AN 210, an initial AMF 305, a target AMF 310, a network repository function (“NRF”) 315, a data storage function (“DSF”) 320, a unified data management entity (“UDM”) 325, and a SMF 330.

5 [0086] The second procedure 400 begins with the same steps 335 and 340 discussed above with reference to Figure 3. In the second procedure 400, NF discovery request/response is unnecessary.

10 [0087] When using the second AMF reselection option, the initial AMF 305 reroutes a NAS message to the 5G-(R)AN 210 (see transaction 405). In some embodiments, the initial AMF 305 includes a context identification received from the DSF 320. The 5G-(R)AN 210 then reselects an AMF (e.g., using capabilities information received from the NRF 315) and performs an N2 connection reestablishment procedure with the target AMF 310 (see transaction 410). Here, the 5G-(R)AN 210 may identify the UE to be served by the target AMF 310. During the N2 connection reestablishment procedure, the 5G-(R)AN 210 sends the context identification to
15 the target AMF 310.

[0088] The target AMF 310 then retrieves the UE context from the DSF 320 (see transaction 415). Here, the target AMF 310 may send a UE context retrieval request to the DSF 320, the context retrieval request including the context identification created when the DSF 320 stored the UE context. In certain embodiments, the context identification identifies the DSF 320
20 from among a plurality of DSFs. If the target AMF 310 belongs to a different data storage group than the initial AMF 305, then target AMF’s data storage will retrieve the UE’s context from the initial AMF’s data storage.

[0089] After retrieving the UE context, the target AMF 310 performs a location update procedure with the UDM 325 (see transaction 420). In response to performing the location
25 update procedure, the target AMF 310 sends a NAS downlink transport message to the 5G-(R)AN 210 (see transaction 425). Optionally, the initial AMF 305 may send a redirect request to the SMF 330 (see transaction 430). Here, the initial AMF 305 includes a context identification received from the DSF 320. The SMF 330 may then initiate an N11 connection re-establishment procedure with the target AMF 310 (see transaction 435). The context identification is included
30 in the procedure.

[0090] Figure 3 and 4 depict alternative options for AMF redirection. No matter which option is used, UE context transfer is facilitated by adding the UE context identification (and an appropriate cause value) in the reroute NAS message (e.g. in transactions 350, 405, 410, 430 and 435) in order to solve the problem of undesired persistence (“stickiness”) of UE-specific

associations. Figures 5, 6 and 7 describe procedures based on the second AMF reselection option (e.g., (R)AN-based AMF reselection). However, the UE context storage and retrieval principles described are equally applicable to both AMF reselection options.

[0091] Figure 5 depicts a procedure 500 for storing UE context and providing a UE context identification when the UE is in a CM-CONNECTED state, according to embodiments of the disclosure. The procedure 500 involves the UE 205, the 5G-(R)AN 210, an old AMF 505 (labeled “AMF-OLD”), a new AMF 510 (labeled “AMF-NEW”), the DSF 320, and the UDM 325.

[0092] The procedure 500 begins when the old AMF 505 decides to stop serving the UE 205 when the UE 205 is in a CM-CONNECTED state (see block 515). This decision may be taken by the old AMF 505 after a certain procedure is complete, based on OA&M trigger, maintenance reasons. In response to this decision, the old AMF 505 stores the UE context in the DSF 320 by sending a UE context storage request and receiving a UE context storage response (see transaction 520).

[0093] Here, the UE context storage request includes the UE context to be stored at the DSF 320. In certain embodiments, the UE context storage request also includes a UE identifier, such as a temporary ID (or permanent ID) of the UE 205. The DSF 320 stores the UE context and generates a context identification corresponding to the stored UE context. The DSF includes this context identification in its response to the old AMF 505. In certain embodiments, the context identification includes a data storage identifier (e.g., to identify the DSF 320 among a plurality of DSFs) and a storage location indicator (e.g., a memory address, or pointer to a memory address, where the UE context is located). After receiving the UE context storage response, the old AMF 505 maps the context identification to a UE identifier of the UE 205 and deletes the UE’s context.

[0094] Because the UE 205 is in the CM-CONNECTED state, there exists at least connection between the 5G-(R)AN 210 and the old AMF 505. The old AMF 505 sends an N2 connection release message to the 5G-(R)AN 210 with appropriate cause value to notify the 5G-(R)AN 210 that the old AMF 505 will no longer contain the UE context for the UE 205 (see transaction 525). The old AMF also sends the UE’s context identification to the 5G-(R)AN 210. Optionally, the old AMF 505 may send the context identification to other NFs (e.g., as described with reference to Figure 3).

[0095] The N2 connection release message informs the 5G-(R)AN 210 that the N2 connection is released and that the AMF does not store UE’s context. However, the 5G-(R)AN 210 still has an N3 connection with a serving UPF (e.g., the UPF 150). Here, the 5G-(R)AN 210

(or another NF) maintains mapping information between the context ID of the UE 205 and other identities of the UE 205, such as a permanent UE identity and/or a temporary UE identity.

[0096] As depicted, the 5G-(R)AN 210 selects the new AMF 510, for example based on AMF selection criteria (see block 530). The 5G-(R)AN 210 also sends NAS signaling to the new AMF 510, depicted here as a NAS uplink transport message (see transaction 535). Here, the NAS signaling (e.g., NAS uplink transport message) includes at least the UE 205's context identification and a cause value.

[0097] Next, the new AMF 510 retrieves the UE context for the UE 205 from the DSF 320 (see transaction 540). Here, the new AMF 510 sends a UE context retrieval message containing the UE 205's context identification. As discussed above, the DSF 320 retrieves the previously stored UE context information based on the context identification. If the new AMF 510 belongs to a different data storage group than the old AMF 505, then new AMF 510's data storage will retrieve the UE's context from the old AMF 505's data storage.

[0098] After retrieving the UE context for the UE 205, the new AMF 510 updates the location information for the UE 205 in the UDM 325 (see transaction 545). The new AMF 510 also sends NAS signaling to the 5G-(R)AN 210, depicted here as a NAS downlink transport message (see transaction 550). Here, the NAS signaling (e.g., NAS downlink transport message) includes a new temporary identifier for the UE 205. Additionally, the 5G-(R)AN 210 sends NAS signaling to the UE 205 including the new temporary identifier.

[0099] Figure 6 depicts a first procedure 600 for storing UE context and providing a UE context identification when the UE is in a CM-IDLE state, according to embodiments of the disclosure. The first procedure 600 involves the UE 205, the 5G-(R)AN 210, the old AMF 505 (labeled "AMF-OLD"), the new AMF 510 (labeled "AMF-NEW"), the DSF 320, the UDM 325, and the SMF 330.

[0100] The first procedure 600 begins when the old AMF 505 decides to stop serving the UE 205 when the UE 205 is in a CM-IDLE state (see block 605). This decision may be taken by the old AMF 505 after a certain procedure is complete, based on OA&M trigger, maintenance reasons. In response to this decision, the old AMF 505 stores the UE context in the DSF 320 by sending a UE context storage request and receiving a UE context storage response (see transaction 520, described above). After receiving the UE context storage response, the old AMF 505 maps the context identification to identities of the UE 205 (e.g., a temporary UE identifier and deletes the UE's context.

[0101] Because the UE 205 is in the CM-IDLE state, there is no connection between the 5G-(R)AN 210 and the old AMF 505 associated with the UE 205. The old AMF 505 maintains

the mapping information between the UE 205's context identification and other identities of the UE 205. However, the old AMF 505 does not contact the 5G-(R)AN 210 or other control plane NFs with regards to the UE 205 until the UE 205 transits from the CM-IDLE state to the CM-CONNECTED state. Transitioning from the CM-IDLE state may occur due to a subsequent MO (mobile-originated) transaction, as depicted here, or due to a subsequent MT (mobile-terminated) transaction, as discussed below with reference to Figure 7. Note that although the old AMF 505 does not contact the 5G-(R)AN 210 or other control plane NFs with regards to the UE 205, it may contact these entities with regards to other UEs or for other reasons not relating to the UE 205.

[0102] When the subsequent MO transaction occurs, the UE 205 sends a NAS service request to the old AMF 505 (see transaction 610). Recall that the UE 205 is not aware that the old AMF 505 has decided to stop serving it. The NAS service request is sent to the old AMF 505 based on the UE 205's temporary UE identifier.

[0103] The old AMF 505 receives the NAS service request and determines that it has no UE context for the UE 205. In response, the old AMF 505 sends a redirection request to the 5G-(R)AN 210 (see transaction 615). Further, the old AMF 505 searches its mapping information to locate the context identification associated with the UE 205 and includes the context identification (and an appropriate cause value) in the redirect request message.

[0104] The redirect request message informs the 5G-(R)AN 210 that the old AMF 505 does not store the UE 205's context. Here, the 5G-(R)AN 210 reselects an AMF (here the new AMF 510), for example based on AMF selection criteria (see block 530). The 5G-(R)AN 210 also sends N2 messages to re-establish the UE-specific N2 association between 5G-(R)AN 210 and the new AMF 510 and forwards the NAS service request to the new AMF 510 (see transaction 620). Here, the forwarded NAS service request message includes at least the UE 205's context identification.

[0105] Next, the new AMF 510 retrieves the UE context for the UE 205 from the DSF 320 based on the context identification (see transaction 540, described above). If needed, the new AMF 510 reestablishes N11 connectivity with an SMF (e.g., with the SMF 140, first SMF 260, second SMF 265, or SMF 330). The new AMF 510 also updates the location information for the UE 205 in the UDM 325 (see transaction 545, discussed above).

[0106] The new AMF 510 also sends NAS signaling to the 5G-(R)AN 210, depicted here as a NAS downlink transport message (see transaction 550, also discussed above). Here, the NAS signaling (e.g., NAS downlink transport message) includes a new temporary identifier for

the UE 205. The 5G-(R)AN 210 sends NAS signaling to the UE 205 including the new temporary identifier.

[0107] Figure 7 depicts a second procedure 700 for storing UE context and providing a UE context identification when the UE is in a CM-IDLE state, according to embodiments of the disclosure. The second procedure 700 involves the UE 205, the 5G-(R)AN 210, the old AMF 505 (labeled "AMF-OLD"), the new AMF 510 (labeled "AMF-NEW"), the DSF 320, the UDM 325, and the SMF 330.

[0108] The second procedure 700 begins when the old AMF 505 decides to stop serving the UE 205 when the UE 205 is in a CM-IDLE state (see block 605). This decision may be taken by the old AMF 505 after a certain procedure is complete, based on OA&M trigger, maintenance reasons. In response to this decision, the old AMF 505 stores the UE context in the DSF 320 by sending a UE context storage request and receiving a UE context storage response (see transaction 520, described above). After receiving the UE context storage response, the old AMF 505 maps the context identification to identities of the UE 205 (e.g., a temporary UE identifier and deletes the UE's context.

[0109] Because the UE 205 is in the CM-IDLE state, there may not be a connection between the 5G-(R)AN 210 and the old AMF 505. The old AMF 505 maintains the mapping information between the UE 205's context identification and other identities of the UE 205. The old AMF 505 does not contact the 5G-(R)AN 210 or other control plane NFs with regards to the UE 205 until the UE 205 transits from the CM-IDLE state to the CM-CONNECTED state. Transitioning from the CM-IDLE state may occur due to a subsequent MT (mobile-terminated) transaction, as depicted here. Note that although the old AMF 505 does not contact the 5G-(R)AN 210 or other control plane NFs with regards to the UE 205, it may contact these entities with regards to other UEs or for other reasons not relating to the UE 205.

[0110] When the subsequent MT transaction occurs, the SMF 330 determines that there is downlink data and/or signaling for the UE 205 (see block 705). In response, the SMF 330 sends a downlink transport message to the old AMF 505 (see transaction 710). Note that the SMF 330 is not aware that the old AMF 505 has decided to stop serving the UE 205.

[0111] The old AMF 505 receives the N11 establishment request and determines that it has no UE context for the UE 205. In response, the old AMF 505 sends a redirection request to the SMF 330 that includes a context identification for the UE 205 (see transaction 715). Here, the old AMF 505 searches its mapping information to locate the context identification associated with the UE 205 and includes the context identification (and an appropriate cause value) in the redirect request message.

[0112] The redirect request message informs the SMF 330 that the old AMF 505 does not store the UE 205's context. Here, the SMF 330 reselects an AMF (here the new AMF 510), for example by querying a selection function such as the NRF 315 (see block 720). The SMF 330 also sends N11 messages to re-establish the UE-specific N11 association between the SMF 330 and the new AMF 510 (see transaction 725). Here, at least one of the N11 reestablishment messages includes the UE 205's context identification and the UE 205's old temporary UE identifier.

[0113] Next, the new AMF 510 retrieves the UE context for the UE 205 from the DSF 320 based on the context identification (see transaction 540, described above). The new AMF 510 also pages the UE 205 using the UE's old temporary UE identifier (see transaction 730) and updates the location information for the UE 205 in the UDM 325 (see transaction 545, discussed above). Here, the paging message also includes the UE's new temporary UE identifier. The UE 205 responds to the paging using the new UE's temporary UE identifier. After the UE 205 responds to the paging, the new AMF 510 sends a response to the SMF 330 including a new temporary UE identifier for the UE 205.

[0114] While Figure 3-7 discuss the new/target AMF retrieving the UE context directly from the DSF 320, in certain embodiments the AMF may communicate with an intermediary NF, such as the network exposure function ("NEF") to store and retrieve UE context with the data storage function. Also, while Figures 3-7 discuss sharing UE context due to AMF reselection, using a data storage function to store and retrieve a UE context based on a (temporary) context identification is applicable to UE contexts stored by other network functions in the core network.

[0115] Figure 8 depicts one embodiment of a data storage apparatus 800 that may be used for storing UE context and providing a UE context identification, according to embodiments of the disclosure. The data storage apparatus 800 may be one embodiment of the DSF 145, first data storage 225, second data storage 230, and/or DSF 320, described above. Furthermore, the data storage apparatus 800 may include a processor 805, a memory 810, an input device 815, an output device 820, a transceiver 825 for communicating with one or more NFs. As depicted, the transceiver 825 may include a transmitter 830 and a receiver 835. The transceiver 825 may also support one or more network interface 840, such as the N18 or N19 interfaces used to communicate with NFs.

[0116] In one embodiment, the data storage apparatus 800 is a part of a NF group, as discussed above with reference to Figure 2. In some embodiments, the input device 815 and the output device 820 are combined into a single device, such as a touchscreen. In certain

embodiments, the data storage apparatus 800 may not include any input device 815 and/or output device 820.

[0117] The processor 805, in one embodiment, may include any known controller capable of executing computer-readable instructions and/or capable of performing logical operations. For example, the processor 805 may be a microcontroller, a microprocessor, a central processing unit (“CPU”), a graphics processing unit (“GPU”), an auxiliary processing unit, a field programmable gate array (“FPGA”), or similar programmable controller. In some embodiments, the processor 805 executes instructions stored in the memory 810 to perform the methods and routines described herein. The processor 805 is communicatively coupled to the memory 810, the input device 815, the output device 820, and the transceiver 825.

[0118] In some embodiments, the receiver 835 receives a storage request (e.g., a UE context storage request) from an NF, such as the AMF 135. Here, the storage request includes UE context for a UE (such as the UE 205). In response, the processor 805 stores the UE context in the memory 810. The processor 805 further generates a context identification (e.g., a first context identification) corresponding to the stored UE context. The context identification allows for later retrieval of the stored UE context.

[0119] The processor 805 further generates a storage response message in response to storing the UE context. The processor 805 further controls the transmitter 830 to send the storage response message to the requesting NF. Here, the storage response message includes the context identification corresponding to the stored UE context. The stored UE context includes a UE identifier, such as a temporary UE identifier.

[0120] In some embodiments, the context identification includes a data storage identifier and a storage location indicator. The data storage identifier indicates a data storage function storing the UE context, while the storage location indicator indicates a location in memory where the stored context is located. In certain embodiment, the context identification also includes a network function group identifier that identifies a NF group serving the UE. In one embodiment, a reselecting function uses the network function group identifier to select a new NF in the same NF group as the old NF.

[0121] In certain embodiments, the receiver 835 receives a retrieval request (e.g., a UE context retrieval request) from a NF to retrieve UE context. Here, the retrieval request may include a second context identification. In such embodiments, the processor 805 determines from the second context identification whether the data storage apparatus 800 stores the requested UE context. If the data storage apparatus 800 stores the request UE context (e.g., stored in the memory 810), then the processor 805 generates a retrieval response that includes the

requested UE context and controls the transmitter 830 to send the retrieval response to the requesting NF.

[0122] Otherwise, if the data storage apparatus 800 does not store the request UE context, then the processor may identify (from a data storage identifier in the second context identification) a data storage function having the requested UE context. Here, the processor 805 controls the transmitter 830 to forward the retrieval request to the appropriate data storage function and the receiver 835 receives the requested UE context from the data storage function. Afterwards, the processor 805 generates a retrieval response that includes the requested UE context and controls the transmitter 830 to send the retrieval response to the requesting NF.

[0123] The memory 810, in one embodiment, is a computer readable storage medium. In some embodiments, the memory 810 includes volatile computer storage media. For example, the memory 810 may include a RAM, including dynamic RAM ("DRAM"), synchronous dynamic RAM ("SDRAM"), and/or static RAM ("SRAM"). In some embodiments, the memory 810 includes non-volatile computer storage media. For example, the memory 810 may include a hard disk drive, a flash memory, or any other suitable non-volatile computer storage device. In some embodiments, the memory 810 includes both volatile and non-volatile computer storage media.

[0124] In some embodiments, the memory 810 stores data relating to storing UE context and providing a UE context identification. For example, the memory may store a received UE context. In some embodiments, the memory 810 also stores program code and related data, such as an operating system or other controller algorithms operating on the remote unit 105 and one or more software applications.

[0125] The input device 815, in one embodiment, may include any known computer input device including a touch panel, a button, a keyboard, a stylus, a microphone, or the like. In some embodiments, the input device 815 may be integrated with the output device 820, for example, as a touchscreen or similar touch-sensitive display. In some embodiments, the input device 815 includes two or more different devices, such as a keyboard and a touch panel. In certain embodiments, the input device 815 may include a camera for capturing images or otherwise inputting visual data.

[0126] The output device 820, in one embodiment, may include any known electronically controllable display or display device. The output device 820 may be designed to output visual, audible, and/or haptic signals. In some embodiments, the output device 820 includes an electronic display capable of outputting visual data to a user. For example, the output device 820 may include, but is not limited to, an LCD display, an LED display, an OLED display, a projector, or similar display device capable of outputting images, text, or the like to a user.

[0127] In certain embodiments, the output device 820 includes one or more speakers for producing sound. For example, the output device 820 may produce an audible alert or notification (*e.g.*, a beep or chime). In some embodiments, the output device 820 includes one or more haptic devices for producing vibrations, motion, or other haptic feedback. In some
5 embodiments, all or portions of the output device 820 may be integrated with the input device 815. For example, the input device 815 and output device 820 may form a touchscreen or similar touch-sensitive display. In other embodiments, the output device 820 may be located near the input device 815.

[0128] The transceiver 825 communicates with NFs within a mobile communication
10 network. The transceiver 825 may have one or more transmitters 830 and one or more receivers 835. As discussed above, the transceiver 825 may supports one or more the network interface 840 for communicating with the NFs or with other data storage apparatuses 800.

[0129] Figure 9 depicts one embodiment of a network function apparatus 900 that may be used for storing UE context and providing a UE context identification, according to
15 embodiments of the disclosure. The network function apparatus 900 may be one embodiment of the control plane NFs described above, such as the AMFs 135, 235-255, 305-310, and 505-510. Furthermore, the network function apparatus 900 may include a processor 905, a memory 910, an input device 915, an output device 920, a transceiver 925 for communicating with one or more NFs, (R)AN, and data storage functions. As depicted, the transceiver 925 may include a
20 transmitter 930 and a receiver 935. The transceiver 935 may also support one or more network interface 940, such as the N2 interface and the N11 and N14 interfaces and similar interfaces used to communicate with NFs.

[0130] In one embodiment, the network function apparatus 900 is a part of a NF group, as discussed above with reference to Figure 2. In some embodiments, the input device 915 and
25 the output device 920 are combined into a single device, such as a touchscreen. In certain embodiments, the network function apparatus 900 may not include any input device 915 and/or output device 920.

[0131] The processor 905, in one embodiment, may include any known controller capable of executing computer-readable instructions and/or capable of performing logical
30 operations. For example, the processor 905 may be a microcontroller, a microprocessor, a central processing unit (“CPU”), a graphics processing unit (“GPU”), an auxiliary processing unit, a field programmable gate array (“FPGA”), or similar programmable controller. In some embodiments, the processor 905 executes instructions stored in the memory 910 to perform the

methods and routines described herein. The processor 905 is communicatively coupled to the memory 910, the input device 915, the output device 920, and the transceiver 925.

[0132] In some embodiments, the processor 905 controls the transmitter 930 to send a storage request (e.g., a UE context storage request) to a data storage function (e.g., the data storage apparatus 800). Here, the storage request includes UE context for a served UE (e.g., the UE 205). The receiver 935 may then receive a storage response message from the data storage function. Here, the storage response message includes a context identification (e.g., first context identification) corresponding to the UE context. The first context identification allows for later retrieval of the UE context. The processor 905 stores mapping information in response to the storage response message. Here, the mapping information associates the received context identification with a UE identifier of the served UE.

[0133] In certain embodiments, the processor 905 determines to cease serving the served UE, wherein the transmitter 930 sends the storage request to the data storage function in response to the processor 905 determining to cease serving the served UE. The UE context storage request includes a UE identifier of the served UE 205, such as a temporary UE identifier. The UE context storage request may also include a network function identifier of the network function apparatus 900, such as an IP address, a NF group identifier, and the like. In one embodiment, the processor 905 deletes the UE context in response to receiving the storage response message. In another embodiment, the processor 905 deletes the UE context in response to mapping the context identification to the UE identifier.

[0134] In some embodiments, the receiver 935 receives a NAS signaling message from an access network serving the served UE, such as the 5G-(R)AN 210, after the processor 905 deletes the UE's context. Here, the NAS signaling message includes the UE identifier. In response, the processor 905 generates a redirect request message that includes the first context identification and a suitable cause value. The transmitter 930 then sends the redirect request message to the access network.

[0135] In certain embodiments, the receiver 935 receives a downlink transport message from a SMF after the processor 905 deletes the UE's context. Here, the message includes the UE identifier of the UE whose context was deleted. In response, the processor 905 generates a redirect request message that includes the first context identification and a suitable cause value. The transmitter 930 then sends the redirect request message to the SMF.

[0136] In some embodiments, the receiver 935 receives a second context identification. For example, the receiver 935 may receive the second context identification in a NAS message, an N2 connection message, an N11 connection message, or the like. Here, the processor 905

parses the second context identification from the message and controls the transmitter 930 to send a retrieval request (e.g., a UE context retrieval request) to a data storage function (e.g., the data storage apparatus 800) in order to retrieve a second UE context belonging to a second UE. Here, the receiver 935 receives the second UE context (e.g., the requested UE context) from the data storage function. In one embodiment, the second UE context is associated with an old temporary UE identifier of the second UE. Here, the processor 905 allocates a new temporary UE identifier to the second UE and controls the transmitter 930 to send a paging message to the second UE that includes the new temporary UE identifier. Thereafter, the second UE uses the new temporary UE identifier when accessing the network. In certain embodiments, the network function apparatus 900 receives the second context identification from an access network, such as the 5G-(R)AN 210. In other embodiments, the network function apparatus 900 receives the second context identification from a network function, such as a SMF or AMF.

[0137] In certain embodiments, the processor 905 determines whether the served UE is in a connected state in response to determining to cease serving the served UE. In such embodiments, the processor 905 controls the transmitter 930 to send a connection release message to an access network serving the served UE (e.g., the 5G-(R)AN 210) in response to the served UE being in a connected state. Here, the connection release message including the first context identification and a cause value. However, in response to the served UE not being in a connected state (e.g., due to being in an idle state), then the network function apparatus 900 does not connect with the access network or other control plane NFs regarding the served UE until a subsequent MO transaction or MT transaction for this UE happens. Thus, the network function apparatus 900 only interacts with the access network regarding the served UE and only interacts with network functions regarding the served UE, in response to the served UE transitioning to a connected state.

[0138] The memory 910, in one embodiment, is a computer readable storage medium. In some embodiments, the memory 910 includes volatile computer storage media. For example, the memory 910 may include a RAM, including dynamic RAM (“DRAM”), synchronous dynamic RAM (“SDRAM”), and/or static RAM (“SRAM”). In some embodiments, the memory 910 includes non-volatile computer storage media. For example, the memory 910 may include a hard disk drive, a flash memory, or any other suitable non-volatile computer storage device. In some embodiments, the memory 910 includes both volatile and non-volatile computer storage media.

[0139] In some embodiments, the memory 910 stores data relating to storing UE context and providing a UE context identification. For example, the memory may store a received UE context. In some embodiments, the memory 910 stores the mapping information between the UE

context identification and the temporary UE identifier. In some embodiments, the memory 910 also stores program code and related data, such as an operating system or other controller algorithms operating on the remote unit 105 and one or more software applications.

[0140] The input device 915, in one embodiment, may include any known computer
5 input device including a touch panel, a button, a keyboard, a stylus, a microphone, or the like. In some embodiments, the input device 915 may be integrated with the output device 920, for example, as a touchscreen or similar touch-sensitive display. In some embodiments, the input device 915 includes two or more different devices, such as a keyboard and a touch panel. In certain embodiments, the input device 915 may include a camera for capturing images or
10 otherwise inputting visual data.

[0141] The output device 920, in one embodiment, may include any known electronically controllable display or display device. The output device 920 may be designed to output visual, audible, and/or haptic signals. In some embodiments, the output device 920 includes an electronic display capable of outputting visual data to a user. For example, the output device 920
15 may include, but is not limited to, an LCD display, an LED display, an OLED display, a projector, or similar display device capable of outputting images, text, or the like to a user.

[0142] In certain embodiments, the output device 920 includes one or more speakers for producing sound. For example, the output device 920 may produce an audible alert or notification (*e.g.*, a beep or chime). In some embodiments, the output device 920 includes one or
20 more haptic devices for producing vibrations, motion, or other haptic feedback. In some embodiments, all or portions of the output device 920 may be integrated with the input device 915. For example, the input device 915 and output device 920 may form a touchscreen or similar touch-sensitive display. In other embodiments, the output device 920 may be located near the input device 915.

[0143] The transceiver 925 communicates with NFs within a mobile communication
25 network. The transceiver 925 may one or more transmitters 930 and one or more receivers 935. As discussed above, the transceiver 925 may supports one or more the network interface 940 for communicating with data storage function, access networks, and/or other NFs.

[0144] Figure 10 is a schematic flow chart diagram illustrating one embodiment of a
30 method 1000 for storing UE context and providing a UE context identification, according to embodiments of the disclosure. In some embodiments, the method 1000 is performed by a data storage function, such as the DSF 145, first data storage 225, second data storage 230, DSF 320 and/or, the data storage apparatus 800, described above. In certain embodiments, the method

1000 may be performed by a processor executing program code, for example, a microcontroller, a microprocessor, a CPU, a GPU, an auxiliary processing unit, a FPGA, or the like.

[0145] The method 1000 begins and receives 1005 a storage request (e.g., a UE context storage request) to store UE context. Here, the storage request includes UE context for a first UE.
5 The method 1000 includes storing 1010 the UE context in a memory and generating 1015 a first context identification corresponding to the stored UE context. In certain embodiments, the storage request identifies the first UE and the stored UE context includes a UE identifier of the first UE.

[0146] The method also includes transmitting 1020 a storage response message in
10 response to storing the UE context. Here, the storage response message includes the first context identification. The first context identification allows for retrieval of stored UE context for the first UE. In some embodiments, the first context identification includes a data storage identifier and a storage location indicator. Here, the data storage identifier indicates a data storage function storing the UE context. The first context identification may also include a network
15 function group identifier that identifies a network function group serving the UE. The method 1000 ends.

[0147] Figure 11 is a schematic flow chart diagram illustrating one embodiment of a method 1100 for storing UE context and providing a UE context identification, according to embodiments of the disclosure. In some embodiments, the method 1100 is performed by a
20 control plane network function described above, such as the AMFs 135, 235-255, 305-310, and 505-510. In certain embodiments, the method 1100 may be performed by a processor executing program code, for example, a microcontroller, a microprocessor, a CPU, a GPU, an auxiliary processing unit, a FPGA, or the like.

[0148] The method 1100 begins and transmits 1105 a storage request to store UE context,
25 for example to a data storage function. Here, the storage request includes UE context for a UE served by a network function. In certain embodiments, the storage request further includes a UE identifier, such as a temporary UE identifier, and a network function identifier of the serving network function. In some embodiments, a serving network function determines to cease serving the first UE, wherein transmitting 1105 the storage request to store UE context for the first UE
30 occurs in response to the serving network function determining to cease serving the first UE.

[0149] The method 1100 includes receiving 1110 a storage response message. Here, the storage response message includes a first context identification corresponding to the stored UE context. A network function may use the first context identification to later retrieve the UE context from the data storage function.

[0150] The method 1100 also includes storing 1115 mapping information in response to receiving the storage response message. Here, the mapping information associates the first context identification with a UE identifier of the first UE, such as a temporary UE identifier. In certain embodiments, storing 1115 the mapping information includes deleting UE context for the first UE stored at the serving network function, in response to storing the mapping information.

[0151] In one embodiment, the method 1100 includes receiving a non-access stratum (“NAS”) signaling message from an access network serving the first UE after storing 1115 the mapping information and transmitting a redirect request message to the access network. Here, the NAS signaling message includes a UE identifier of the first UE and the redirect request message includes the first context identification and a cause value. The redirect request message indicates to the access network that the transmitting network function no longer stores UE context for the first UE.

[0152] In another embodiment, the method 1100 includes receiving a connection establishment request from a SMF after storing 1115 the mapping information and transmitting a redirect request message to the SMF. Here, the connection establishment request includes a UE identifier of the first UE and the redirect request message includes the first context identification and a cause value. The redirect request message indicates to the access network that the transmitting network function no longer stores UE context for the first UE.

[0153] In certain embodiments, the method 1100 includes determining whether the first UE is in a connected state and transmitting a connection release message to an access network (“AN”) serving the first UE in response to the first UE being in a connected state, the connection release message including the first context identification and a cause value. In further embodiments, in response to the first UE not being in a connected state, method includes only interacting with the AN regarding the first UE or only interacting with network functions regarding the first UE, in response to the first UE transitioning to a connected state. The method 1100 ends.

[0154] Figure 12 is a schematic flow chart diagram illustrating one embodiment of a method 1200 for receiving a UE context identification and retrieving UE context, according to embodiments of the disclosure. In some embodiments, the method 1200 is performed by a control plane network function described above, such as the AMFs 135, 235-255, 305-310, and 505-510. In certain embodiments, the method 1200 may be performed by a processor executing program code, for example, a microcontroller, a microprocessor, a CPU, a GPU, an auxiliary processing unit, a FPGA, or the like.

[0155] The method 1200 begins and receives 1205 a second context identification. In certain embodiments, receiving 1205 the second context identification from an access network or from a second network function. The second network function may be an SMF serving a second UE or an AMF serving the second UE. In one embodiment, receiving 1205 the second context
5 identification includes receiving a connection reestablishment message that includes the second context identification.

[0156] In some embodiments, the second context identification includes a data storage identifier and a storage location indicator. The data storage identifier indicates a data storage function storing the UE context, while the storage location indicator indicates a location in
10 memory where the stored context is located. In certain embodiment, the context identification also includes a network function group identifier that identifies a NF group serving the second UE.

[0157] The method 1200 includes transmitting 1210 a retrieval request (e.g., a UE context retrieval request) to a data storage function to retrieve UE context corresponding to the
15 second context identification. Here, the retrieval request includes the second context identification which is used to retrieve the second UE context which belongs to a second UE. In certain embodiments, transmitting 1210 a retrieval request to a data storage function includes identifying an appropriate data storage function from the second context identification. In other embodiments, transmitting 1210 a retrieval request to a data storage function may include
20 transmitting to the data storage function of a network function group.

[0158] The method 1200 includes receiving 1215 second UE context from the data storage function, the second UE context belonging to the second UE. The method 1200 ends.

[0159] Embodiments may be practiced in other specific forms. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The
25 scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

CLAIMS

1. An apparatus comprising:

a receiver that receives a storage request to store user equipment ("UE") context,
the storage request including UE context for a UE;

a processor that stores the UE context, wherein the processor generates a first
context identification corresponding to the stored UE context; and

a transmitter that sends a storage response message in response to the processor
storing the UE context, the storage response message including the first
context identification, wherein the first context identification allows for
retrieval of the stored UE context.

2. The apparatus of claim 1,

wherein the stored UE context includes a UE identifier,

wherein the first context identification includes a data storage identifier and a
storage location indicator, and

wherein the data storage identifier indicates a data storage function storing the UE
context.

3. The apparatus of claim 2, wherein the first context identification further includes a

network function group identifier that identifies a network function group serving the UE.

4. The apparatus of claim 1, wherein:

the receiver receives a retrieval request to retrieve UE context, the retrieval
request including a second context identification,

the processor determines from the second context identification whether the
apparatus stores the requested UE context, and

the transmitter returns the requested UE context in response to apparatus storing
the requested UE context.

5. The apparatus of claim 4,

wherein the transmitter forwards the retrieval request to a data storage function in response to the processor determining from the second context identification that the apparatus does not store the requested UE context, wherein the receiver receives the requested UE context from the data storage function.

6. The apparatus of claim 5,

wherein the second context identification includes a data storage identifier and a storage location indicator, the data storage identifier indicating a data storage function storing the requested UE context, wherein the transmitter forwarding the retrieval request to a data storage function comprises the transmitter forwarding the retrieval request to the data storage function indicated by the data storage identifier.

7. A method comprising:

receiving a storage request to store user equipment ("UE") context, the storage request including UE context for a UE;
storing the UE context in a memory;
generating a first context identification corresponding to the stored UE context;
and
transmitting a storage response message in response to storing the UE context, the storage response message including the first context identification, wherein the first context identification allows for retrieval of the stored UE context.

8. The method of claim 7,

wherein the stored UE context includes a UE identifier,
wherein the first context identification includes a data storage identifier and a storage location indicator, and
wherein the data storage identifier indicates a data storage function storing the UE context.

9. The method of claim 8, wherein the first context identification further includes a network function group identifier that identifies a network function group serving the UE.

10. The method of claim 7, further comprising:

receiving a retrieval request to retrieve UE context, the retrieval request including
a second context identification,
determining from the second context identification whether the memory stores the
requested UE context, and
returning the requested UE context in response to memory storing the requested
UE context.

11. The method of claim 10, further comprising:

forwarding the retrieval request to a data storage function in response to
determining from the second context identification that the memory does
not store the requested UE context; and
receiving the requested UE context from the data storage function.

12. The method of claim 11,

wherein the second context identification includes a data storage identifier and a
storage location indicator, the data storage identifier indicating a data
storage function storing the requested UE context, and
wherein forwarding the retrieval request to a data storage function comprises
forwarding the retrieval request to the data storage function indicated by
the data storage identifier.

13. An apparatus comprising:

a transmitter that sends a storage request to store user equipment ("UE") context,
the storage request including UE context for a first UE;
a receiver that receives a storage response message, the storage response message
including a first context identification corresponding to the UE context,
wherein the first context identification allows for retrieval of the UE
context; and

a processor that stores mapping information in response to the storage response message, the mapping information associating the first context identification with a UE identifier of the first UE.

14. The apparatus of claim 13, wherein the storage request further includes the UE identifier
5 and a network function identifier of the apparatus.

15. The apparatus of claim 13,
wherein the transmitter sends a retrieval request to a data storage function to
retrieve UE context, the retrieval request including a second context
identification,
10 wherein the receiver receives second UE context from the data storage function,
the second UE context belonging to a second UE.

16. The apparatus of claim 15,
wherein the second UE context is associated with an old temporary UE identifier
of the second UE,
15 wherein the processor allocates a new temporary UE identifier to the second UE;
and
wherein the transmitter sends a paging message to the second UE, the paging
message including the new temporary UE identifier, wherein the second
UE performs network access using the new temporary UE identifier.

17. The apparatus of claim 15, wherein the receiver receives the second context identification
20 from one of: an access network and a network function.

18. The apparatus of claim 17, wherein the network function is one of a session management
function ("SMF") serving the second UE and an access and mobility management
function ("AMF") serving the second UE.
25

19. The apparatus of claim 13,
wherein the receiver receives a non-access stratum ("NAS") signaling message
from an access network ("AN") serving the first UE, the NAS signaling
message including the UE identifier, and
5 wherein the transmitter sends a redirect request message to the AN, the redirect
request message including the first context identification and a cause value.
20. The apparatus of claim 13,
wherein the receiver receives a downlink transport message from a session
management function ("SMF"), the downlink transport message including
10 the UE identifier, and
wherein the transmitter sends a redirect request message to the SMF, the redirect
request message including the first context identification and a cause value.
21. The apparatus of claim 13, wherein the processor determines to cease serving the first UE,
wherein the transmitter sends the storage request to store UE context for the first UE in
15 response to the processor determining to cease serving the first UE, wherein the processor
deletes the UE context for the first UE in response to storing the mapping information.
22. The apparatus of claim 21,
wherein the processor determines whether the first UE is in a connected state in
response to determining to cease serving the first UE,
20 wherein the transmitter sends a connection release message to an access network
("AN") serving the first UE in response to the first UE being in a
connected state, the connection release message including the first context
identification and a cause value.
23. The apparatus of claim 22, wherein, in response to the first UE not being in a connected
25 state, the apparatus only interacts with the AN regarding the first UE or only interacts
with network functions regarding the first UE, in response to the first UE transitioning to
a connected state.
24. A method comprising:

transmitting a storage request to store user equipment (“UE”) context, the storage request including UE context for a first UE served by a network function; receiving a storage response message, the storage response message including a first context identification corresponding to the UE context, wherein the first context identification allows for retrieval of the UE context; and storing mapping information in response to receiving the storage response message, the mapping information associating the first context identification with a UE identifier of the first UE.

25. The method of claim 24, wherein the storage request further includes the UE identifier and a network function identifier of the serving network function.

26. The method of claim 24, further comprising:
transmitting a retrieval request to a data storage function to retrieve UE context, the retrieval request including a second context identification; and receiving second UE context from the data storage function, the second UE context belonging to a second UE.

27. The method of claim 26, wherein the second UE context is associated with an old temporary UE identifier of the second UE, the method further comprising:
allocating a new temporary UE identifier to the second UE; and sending a paging message to the second UE, the paging message including the new temporary UE identifier, wherein the second UE performs network access using the new temporary UE identifier.

28. The method of claim 26, further comprising receiving the second context identification from one of: an access network and a second network function.

29. The method of claim 28, wherein the second network function is one of a session management function (“SMF”) serving the second UE and an access and mobility management function (“AMF”) serving the second UE.

30. The method of claim 24, further comprising

receiving a non-access stratum (“NAS”) signaling message from an access network (“AN”) serving the first UE, the NAS signaling message including the UE identifier; and
transmitting a redirect request message to the AN, the redirect request message including the first context identification and a cause value.

31. The method of claim 24, further comprising
receiving a downlink transport message from a session management function (“SMF”), the downlink transport message including the UE identifier; and
transmitting a redirect request message to the SMF, the redirect request message including the first context identification and a cause value.

32. The method of claim 24, further comprising:
determining, by the serving network function, to cease serving the first UE, wherein transmitting the storage request to store UE context for the first UE occurs in response to the serving network function determining to cease serving the first UE; and
deleting UE context for the first UE stored at the serving network function, in response to storing the mapping information.

33. The method of claim 32, further comprising:
determining whether the first UE is in a connected state in response to determining to cease serving the first UE; and
transmitting a connection release message to an access network (“AN”) serving the first UE in response to the first UE being in a connected state, the connection release message including the first context identification and a cause value.

34. The method of claim 33, wherein, in response to the first UE not being in a connected state, the serving network function only interacts with the AN regarding the first UE or only interacts with network functions regarding the first UE, in response to the first UE transitioning to a connected state.

35. A system comprising:

a data storage apparatus comprising:

a first receiver that receives a storage request to store user equipment (“UE”) context, the storage request including UE context for a first UE;

a first processor that stores the UE context, wherein the first processor generates a first context identification corresponding to the stored UE context; and

a first transmitter that sends a storage response message in response to the processor storing the UE context, the storage response message including the first context identification, wherein the first context identification allows for retrieval of the stored UE context; and

a network function apparatus comprising:

a second transmitter that sends the storage request to the data storage apparatus;

a second receiver that receives a storage response message; and

a second processor that stores mapping information in response to the storage response message, the mapping information associating the first context identification with a UE identifier of the first UE.

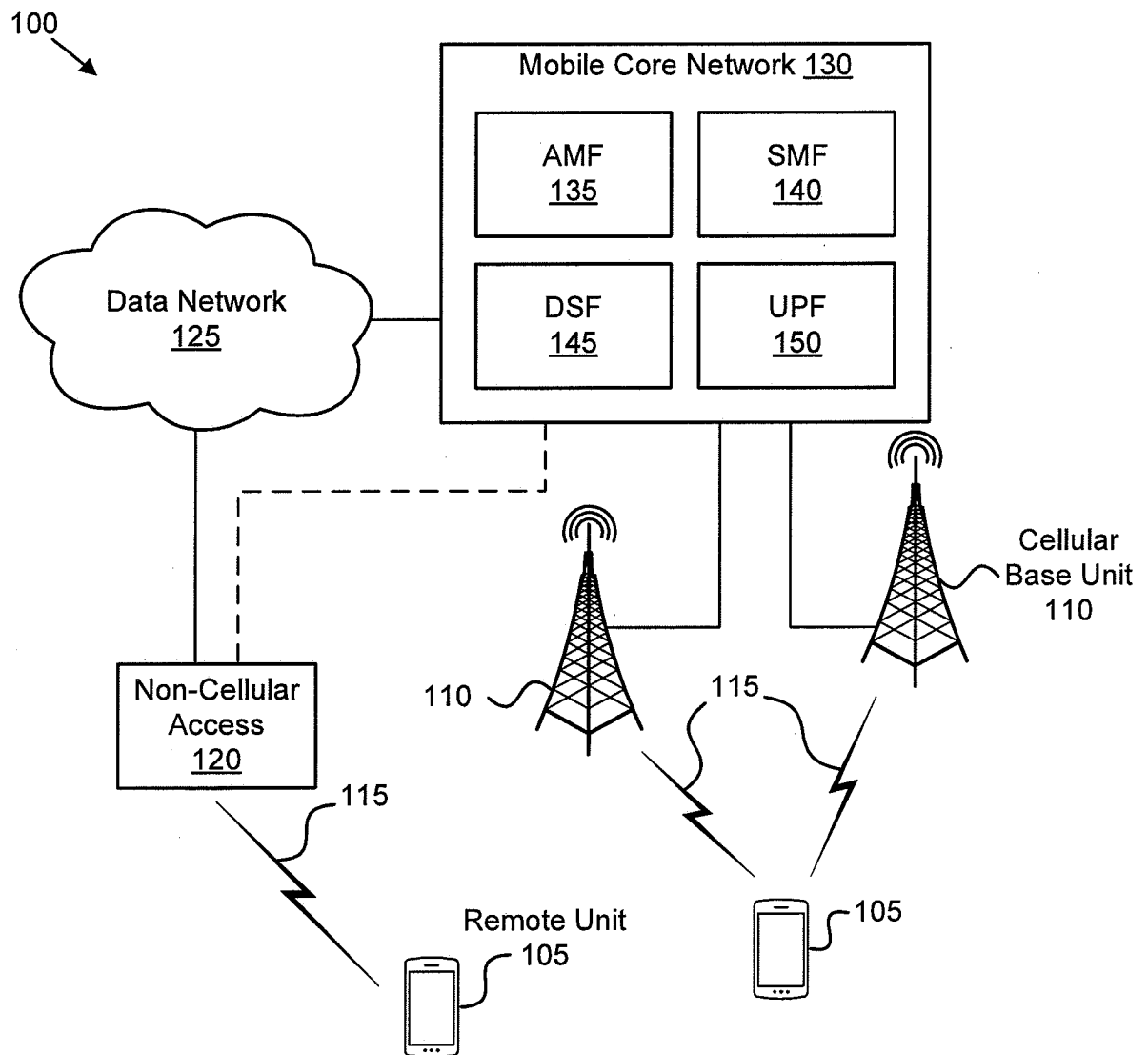


FIG. 1

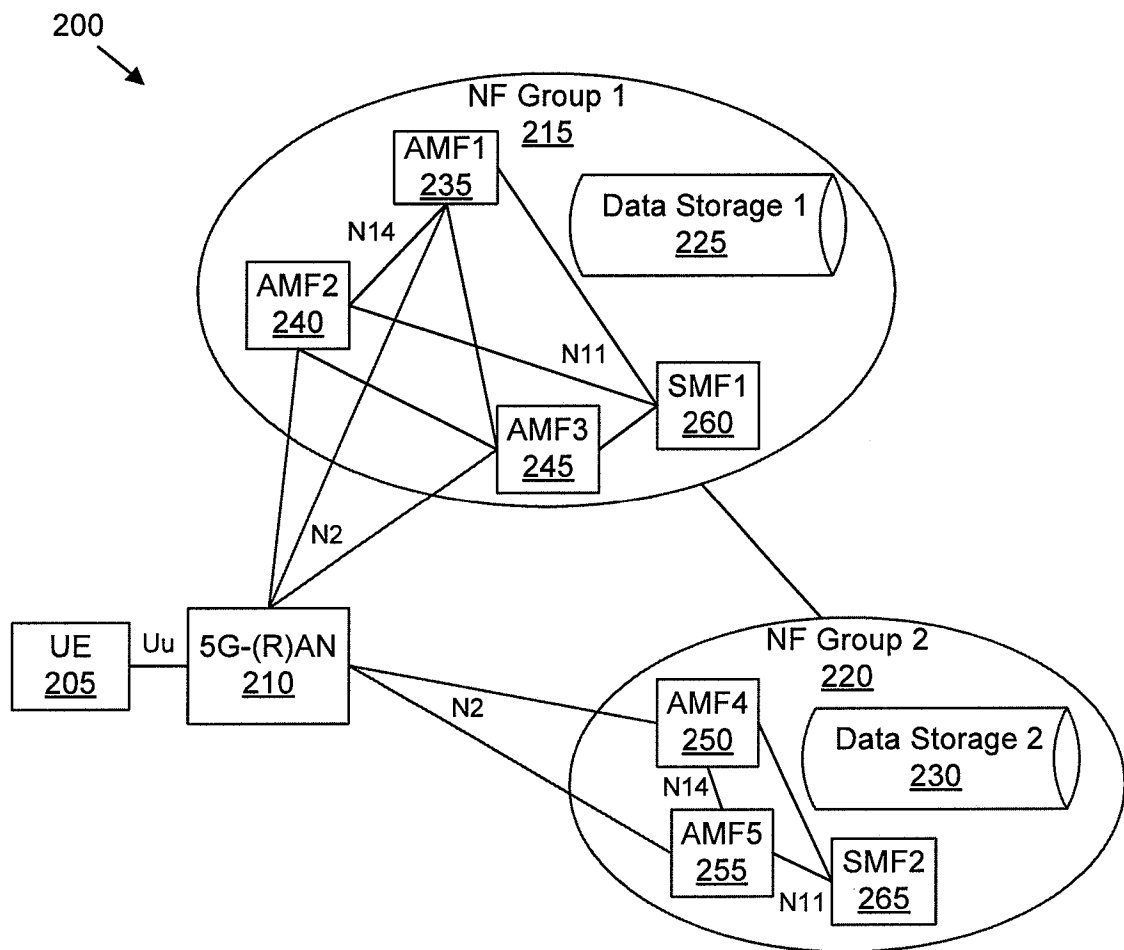


FIG. 2

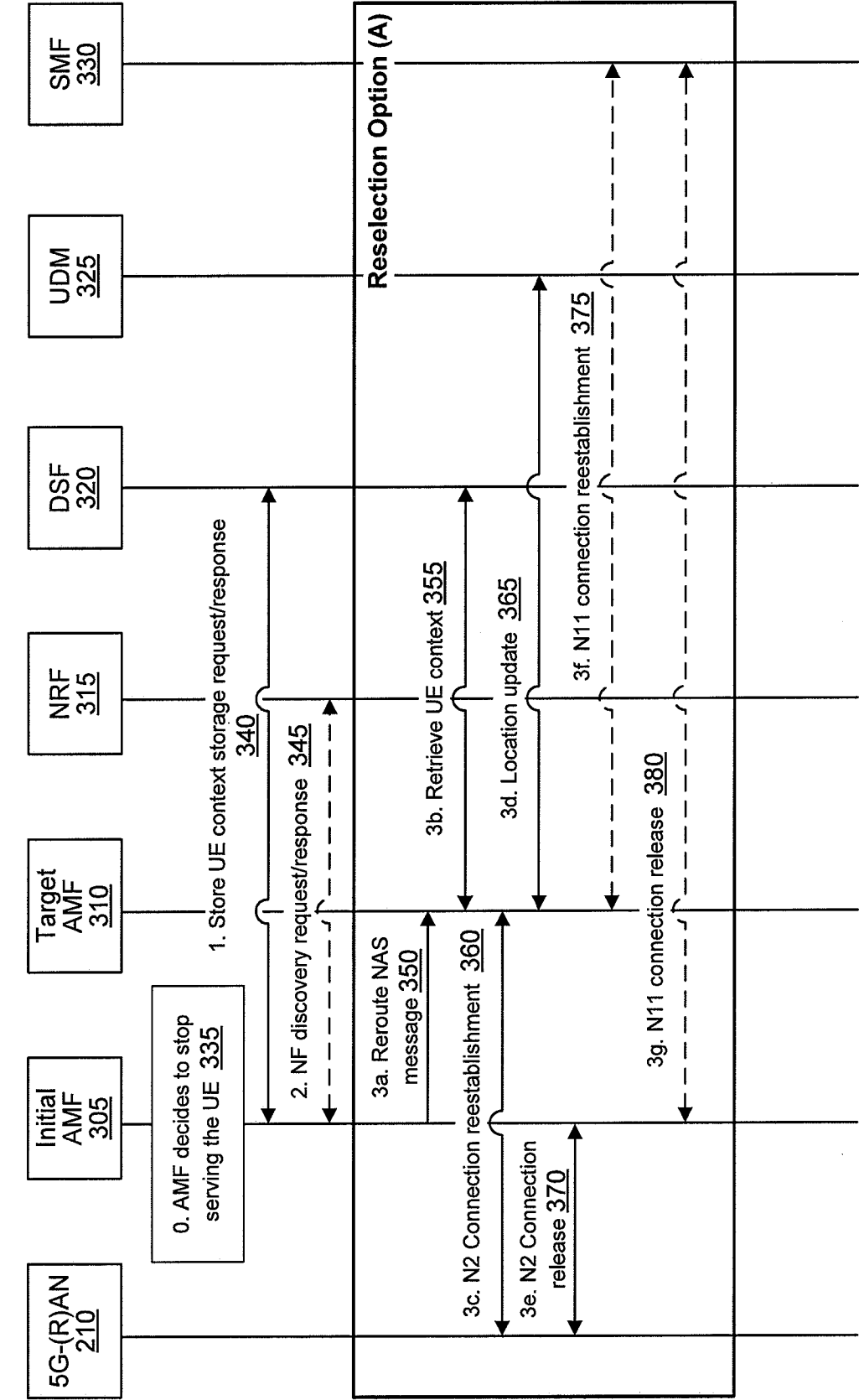


FIG. 3

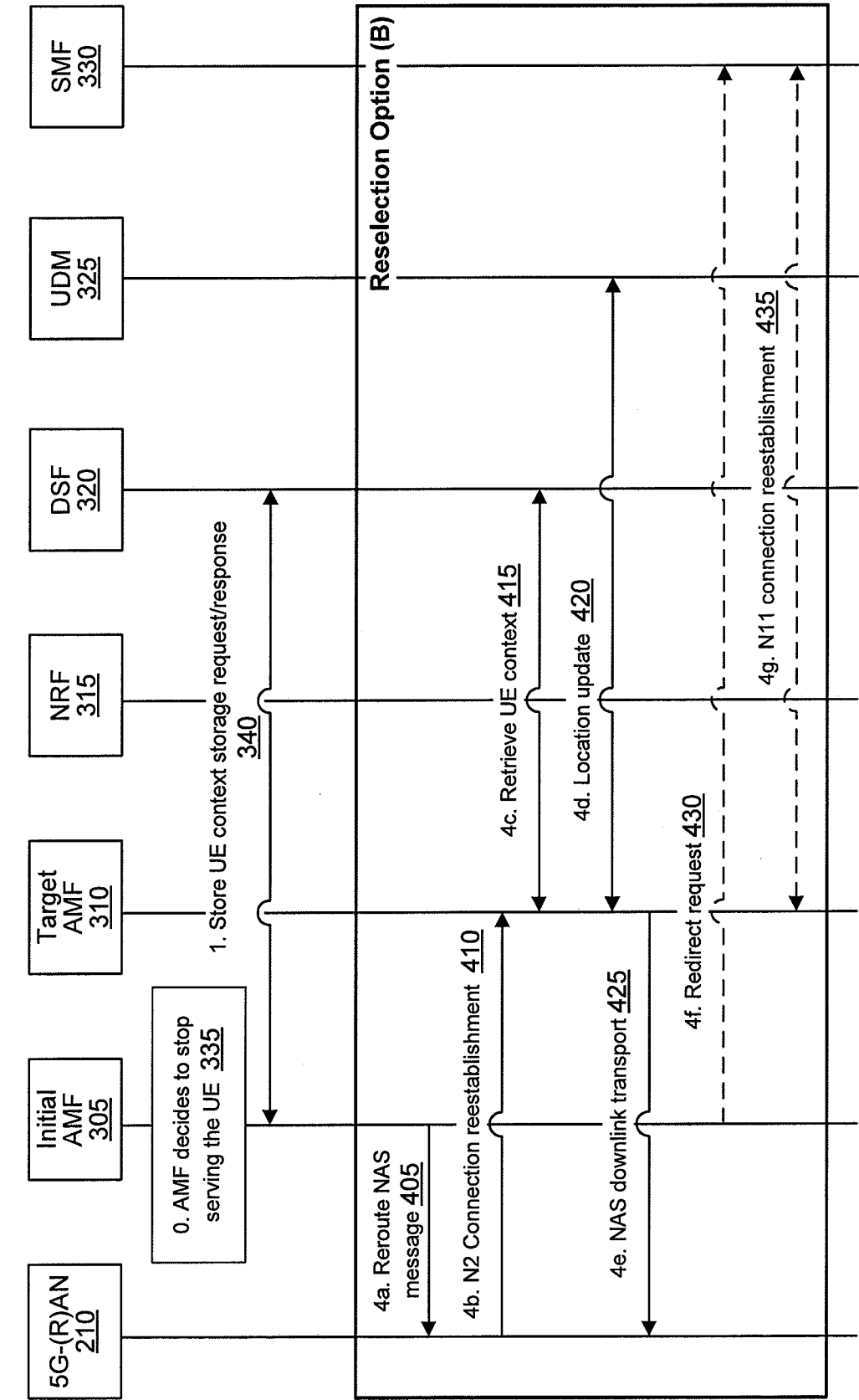


FIG. 4

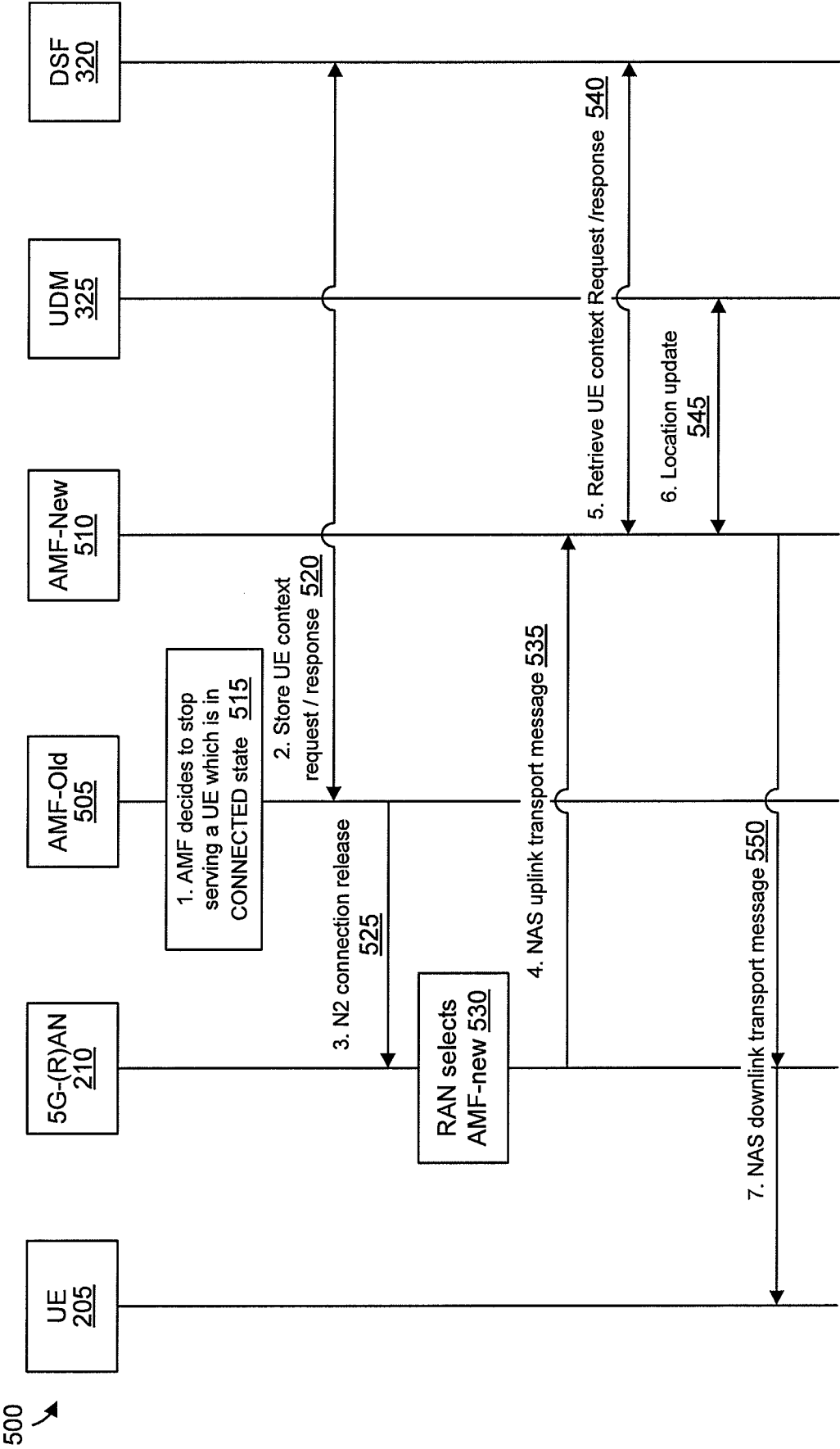


FIG. 5

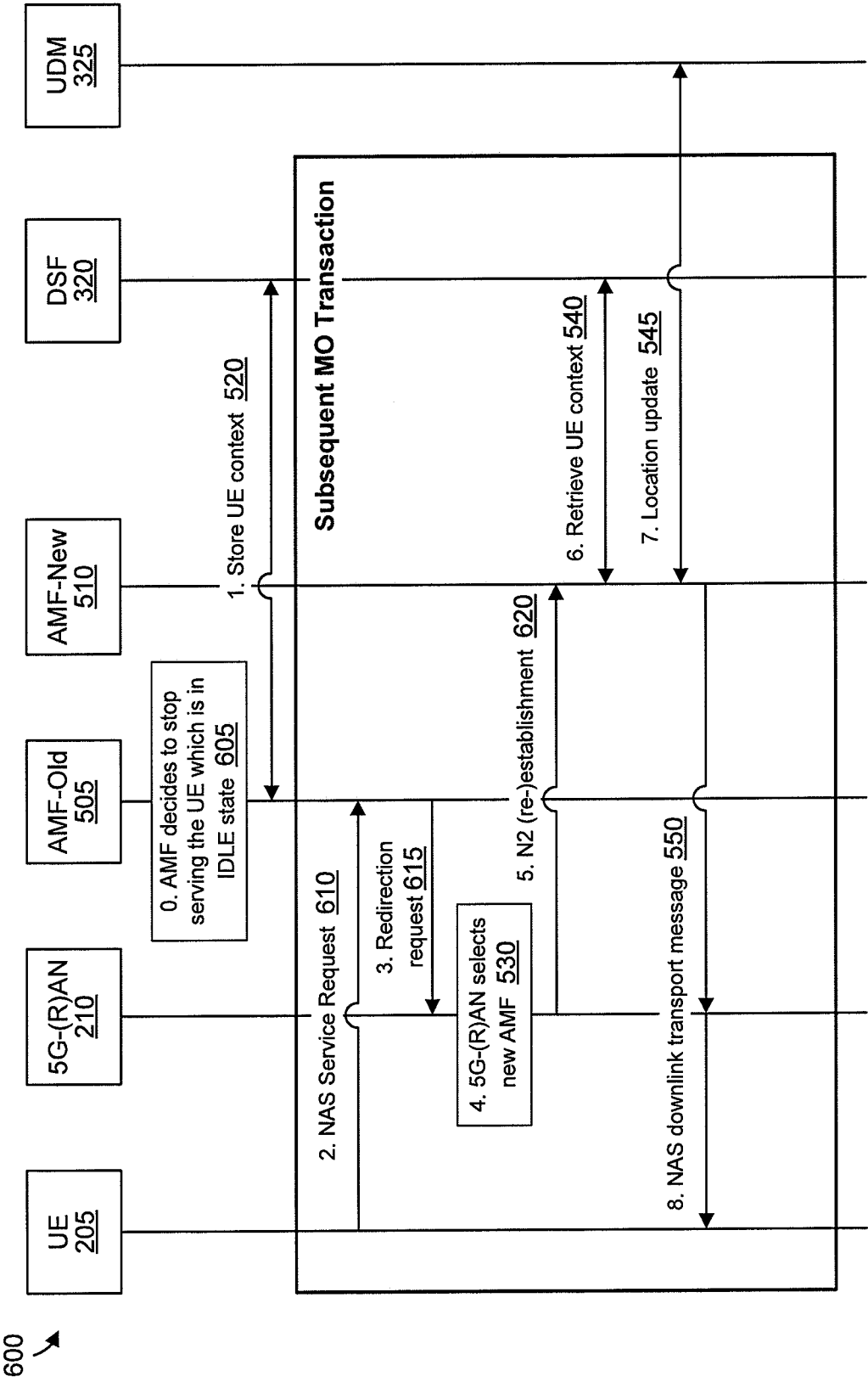


FIG. 6

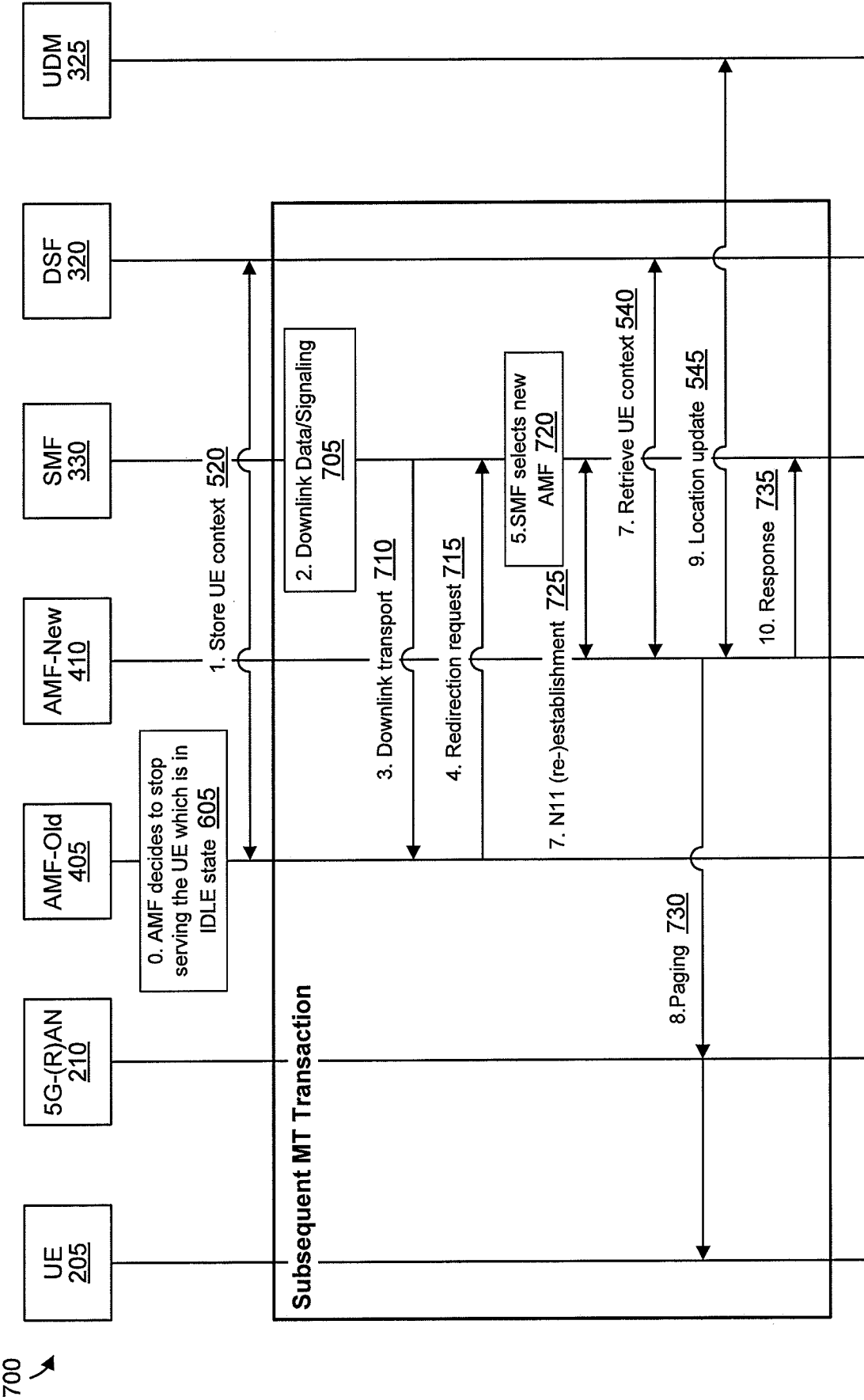


FIG. 7

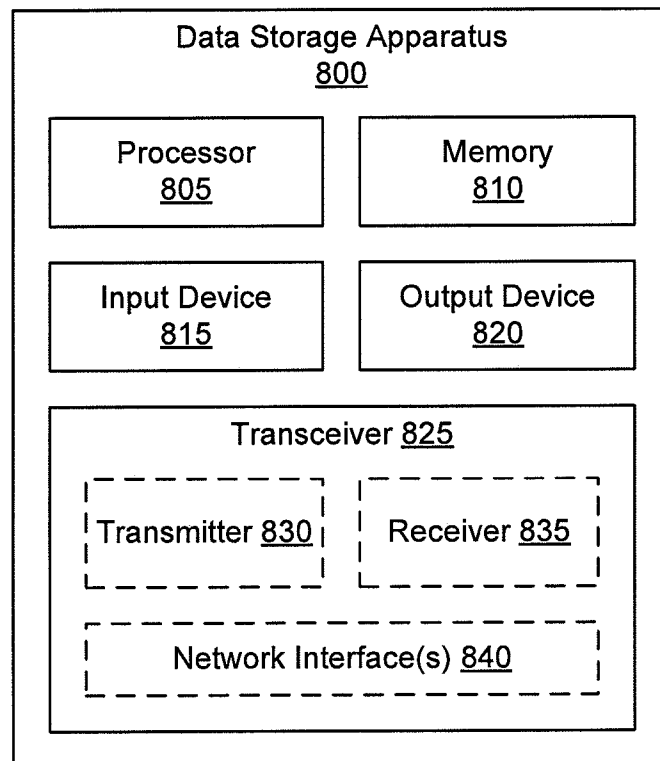


FIG. 8

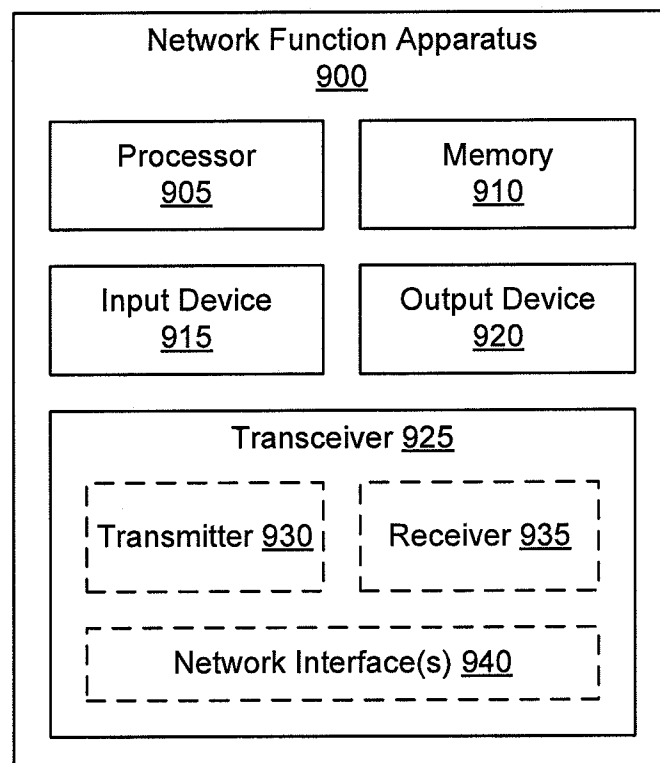


FIG. 9

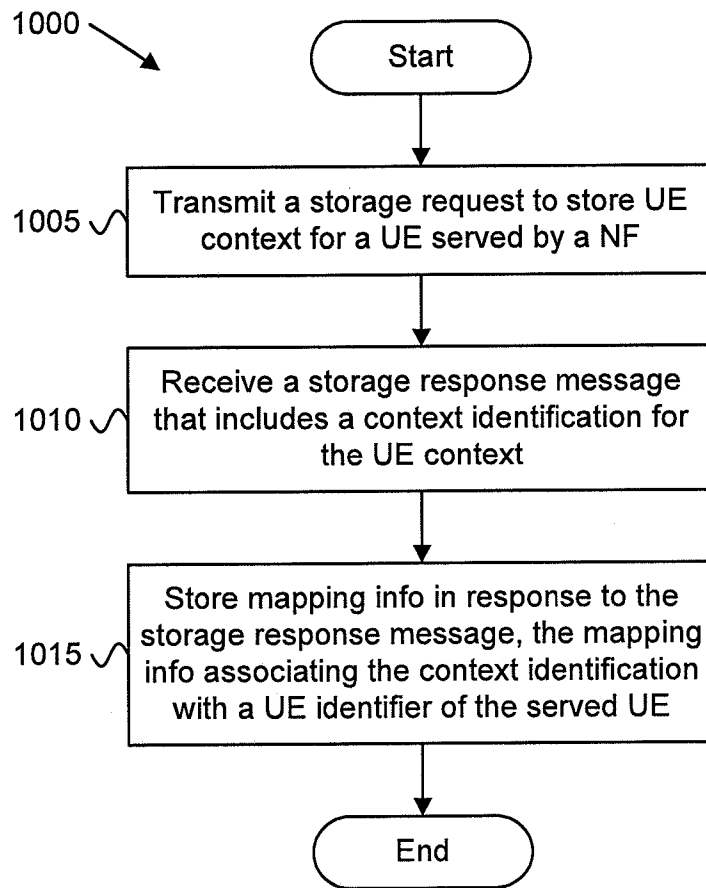


FIG. 10

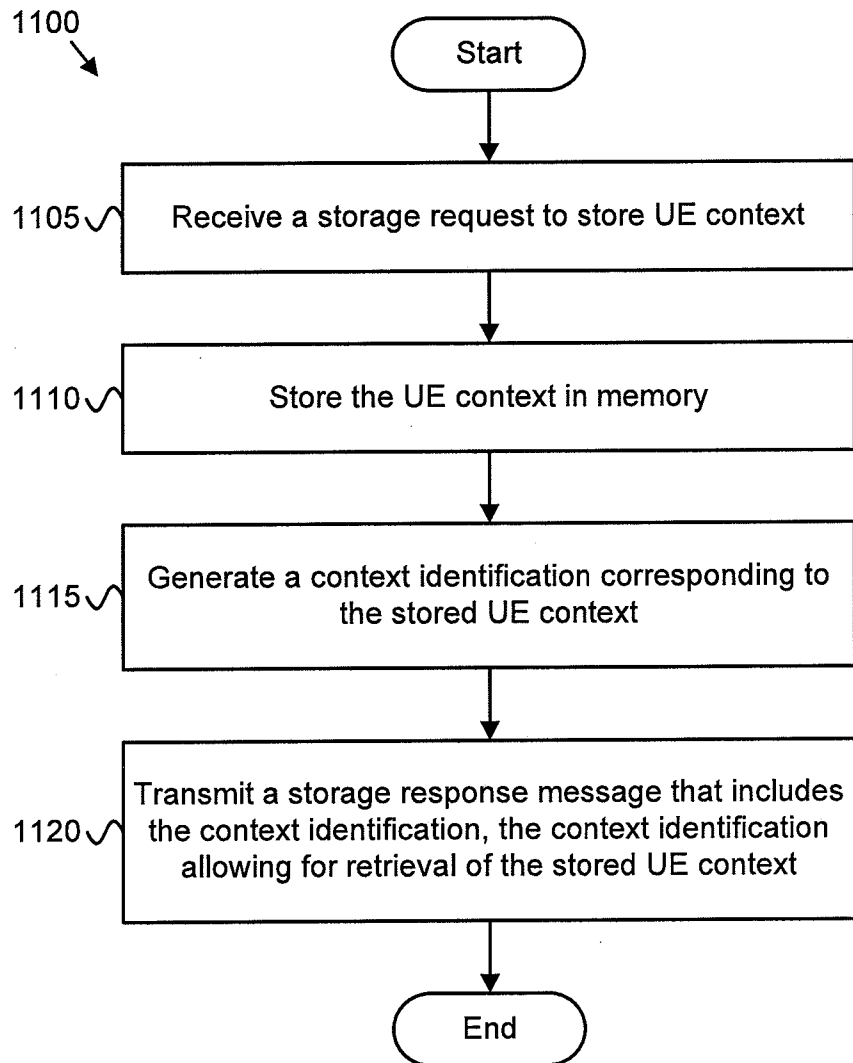


FIG. 11

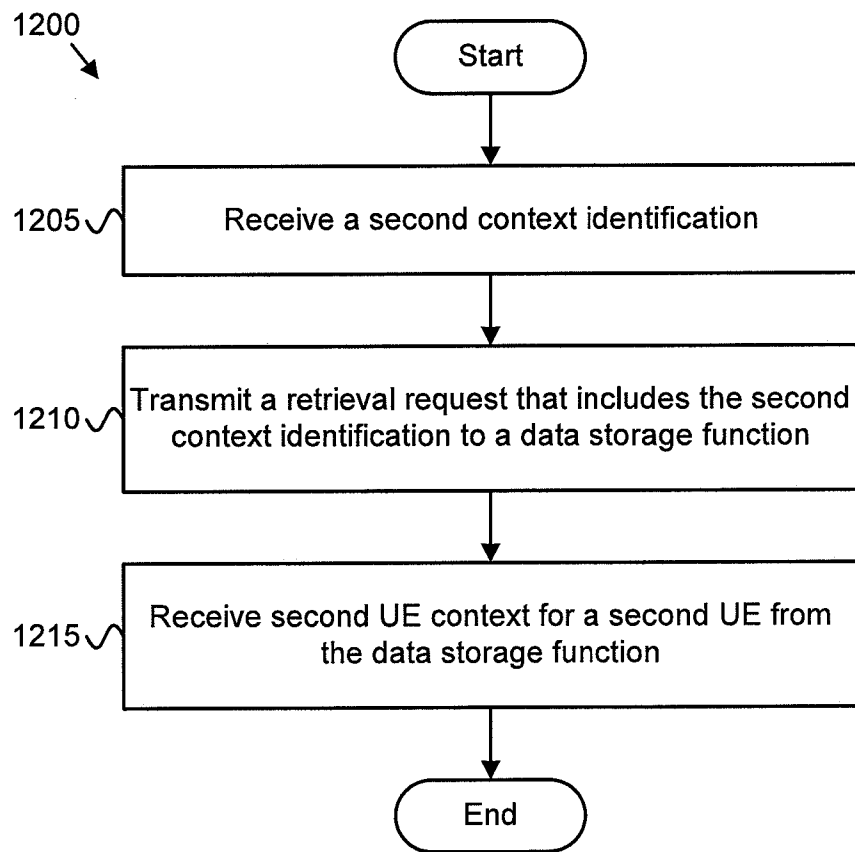


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2017/077561

A. CLASSIFICATION OF SUBJECT MATTER H04W 48/16(2009.01)i; H04W 64/00(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; 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,VEN,USTXT,WOTXT,EPTXT,3GPP,CNKI:UE,context,id,correspond+,map+,AMF,DSF,retriev+,request, response																				
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>CN 105307173 A (ZTE CORP) 03 February 2016 (2016-02-03) claims 4-20, figures 7-11, abstract</td> <td>1-35</td> </tr> <tr> <td>A</td> <td>US 2011305221 A1 (WANG JINGET AL.) 15 December 2011 (2011-12-15) the whole document</td> <td>1-35</td> </tr> <tr> <td>A</td> <td>WO 2013056676 A1 (HUAWEI TECH CO LTD) 25 April 2013 (2013-04-25) the whole document</td> <td>1-35</td> </tr> <tr> <td>A</td> <td>CN 102014487 A (DATANG MOBILE COMMUNICATION EQUIP CO LTD) 13 April 2011 (2011-04-13) the whole document</td> <td>1-35</td> </tr> <tr> <td>A</td> <td>CN 106454962 A (ZTE CORP) 22 February 2017 (2017-02-22) the whole document</td> <td>1-35</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	CN 105307173 A (ZTE CORP) 03 February 2016 (2016-02-03) claims 4-20, figures 7-11, abstract	1-35	A	US 2011305221 A1 (WANG JINGET AL.) 15 December 2011 (2011-12-15) the whole document	1-35	A	WO 2013056676 A1 (HUAWEI TECH CO LTD) 25 April 2013 (2013-04-25) the whole document	1-35	A	CN 102014487 A (DATANG MOBILE COMMUNICATION EQUIP CO LTD) 13 April 2011 (2011-04-13) the whole document	1-35	A	CN 106454962 A (ZTE CORP) 22 February 2017 (2017-02-22) the whole document	1-35
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																		
A	CN 105307173 A (ZTE CORP) 03 February 2016 (2016-02-03) claims 4-20, figures 7-11, abstract	1-35																		
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A	CN 106454962 A (ZTE CORP) 22 February 2017 (2017-02-22) the whole document	1-35																		
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Date of the actual completion of the international search 15 December 2017		Date of mailing of the international search report 26 December 2017																		
Name and mailing address of the ISA/CN STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China Facsimile No. (86-10)62019451		Authorized officer CAO,Juan Telephone No. (86-10)62411251																		

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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				EP	2498519	A4	01 March 2017
				WO	2011054302	A1	12 May 2011
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