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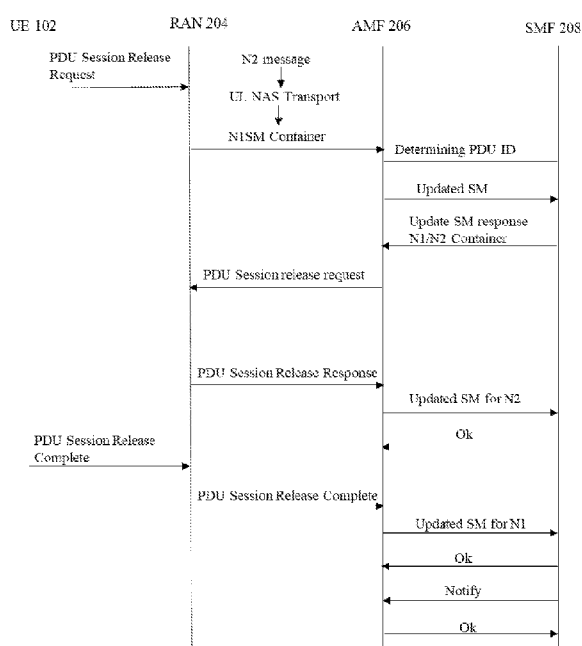


FIG. 2

(57) Abstract: The present disclosure relates to a system (108) and a method (400) for deletion of the PDU session ID. The system (108) includes a receiving unit (310) to receive a first PDU session release request from a UE (102). The system (108) includes an updating unit (312) to update the received first PDU release request message. The system (108) includes a transmittal unit (314) to transmit the first and second SM container to the AMF (206) via the RAN (204). The system (018) includes a checking unit (316) to check if the PDU session ID is available within each of the first and second SM container. The system (108) includes the transmittal unit (314) to transmit an update SM request message from the AMF (206) to the SMF (208). The system (108) includes a deletion unit (318) to delete the PDU session at the SMF (208). Ref.

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## METHOD AND SYSTEM FOR DELETION OF A PACKET DATA UNIT (PDU) SESSION ID

### FIELD OF THE INVENTION

**[0001]** The present invention relates to the field of 5G core network and, more particularly, relates to a method and system for deletion of a Packet Data Unit (PDU) session ID during a PDU release.

### BACKGROUND OF THE INVENTION

**[0002]** Mobile communication systems have traditionally focused on providing voice services. However, with the expansion of mobile communication systems to include data services, there has been a significant increase in traffic, leading to resource constraints. Users now require higher-speed services, necessitating the development of a more advanced mobile communication system.

**[0003]** The requirements for a next-generation mobile communication system are driven by the need to support the explosive growth of data traffic, provide higher transmission rates per user, accommodate a significantly increased number of connection devices, achieve low end-to-end latency, and improve energy efficiency. These demands have led to the development of improved 5G communication systems.

**[0004]** In a 5G communication system, a Packet Data Unit (PDU) Session Establishment Request is received from User Equipment (UE), which is processed through Radio Access Network (RAN), an Access and Mobility Management Function (AMF) and a Session Management Function (SMF) whenever any data session needs to be established by User Equipment. To cater the PDU Establishment request, PDU sessions are established and processed between UE and SMF using NAS Signaling message exchange between these two network nodes as per 3GPP standard TS 24.501 – related to PDU Session Establishment Procedure. The established PDU session is/are deleted or released upon the release request made by the UE or network.

The PDU Session Release request when received from UE via RAN/AMF is sent to the SMF. SMF sends PDU Session Release response to the UE (by sending PDU SESSION RELEASE COMMAND – NAS Signaling message) and receives the acknowledgement message back from UE (in form of PDU SESSION RELEASE COMPLETE – NAS Signaling message). Upon receiving the acknowledgement message, the SMF sends the release notification to AMF. AMF on receiving release notification finally deletes the PDU Session context corresponding to UE (Identified uniquely by the PDU ID protocol field).

**[0005]** Typically, the AMF waits for release notification message from SMF for deleting the PDU Session context. Such technique renders the system more complicated and results in procedural collisions as AMF is unnecessarily waiting for release notification from SMF though PDU Session context has been successfully deleted from UE/RAN when PDU Session Release COMPLETE message (received from UE) is sent to SMF. This procedural collision mainly arises because AMF is waiting for release notification transaction to get completed and UE/RAN can initiate new procedures because as per UE/RAN state, PDU Session Release signaling has been completed from their end. AMF on receiving new procedure request from UE/RAN needs to hold it for processing as it needs to first complete the PDU Release procedure (i.e., release notification transaction between itself and SMF). This holding of new procedures results in delay in processing or procedure handling race condition or even procedure failure scenarios.

**[0006]** There is a need for a solution that can complete the PDU Release procedure at the AMF early while waiting for Release Notification message from SMF. As a result, AMF can handle new procedures from UE/Network while in release notification wait state and is able to respond to release notification message received from SMF. By optimizing the end transaction part of PDU Release procedure, AMF is able to avoid procedure collision or new procedure handling delay or new procedure failure scenarios and ultimately improving the UE user experience as underlying 5G core signaling procedure is optimally handled.

## SUMMARY OF THE INVENTION

**[0007]** One or more embodiments of the present disclosure provide a method and a system for deletion of a Packet Data Unit (PDU) session ID during a PDU release.

**[0008]** In one aspect of the present invention, the system for deletion of the PDU session ID during a PDU release is disclosed. The system includes a receiving unit configured to receive a first PDU session release request message from a User Equipment (UE). The first PDU session release request message is included in a first Session Management (SM) container along with the PDU session ID. The system further includes an updating unit configured to update the received first PDU release request message with an indication of a User Location Information (ULI). The updated PDU release request message is included in a second SM container. The system further includes a transmittal unit configured to transmit the first SM container and the second SM container to an Access and Mobility Management Function (AMF) via a Radio Access Network (RAN).

**[0009]** The system further includes a checking unit configured to check if a PDU session ID is available within each of the first SM container and the second SM container. Each of the first and the second SM containers are accepted if the PDU session ID is available therein. The system further includes the transmittal unit configured to transmit an update SM request message from the AMF to the SMF. The update SM request message includes each of the first and the second containers and the PDU session ID. The system further includes a deletion unit configured to delete a PDU session at the SMF on receipt of the update SM request message. On deletion, the PDU session is deleted from an upper function and a response message containing the first SM container and the second SM container is transmitted to the AMF.

**[0010]** In an embodiment, the transmittal unit is configured to transmit the first SM container and the second SM container to the RAN from the SMF via the AMF. The received first SM container includes the PDU session release command and the second SM container includes the PDU session release command transfer. The transmittal unit

is further configured to transmit the received first SM container from the RAN to the UE. The transmittal unit is further configured to transmit the received second SM container from the RAN to the SMF via the AMF. The received second SM container includes the PDU session resource release response transfer message included therein.

**[0011]** In an embodiment, upon transmission of the received first SM container from the RAN to the UE, the transmittal unit is configured to transmit the first SM container from the UE to the SMF via the AMF. The first SM container includes a message indicating completion of the PDU session. Further, upon transmission of the received first SM container from the RAN to the UE the deletion unit is configured to delete the PDU session ID at the AMF.

**[0012]** In an embodiment, the first PDU session release request message is at least one of an N1 message type and the updated PDU release request message is at least one of an N2 message type.

**[0013]** In an embodiment, the update SM request message is transmitted to the SMF from the AMF utilizing at least one communication protocol, such as, a Hypertext Transfer Protocol 2 (HTTP) protocol.

**[0014]** In an embodiment, each of the first and the second SM container is a N1 SM container and a N2 SM container, respectively.

**[0015]** In another aspect of the present invention, a method for deletion of the PDU session Id during the PDU release is disclosed. The method includes the step of receiving the first PDU session release request message from the User Equipment (UE). The first PDU session release request message is included in the first Session Management (SM) container along with the PDU session ID. The method further includes the step of updating the received first PDU release request message with the indication of the User Location Information (ULI). The updated PDU release request message is included in the second SM container. The method further includes the step

of transmitting the first SM container and the second SM container to the Access and Mobility Management Function (AMF) via the Radio Access Network (RAN).

**[0016]** The method further includes the step of checking if the PDU session ID is available within each of the first SM container and the second SM container. Each of the first and the second SM containers are accepted if the PDU session ID is available therein. The method further includes the step of transmitting the update SM request message from the AMF to the SMF, the update SM request message includes each of the first and the second containers and the PDU session ID. The method further includes the step of deleting the PDU session at the SMF on receipt of the update SM request message. Upon deletion, the PDU session is deleted from the upper function and the response message containing the first SM container and the second SM container is transmitted to the AMF.

**[0017]** Other features and aspects of this invention will be apparent from the following description and the accompanying drawings. The features and advantages described in this summary and in the following detailed description are not all-inclusive, and particularly, many additional features and advantages will be apparent to one of ordinary skill in the relevant art, in view of the drawings, specification, and claims hereof. Moreover, it should be noted that the language used in the specification has been principally selected for readability and instructional purposes and may not have been selected to delineate or circumscribe the inventive subject matter, resort to the claims being necessary to determine such inventive subject matter.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0018]** The accompanying drawings, which are incorporated herein, and constitute a part of this disclosure, illustrate exemplary embodiments of the disclosed methods and systems in which like reference numerals refer to the same parts throughout the different drawings. Components in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Some drawings may indicate the components using block diagrams and may not

represent the internal circuitry of each component. It will be appreciated by those skilled in the art that disclosure of such drawings includes disclosure of electrical components, electronic components or circuitry commonly used to implement such components.

[0019] **FIG. 1** is an exemplary block diagram of a communication system for deletion of a Packet Data Unit (PDU) session ID during a PDU release, according to one or more embodiments of the present invention;

[0020] **FIG. 2** is an exemplary signal flow diagram for deletion of the PDU session ID during the PDU release, according to one or more embodiments of the present invention;

[0021] **FIG. 3** an exemplary block diagram of a system for deletion of the PDU session ID during the PDU release, according to one or more embodiments of the present invention;

[0022] **FIG. 4** is a schematic representation of a workflow of the communication system of **FIG. 1**, according to the one or more embodiments of the present invention;

[0023] **FIG. 5** is a schematic representation of a method for deletion of the PDU session ID during the PDU release, according to one or more embodiments of the present invention.

[0024] The foregoing shall be more apparent from the following detailed description of the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

[0025] Some embodiments of the present disclosure, illustrating all its features, will now be discussed in detail. It must also be noted that as used herein and in the appended claims, the singular forms "a", "an" and "the" include plural references unless the context clearly dictates otherwise.

[0026] Various modifications to the embodiment will be readily apparent to those skilled in the art and the generic principles herein may be applied to other embodiments. However, one of ordinary skill in the art will readily recognize that the present disclosure including the definitions listed here below are not intended to be limited to the embodiments illustrated but is to be accorded the widest scope consistent with the principles and features described herein.

[0027] A person of ordinary skill in the art will readily ascertain that the illustrated steps detailed in the figures and here below are set out to explain the exemplary embodiments shown, and it should be anticipated that ongoing technological development will change the manner in which particular functions are performed. These examples are presented herein for purposes of illustration, and not limitation. Further, the boundaries of the functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternative boundaries can be defined so long as the specified functions and relationships thereof are appropriately performed. Alternatives (including equivalents, extensions, variations, deviations, etc., of those described herein) will be apparent to persons skilled in the relevant art(s) based on the teachings contained herein. Such alternatives fall within the scope and spirit of the disclosed embodiments.

[0028] As per various embodiments depicted, the present invention discloses a system and method for deletion of a Packet Data Unit (PDU) session ID during a PDU release.

[0029] **FIG. 1** illustrates an exemplary block diagram of a communication system **100** for deletion of the PDU session ID during the PDU release, according to one or more embodiments of the present disclosure. In this regard, the communication system **100** includes a User Equipment (UE) **102**, a server **104**, a network **106** and a system **108** communicably coupled to each other for deletion of the PDU session during the PDU release. The UE **102** aids a user to interact with the system **108** for transmitting, a first Packet Data Unit (PDU) session release request message to one or more

processor **302** (as shown in FIG. 3). Further, the UE **102** transmits a first Session Management (SM) container to a Session Management Function (SMF).

[0030] As per the illustrated embodiment and for the purpose of description and illustration, the UE **102** includes, but not limited to, a first UE **102a**, a second UE **102b**, and a third UE **102c**, and should nowhere be construed as limiting the scope of the present disclosure. In alternate embodiments, the UE **102** may include a plurality of UEs as per the requirement. For ease of reference, each of the first UE **102a**, the second UE **102b**, and the third UE **102c**, will hereinafter be collectively and individually referred to as the “User Equipment (UE) **102**”.

[0031] In an embodiment, the UE **102** is one of, but not limited to, any electrical, electronic, electro-mechanical or an equipment and a combination of one or more of the above devices such as virtual reality (VR) devices, augmented reality (AR) devices, laptop, a general-purpose computer, desktop, personal digital assistant, tablet computer, mainframe computer, or any other computing device.

[0032] The communication system **100** includes the server **104** accessible via the network **106**. The server **104** may include, by way of example but not limitation, one or more of a standalone server, a server blade, a server rack, a bank of servers, a server farm, hardware supporting a part of a cloud service or system, a home server, hardware running a virtualized server, one or more processors executing code to function as a server, one or more machines performing server-side functionality as described herein, at least a portion of any of the above, some combination thereof. In an embodiment, the entity may include, but is not limited to, a vendor, a network operator, a company, an organization, a university, a lab facility, a business enterprise side, a defence facility side, or any other facility that provides service.

[0033] The network **106** includes, by way of example but not limitation, one or more of a wireless network, a wired network, an internet, an intranet, a public network, a private network, a packet-switched network, a circuit-switched network, an ad hoc

network, an infrastructure network, a Public-Switched Telephone Network (PSTN), a cable network, a cellular network, a satellite network, a fiber optic network, or some combination thereof. The network **106** may include, but is not limited to, a Third Generation (3G), a Fourth Generation (4G), a Fifth Generation (5G), a Sixth Generation (6G), a New Radio (NR), a Narrow Band Internet of Things (NB-IoT), an Open Radio Access Network (O-RAN), and the like.

[0034] The network **106** may also include, by way of example but not limitation, at least a portion of one or more networks having one or more nodes that transmit, receive, forward, generate, buffer, store, route, switch, process, or a combination thereof, etc. one or more messages, packets, signals, waves, voltage or current levels, some combination thereof, or so forth. The network **106** may also include, by way of example but not limitation, one or more of a wireless network, a wired network, an internet, an intranet, a public network, a private network, a packet-switched network, a circuit-switched network, an ad hoc network, an infrastructure network, a Public-Switched Telephone Network (PSTN), a cable network, a cellular network, a satellite network, a fiber optic network, a VOIP or some combination thereof.

[0035] The communication system **100** further includes the system **108** communicably coupled to the server **104** and the UE **102** via the network **106**. The system **108** is configured to delete the PDU session during the PDU release. As per one or more embodiments, the system **108** is adapted to be embedded within the server **104** or embedded as an individual entity. However, for the purpose of description, the system **108** is described as an integral part of the server **104**, without deviating from the scope of the present disclosure.

[0036] Operational and construction features of the system **108** will be explained in detail with respect to the following figures.

[0037] **FIG. 2** is an exemplary signal flow diagram for deletion of the PDU session ID during the PDU release, according to one or more embodiments of the present invention.

[0038] As per the illustrated embodiment, the system **108** includes, but not limited to, various system components, such as the UE **102**, a Radio Access Network (RAN) **204**, an Access and Mobility Management Function (AMF) **206**, and a Session Management Function (SMF) **208**.

[0039] In one embodiment, a first PDU session release request message is forwarded to the RAN **204** from the UE **102**. As per one embodiment, the RAN **204** is configured to connect each of the UEs **102** to the network **106** via at least one wireless link. The RAN unit **204** includes, but not limited to Open RAN, Global System for Mobile communications (GSM) RAN, or GERAN, GSM Enhanced Data GSM Environment (EDGE) RAN, or GERAN, Universal Mobile Telecommunications System (UMTS) Terrestrial RAN, or UTRAN, Evolved Universal Terrestrial RAN, or E-UTRAN.

[0040] The UE **102** is configured to transmit the first PDU session release request message to the RAN **204** as an N1 message. The N1 message is sent through an N1 interface established between the UE **102** and the RAN **204**. The N1 interface typically refers to the interface between the UE **102** and the AMF **206**. The N1 message refers to the message exchanged between the network **106** functions over the N1 interface. The N1 message includes a Non-Access Stratum (NAS) message. The N1 interface is the specific interface for the NAS protocol between the network **106** and the UE **102**.

[0041] The first PDU session release request message is included in a first Session Management (SM) container along with the PDU session ID. The first SM container is also referred to as N1 SM container in the present disclosure. The first SM container is a containerized environment configured to perform session management, such as session setup, authentication, authorization, policy enforcement, and session

termination. The PDU session ID is a unique identifier assigned to each PDU session established between the UE **102** and the network **106**.

[0042] On receiving the first PDU session release request message, the RAN **204** forwards the first PDU session release request message to the AMF **206**. The AMF **206** is configured to handle access authentication, mobility management, and security functions for the UE **102** accessing the network **106**. The AMF unit **206** is configured to, but not limited to, access authentication, registration management, mobility management, session management, security functions, policy enforcement, and interworking with legacy networks.

[0043] The first PDU session release request message is forwarded with an indication of User Location Information (ULI) to the AMF **206**. The ULI refers to the data related to the geographical position of the UE **102** within the network **106** coverage area.

[0044] In an embodiment, the first SM container is transmitted from the RAN unit **204** to the AMF unit **206**. The first SM container includes the first PDU session release request message and a second SM container. The second SM container is a containerized environment responsible for session management functionalities such as session setup, mobility management, Quality of Service (QoS) enforcement, and session release specific to the radio access network. The second SM container is referred to as N2 SM container in the present disclosure.

[0045] Upon receiving the first and the second SM containers, the AMF **206** determines if the PDU session ID is available within each of the first and the second SM containers. If the PDU session ID is present, then the PDU session ID is accepted by the AMF **206**. If the PDU session ID is not available in each of the first and second SM containers, the PDU session ID will be rejected.

[0046] Upon determining the availability of the PDU session ID, the AMF **206** creates and transmits an update SM request message to the SMF **208**. The SMF **208** is

configured to establish, manage, and terminate sessions. The SMF unit **208** is further configured to, but is not limited to, user session establishment, mobility management, Quality of Service (QoS) enforcement, policy enforcement, session termination and charging and billing.

**[0047]** The update SM request message is created using at least one network protocol connection. The at least one network protocol connection includes, but not limited to, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), File Transfer Protocol (FTP), Hypertext Transfer Protocol (HTTP), Simple Network Management Protocol (SNMP), Internet Control Message Protocol (ICMP), Hypertext Transfer Protocol Secure (HTTPS) and Terminal Network (TELNET). Further, the update SM request message includes each of the first and the second containers and the PDU session ID.

**[0048]** Upon receiving the update SM request message, at the SMF **208**, the PDU session release is initiated and deleted from upper functions by the SMF **208**. In response, the update SM response message i.e., the PDU session release response message, along with the first SM container and the second SM container is transmitted to the AMF **206**. The upper function refers to the network function that initiates or manages the release of the PDU session. Typically, the upper function could be the SMF **208**. The SMF **208** initiate the release of the PDU session in response to the updated SM request message. Upon releasing the PDU session by the SMF **208**, the AMF **206** initiates or coordinates the release of the PDU session.

**[0049]** Thereafter, the AMF **206** transmits the PDU session release response message including the first and second SM containers to the RAN **204**. The first SM container includes a PDU session release command, and the second SM container includes a PDU session resource release command transfer.

**[0050]** The PDU session release command is a command used in the network **106**. In particular, when the PDU session is no longer needed or when the UE **102** is

deactivating or detaching from the network **106**, a release command is sent to terminate the PDU session. The PDU session resource release command transfer refers to the process of releasing resources associated with the PDU session in a mobile network. This command is typically exchanged between network elements to initiate the release of resources allocated for a specific PDU session. More specifically, when the PDU session is irrelevant, i.e., when the UE **102** is deactivating or detaching from the network **106**, the network **106** initiates the release of resources associated with the respective PDU session. The network **106** deallocates IP addresses, releasing bearer resources, and freeing up other network resources that were allocated for the session.

**[0051]** Upon receiving the PDU session release response message, the RAN **204** transmits the first SM container including the PDU session release command to the UE **102**. Subsequently, the RAN **204** will respond utilizing the second SM container including the PDU session resource release command transfer to the AMF **208**. The RAN **204** will respond to the AMF **208** with the second SM container including a PDU session resource release response transfer.

**[0052]** Upon receiving the response, the AMF **206** transmits the update SM including the second SM container to the SMF **208**. On receipt of the update SM request, the SMF **208** transmits an acknowledgment response to the AMF **206**.

**[0053]** Subsequently, the UE **102** will respond back to the AMF **206** via the RAN **204** with the first SM container including a PDU session release complete message.

**[0054]** On receiving the PDU session release complete message, the AMF **206** transmits the PDU session release complete message including the first SM container to the SMF **208**. On receipt of the PDU session release complete message, the SMF **208** transmits an acknowledgment response of receiving the PDU session release complete message to the AMF **206**. Upon receiving the acknowledgement response, the AMF **206** deletes the PDU session ID.

[0055] Upon transmitting the acknowledgement response, the SMF **208** transmits a notify request to the AMF **206**. The notify request is to notify the AMF **206** that the SM context for this PDU session is released. Thereafter, the AMF **206** will respond with an acknowledgement response to the notify request at the SMF **208**. The notify request notifies that the release of the PDU session ID is successful. Accordingly, the PDU session ID is deleted during the PDU release.

[0056] **FIG. 3** is an exemplary block diagram of the system **108** for deletion of the PDU session ID during the PDU release, according to one or more embodiments of the present invention.

[0057] As per the illustrated embodiment, the system **108** includes one or more processors **302**, a memory **304**, a user interface **306**, and a database **308**. For the purpose of description and explanation, the description will be explained with respect to one processor **302** and should nowhere be construed as limiting the scope of the present disclosure. In alternate embodiments, the system **108** may include more than one processors **302** as per the requirement of the network **106**. The one or more processors **302**, hereinafter referred to as the processor **302** may be implemented as one or more microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, state machines, logic circuitries, single board computers, and/or any devices that manipulate signals based on operational instructions.

[0058] As per the illustrated embodiment, the processor **302** is configured to fetch and execute computer-readable instructions stored in the memory **304**. The memory **304** may be configured to store one or more computer-readable instructions or routines in a non-transitory computer-readable storage medium, which may be fetched and executed to create or share data packets over a network service. The memory **304** may include any non-transitory storage device including, for example, volatile memory such as RAM, or non-volatile memory such as disk memory, EPROMs, FLASH memory, unalterable memory, and the like.

[0059] In an embodiment, the user interface **306** includes a variety of interfaces, for example, interfaces for a graphical user interface, a web user interface, a Command Line Interface (CLI), and the like. The user interface **306** facilitates communication of the system **108**. In one embodiment, the user interface **306** provides a communication pathway for one or more components of the system **108**. Examples of such components include, but are not limited to, the UE **102** and the database **308**.

[0060] The database **308** is one of, but not limited to, a centralized database, a cloud-based database, a commercial database, an open-source database, a distributed database, an end-user database, a graphical database, a No-Structured Query Language (NoSQL) database, an object-oriented database, a personal database, an in-memory database, a document-based database, a time series database, a wide column database, a key value database, a search database, a cache databases, and so forth. The foregoing examples of database **308** types are non-limiting and may not be mutually exclusive e.g., a database can be both commercial and cloud-based, or both relational and open-source, etc.

[0061] In order for the system **108** to delete the PDU session ID during the PDU release, the processor **302** includes one or more modules. In one embodiment, the one or more modules includes, but not limited to, a receiving unit **310**, an updating unit **312**, a transmittal unit **314**, a checking unit **316**, and a deletion unit **318** communicably coupled to each other to delete the PDU session ID during the PDU release.

[0062] In one embodiment, the receiving unit **310** of the system **108** is configured to receive the first PDU session release request message from the UE **102**. The first PDU session release request message is included in the first SM container along with the PDU session ID. The first PDU session release request message is at least one of the N1 message type.

[0063] On receiving the first PDU session release request message, the updating unit **312** updates the received first PDU session release request message. The received first

PDU release request message is updated with the indication of the ULI. Further, the updated PDU release request message is included in the second SM container. More specifically, the updated PDU release request message is stored in the second SM container. The updated PDU release request message is at least one of an N2 message type. The N2 message refers to the messages exchanged over the N2 interface. The N2 interface is the communication between the RAN **204** and the AMF **206**. The N2 messages carry various types of signaling and control information between the RAN **204** and the AMF **206**.

[0064] Upon updating, the first SM container and the second SM container are transmitted by the transmittal unit **314** to the AMF **206** from the RAN **204**.

[0065] On receipt of transmitting of the first and the second SM containers, the AMF **206** checks if the PDU session ID is available within each of the first SM container and the second SM container by using the checking unit **316**. If the PDU session ID is available in each of the first and the second SM containers, then PDU session is accepted. Alternatively, if the PDU session ID is not available within each of the first and the second SM containers, then the PDU session ID is rejected.

[0066] Upon confirming the availability of the PDU session ID within each of the first and the second SM containers, the AMF **206** transmits the update SM request message to the SMF **208**. The update SM request message includes each of the first and the second containers and the PDU session ID. Further, the update SM request message is transmitted to the SMF **208** from the AMF **206** by utilizing at least one network protocol connection, such as, the Hypertext Transfer Protocol 2 (HTTP) protocol.

[0067] On receipt of receiving the update SM request message from the AMF **206**, the SMF **208** deletes the PDU session using the deletion unit **318**. In particular, at the SMF **208**, the PDU session is deleted from the upper function. Thereafter, the update

SM response message, i.e., the PDU session release response message along with the first SM container and the second SM container, is transmitted to the AMF **206**.

[0068] Thereafter, the AMF **206** transmits the PDU session release response message including the first and second SM containers to the RAN **204** by using the transmittal unit **314**. The received first SM container includes the PDU session release command, and the received second SM container includes the PDU session resource release command transfer.

[0069] On receiving the PDU session release response message, the transmittal unit **314** transmits the received first SM container including the PDU session release command from the RAN **204** to the UE **102**. Further, the transmittal unit **314** transmits the received second SM container from the RAN **204** to the SMF **208** via the AMF **206**. The received second SM container includes the PDU session resource release command transfer message. In particular, the RAN **204** will respond to the AMF unit **208** with the second SM container including a PDU session resource release response transfer.

[0070] On receiving the PDU session resource release response transfer, the AMF **206** transmits the update SM including the second SM container to the SMF **208**. On receipt of the update SM request, the SMF **208** transmits the acknowledgment response to the AMF **206**.

[0071] Further, on receiving the PDU session release command, the transmittal unit **314** transmits the first SM container to the SMF **208** from the UE **102** via the AMF **206**. The first SM container includes a message indicating the completion of the PDU session.

[0072] On receipt of receiving the message indicating the completion of the PDU session, the deletion unit **318** deletes the PDU session ID at the AMF **206**. More specifically, on receipt of the PDU session release complete message, the SMF **208** transmits an acknowledgment response to the AMF **206**. Upon transmitting the

acknowledgement response, the SMF **208** transmits the notify request to the AMF **206**. The notify request is to notify the AMF **206** that the SM context for this PDU session is released. Then the AMF **206** will respond with the acknowledgement response to the notify request to the SMF **208**. The notify request notifies that the release of the PDU session ID is successful. Accordingly, the PDU session ID is deleted during the PDU release. By doing so, the system **108** reduces memory space requirement and improves processing speed of the processor **302**.

[0073] FIG. 4 describes a preferred embodiment of the system **108** of FIG. 3, according to various embodiments of the present invention. It is to be noted that the embodiment with respect to FIG. 4 will be explained with respect to the first UE **102a** and the system **108** for the purpose of description and illustration and should nowhere be construed as limited to the scope of the present disclosure.

[0074] As mentioned earlier in FIG.1, each of the first UE **102a** the second UE **102b**, and the third UE **102c** may include an external storage device, a bus, a main memory, a read-only memory, a mass storage device, communication port(s), and a processor. The exemplary embodiment as illustrated in the FIG. 4 will be explained with respect to the first UE **102a**. The first UE **102a** includes one or more primary processors **402** communicably coupled to the one or more processors **302** of the system **108**.

[0075] The one or more primary processors **402** are coupled with a memory unit **404** storing instructions which are executed by the one or more primary processors **402**. Execution of the stored instructions by the one or more primary processors **402** enables the first UE **102a** to transmit the first PDU session release request message to the processor **302**, and the first SM container to the SMF **208**.

[0076] As mentioned earlier in FIG. 3, the one or more processors **302** of the system **108** is configured to delete the PDU session ID using the PDU release. The receiving unit **310** is configured to receive the first PDU session release request message from

the one or more applications hosted by the UE **102** and transmitted to the RAN **204**. The first PDU session release request message is included in the first SM container along with the PDU session ID. The first PDU session release request message is at least one of the N1 message type.

[0077] As per the illustrated embodiment, the system **108** includes the one or more processors **302**, the memory **304**, the user interface **306**, and the database **308**. The operations and functions of the one or more processors **302**, the memory **304**, the user interface **306**, and the database **308** are already explained in **FIG. 3**. For the sake of brevity, a similar description related to the working and operation of the system **108** as illustrated in **FIG. 3** has been omitted to avoid repetition.

[0078] Further, the processor **302** includes the receiving unit **310**, the updating unit **312**, the transmittal unit **314**, the checking unit **316**, and the deletion unit **318**. The operations and functions of the receiving unit **310**, the updating unit **312**, the transmittal unit **314**, the checking unit **316**, and the deletion unit **318** are already explained in **FIG. 3**. Hence, for the sake of brevity, a similar description related to the working and operation of the system **108** as illustrated in **FIG. 3** has been omitted to avoid repetition. The limited description provided for the system **108** in **FIG. 4**, should be read with the description as provided for the system **108** in the **FIG. 3** above, and should not be construed as limiting the scope of the present disclosure.

[0079] **FIG. 5** is a flow diagram of a method **500** for deletion of the PDU session ID during the PDU release, according to one or more embodiments of the present invention. For the purpose of description, the method **500** is described with the embodiments as illustrated in **FIG. 3** and should nowhere be construed as limiting the scope of the present disclosure.

[0080] At step **502**, the method **500** includes the step of receiving the first PDU session release request message from the UE **102** by receiving unit **310**. The first PDU

session release request message is included in the first SM container along with the PDU session ID.

[0081] At step **504**, the method **500** includes the step of updating the received first PDU release request message with the indication of the ULI by the updating unit **312**. The updated PDU release request message is included in the second SM container.

[0082] At step **506**, the method **500** includes the step of transmitting the first SM container and the second SM container to the AMF **206** via the RAN **204** using the transmittal unit **314**.

[0083] At step **508**, the method **500** includes the step of checking if the PDU session ID is available within each of the first SM container and the second SM container using the checking unit **316**.

[0084] At step **510**, the method **500** includes the step of transmitting the update SM request message from the AMF **206** to the SMF **208** using the transmittal unit **314**. The update SM request message includes each of the first and the second containers and the PDU session ID.

[0085] At step **512**, the method **500** includes the step of deleting the PDU session at the SMF **208** on receipt of the update SM request message using the deletion unit **318**. The PDU session is deleted from the upper function and the response message containing the first SM container and the second SM container is transmitted to the AMF **206**.

[0086] Further, the transmittal unit **314** transmits the first SM container and the second SM container to the RAN **204** from the SMF **208** via the AMF **206**. The received first SM container includes the PDU session release command and the second SM container includes the PDU session release command transfer. The transmittal unit **314** is configured to transmit the received first SM container from the RAN **204** to the

UE **102** and the received second SM container from the RAN **204** to the SMF **208** via the AMF **206**.

[0087] Upon transmission of the received first SM container from the RAN **204** to the UE **102**, the transmittal unit **314** transmits the first SM container from the UE **102** to the SMF **208** via the AMF **206**. The first SM container includes a message indicating completion of the PDU session. Hence the deletion unit **318** deleted the PDU session ID at the AMF **206**.

[0088] The present invention further discloses a non-transitory computer-readable medium having stored thereon computer-readable instructions. The computer-readable instructions are executed by the processor **302**. The processor **302** is configured to receive the first PDU session release request message from the UE **102**. The first PDU session release request message is included in the first SM container along with the PDU session ID. The processor **302** is further configured to update the received first PDU release request message with the indication of the ULI. The updated PDU release request message is included in the second SM container. The processor **302** is further configured to transmit the first SM container and the second SM container to the AMF **206** via the RAN **204**.

[0089] The processor **302** is further configured to check if the PDU session ID is available within each of the first SM container and the second SM container. Each of the first and the second SM containers are accepted if the PDU session ID is available therein. The processor **302** is further configured to transmit the update SM request message from the AMF **206** to the SMF **208**. The update SM request message includes each of the first and the second containers and the PDU session ID. The processor **302** is further configured to delete the PDU session at the SMF **208** on receipt of the update SM request message. The PDU session is deleted from the upper function and the response message containing the first SM container and the second SM container is transmitted to the AMF **206**.

[0090] A person of ordinary skill in the art will readily ascertain that the illustrated embodiments and steps in description and drawings (FIG.1-5) are set out to explain the exemplary embodiments shown, and it should be anticipated that ongoing technological development will change the manner in which particular functions are performed. These examples are presented herein for purposes of illustration, and not limitation. Further, the boundaries of the functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternative boundaries can be defined so long as the specified functions and relationships thereof are appropriately performed. Alternatives (including equivalents, extensions, variations, deviations, etc., of those described herein) will be apparent to persons skilled in the relevant art(s) based on the teachings contained herein. Such alternatives fall within the scope and spirit of the disclosed embodiments.

[0091] The present disclosure incorporates technical advancement of optimizing the end transaction part of PDU release procedure. More specifically, by using the present invention the AMF is able to avoid procedure collision or new procedure handling delay or new procedure failure scenarios. The PDU session ID is deleted during the PDU release, thereby reducing memory space requirement, and improving processing speed of the system, which improves user experience of the UE.

[0092] The present invention offers multiple advantages over the prior art and the above listed are a few examples to emphasize on some of the advantageous features. The listed advantages are to be read in a non-limiting manner.

## REFERENCE NUMERALS

|         |                                                 |     |
|---------|-------------------------------------------------|-----|
| [0093]  | Communication System-                           | 100 |
| [0094]  | User Equipment (UE)-                            | 102 |
| [0095]  | Server-                                         | 104 |
| [0096]  | Network-                                        | 106 |
| [0097]  | System -                                        | 108 |
| [0098]  | Radio Access Network (RAN) -                    | 204 |
| [0099]  | Access and Mobility Management Function (AMF) - | 206 |
| [00100] | Session Management Function (SMF) -             | 208 |
| [00101] | Processor-                                      | 302 |
| [00102] | Memory-                                         | 304 |
| [00103] | User Interface-                                 | 306 |
| [00104] | Database-                                       | 308 |
| [00105] | Receiving Unit-                                 | 310 |
| [00106] | Updating Unit-                                  | 312 |
| [00107] | Transmittal Unit-                               | 314 |
| [00108] | Checking Unit-                                  | 316 |
| [00109] | Deletion Unit-                                  | 318 |
| [00110] | Primary processor-                              | 402 |
| [00111] | Memory-                                         | 404 |

We claim:

1. A method (500) for deletion of a Packet Data Unit (PDU) session ID during a PDU release, the method (500) comprises the steps of:
  - receiving, by a processor (302), a first PDU session release request message from a User Equipment (UE) (102), wherein the first PDU session release request message is included in a first Session Management (SM) container along with a PDU session ID;
  - updating, by the processor (302), the received first PDU release request message with an indication of a User Location Information (ULI), wherein the updated PDU release request message is included in a second SM container;
  - transmitting, by the processor (302), the first SM container and the second SM container to an Access and Mobility Management Function (AMF) (206) via a Radio Access Network (RAN) (204);
  - checking, by the processor (302), if the PDU session ID is available within each of the first SM container and the second SM container, wherein each of the first and the second SM containers are accepted if the PDU session ID is available therein;
  - transmitting, by the processor (302), an update SM request message from the AMF (206) to Session Management Function (SMF) (208), the update SM request message includes each of the first and the second containers and the PDU session ID; and
  - deleting, by the processor (302), a PDU session at the SMF (208) on receipt of the update SM request message, wherein on deletion, the PDU session is deleted from an upper function and a response message containing the first SM container and the second SM container is transmitted to the AMF (206).
2. The method (500) as claimed in claim 1, wherein the method comprises the steps of:
  - transmitting, by the processor (302), the first SM container and the second SM container to the RAN (204) from the SMF (208) via the AMF (204), wherein

the received first SM container includes a PDU session release command and the second SM container includes a PDU session release command transfer;

transmitting, by the processor (302), the received first SM container from the RAN (204) to the UE (102); and

transmitting, by the processor (302), the received second SM container from the RAN (204) to the SMF (208) via the AMF (206), wherein the received second SM container includes the PDU session resource release response transfer message.

3. The method (500) as claimed in claim 2, wherein on transmission of the received first SM container from the RAN (204) to the UE (102), the processor (302) is configured to perform the step of:

transmitting, the first SM container from the UE (102) to the SMF (208) via the AMF (206), wherein the first SM container includes a message indicating completion of the PDU session; and

deleting the PDU session ID at the AMF (206).

4. The method (500) as claimed in claim 1, wherein the first PDU session release request message is at least one of an N1 message type and the updated PDU release request message is at least one of an N2 message type.
5. The method (500) as claimed in claim 1, wherein the update SM request message is transmitted to the SMF (208) from the AMF (206) utilizing at least one communication protocol, such as, at least one of a Hypertext Transfer Protocol 2 (HTTP) protocol.
6. The method (500) as claimed in claim 1, wherein each of the first and the second SM container is a N1 SM container and a N2 SM container, respectively.
7. A User Equipment (UE) (102), comprising:

one or more primary processors (402) coupled with a memory (404), wherein said memory (404) stores instructions which when executed by the one or more primary processors (402) causes the UE (102) to:

transmit, a first Packet Data Unit (PDU) session release request message to a processor (402); and

transmit, a first Session Management (SM) container to a Session Management Function (SMF),

wherein the processor (402) is further configured to perform the method (500) as claimed in claim 1.

8. A system (108) for deletion of a Packet Data Unit (PDU) Session ID during a PDU release, the system (108) comprising:

a receiving unit (310) configured to receive, a first PDU session release request message from a User Equipment (UE) (102), wherein the first PDU session release request message is included in a first Session Management (SM) container along with the PDU session ID;

an updating unit (312) configured to update, the received first PDU release request message with an indication of a User Location Information (ULI), wherein the updated PDU release request message is included in a second SM container;

a transmittal unit (314) configured to transmit, the first SM container and the second SM container to an Access and Mobility Management Function (AMF) (206) via a Radio Access Network (RAN) (204);

a checking unit (316) configured to check, if a PDU session ID is available within each of the first SM container and the second SM container, wherein each of the first and the second SM containers are accepted if the PDU session ID is available therein;

the transmittal unit (314) configured to transmit, an update SM request message from the AMF (206) to the SMF (208), the update SM request

message includes each of the first and the second containers and the PDU session ID; and

a deletion unit (318) configured to delete, a PDU session at the SMF (208) on receipt of the update SM request message, wherein on deletion, the PDU session is deleted from an upper function and a response message containing the first SM container and the second SM container is transmitted to the AMF (206).

9. The system (108) as claimed in claim 8, wherein the transmittal unit (314) is configured to:

transmit, the first SM container and the second SM container to the RAN (204) from the SMF (208) via the AMF (206), wherein the received first SM container includes the PDU session release command and the second SM container includes the PDU session release command transfer;

transmit, the received first SM container from the RAN (204) to the UE (102); and

transmit, the received second SM container from the RAN (204) to the SMF (208) via the AMF (206), wherein the received second SM container includes the PDU session resource release response transfer message included therein.

10. The system (108) as claimed in claim 8, wherein, on transmission of the received first SM container from the RAN (204) to the UE (102),:

the transmittal unit (314) is configured to transmit, the first SM container from the UE (102) to the SMF (208) via the AMF (206), wherein the first SM container includes a message indicating completion of the PDU session; and

the deletion unit (318) is configured to delete, the PDU session ID at the AMF (206).

11. The system (108) as claimed in claim 8, wherein the first PDU session release request message is at least one of an N1 message type and the updated PDU release request message is at least one of an N2 message type.
12. The system (108) as claimed in claim 8, wherein the update SM request message is transmitted to the SMF from the AMF utilizing at least one communication protocol, such as, a Hypertext Transfer Protocol 2 (HTTP) protocol.
13. The system (108) as claimed in claim 8, wherein each of the first and the second SM container is a N1 SM container and a N2 SM container, respectively.
14. A non-transitory computer-readable medium having stored thereon computer-readable instructions that, when executed by a processor, causes the processor (302) to:
  - receive, a first Packet Data Unit (PDU) session release request message from a User Equipment (UE) (102), wherein the first PDU session release request message is included in a first Session Management (SM) container along with the PDU session ID;
  - update, the received first PDU release request message with an indication of a User Location Information (ULI), wherein the updated PDU release request message is included in a second SM container;
  - transmit, the first SM container and the second SM container to an Access and Mobility Management Function (AMF)(206) via a Radio Access Network (RAN) (204);
  - check, by the processor (302), if a PDU session ID is available within each of the first SM container and the second SM container, wherein each of the first and the second SM containers are accepted if the PDU session ID is available therein;
  - transmit, an update SM request message from the AMF (206) to the Session Management Function (SMF) (208), the update SM request message

includes each of the first and the second containers and the PDU session ID;  
and

delete, a PDU session at the SMF (208) on receipt of the update SM request message, wherein on deletion, the PDU session is deleted from an upper function and a response message containing the first SM container and the second SM container is transmitted to the AMF (206).

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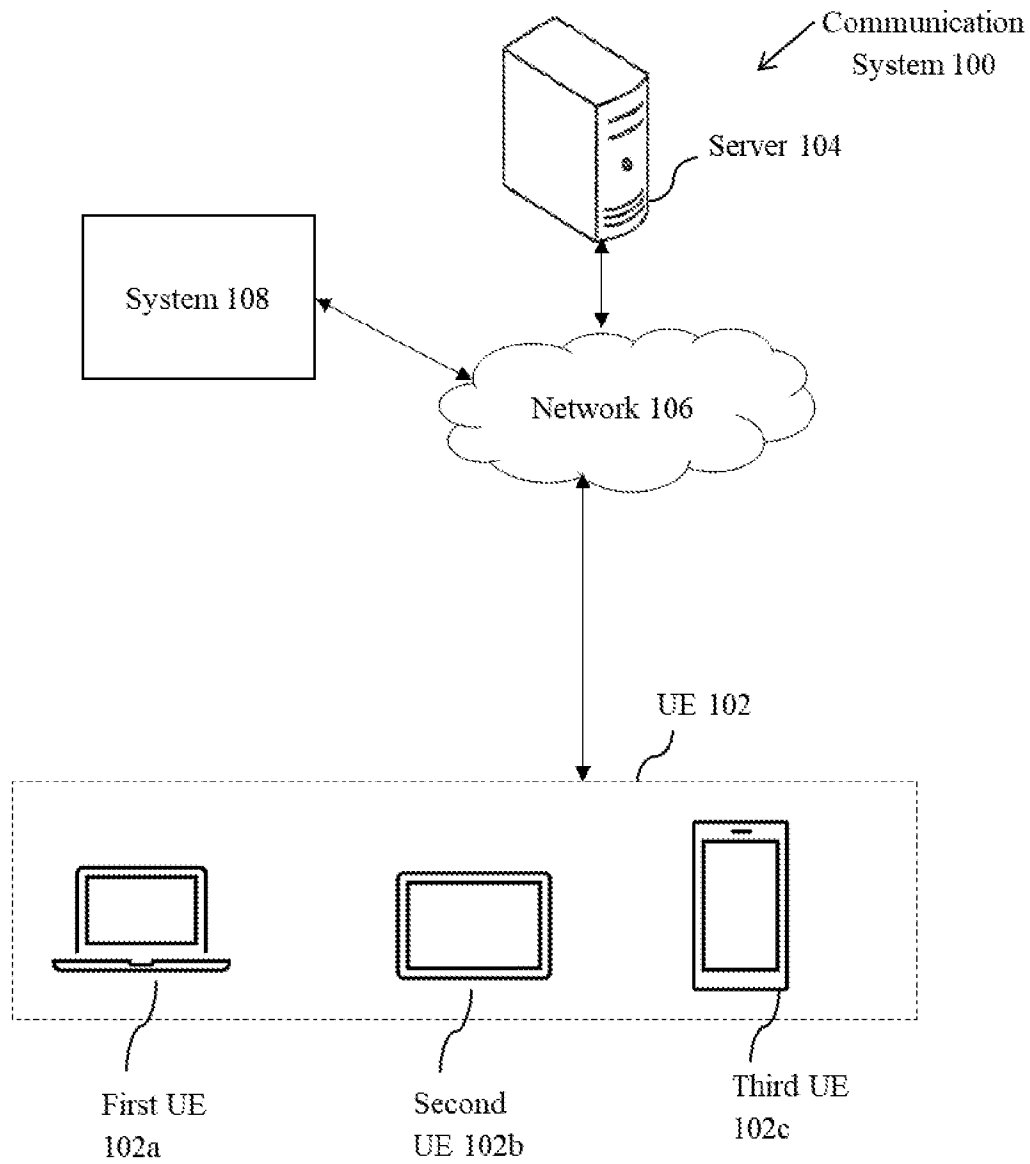


FIG. 1

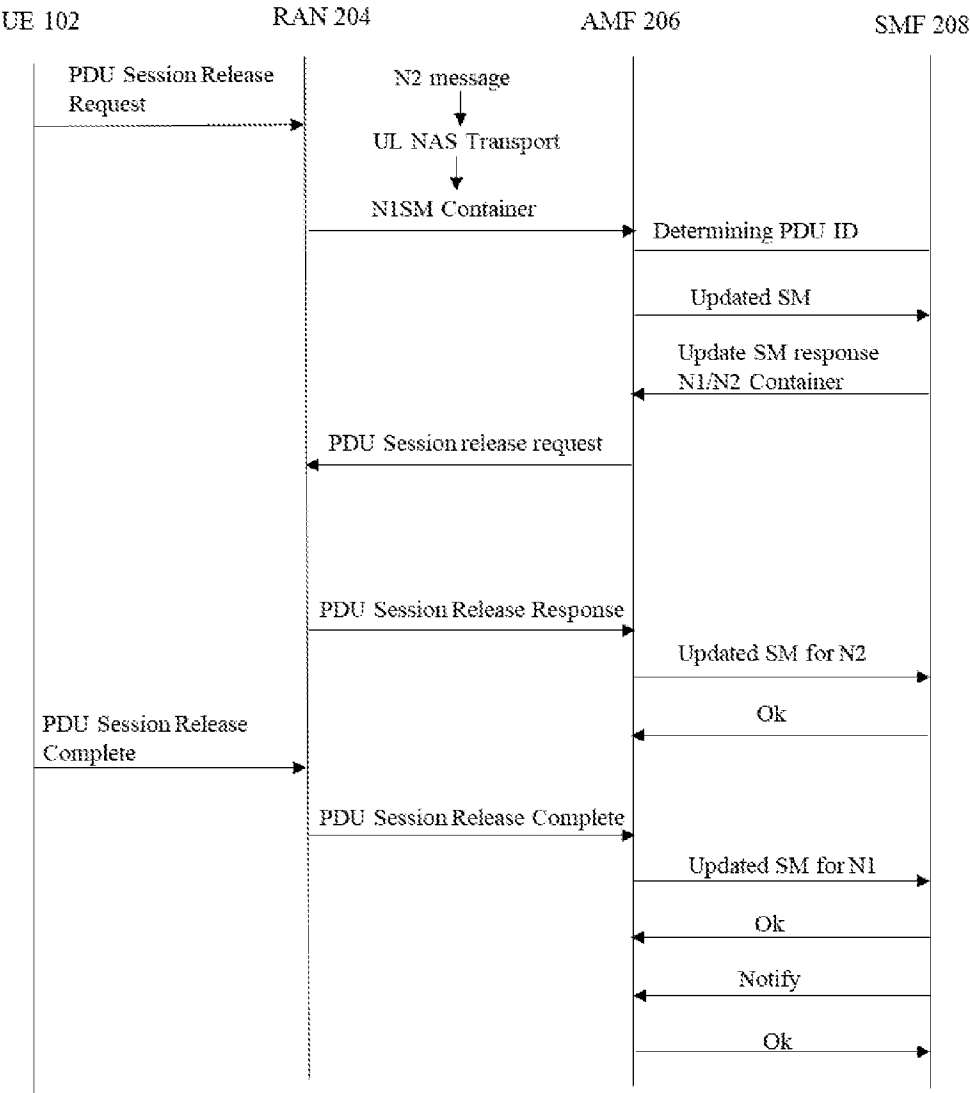


FIG. 2

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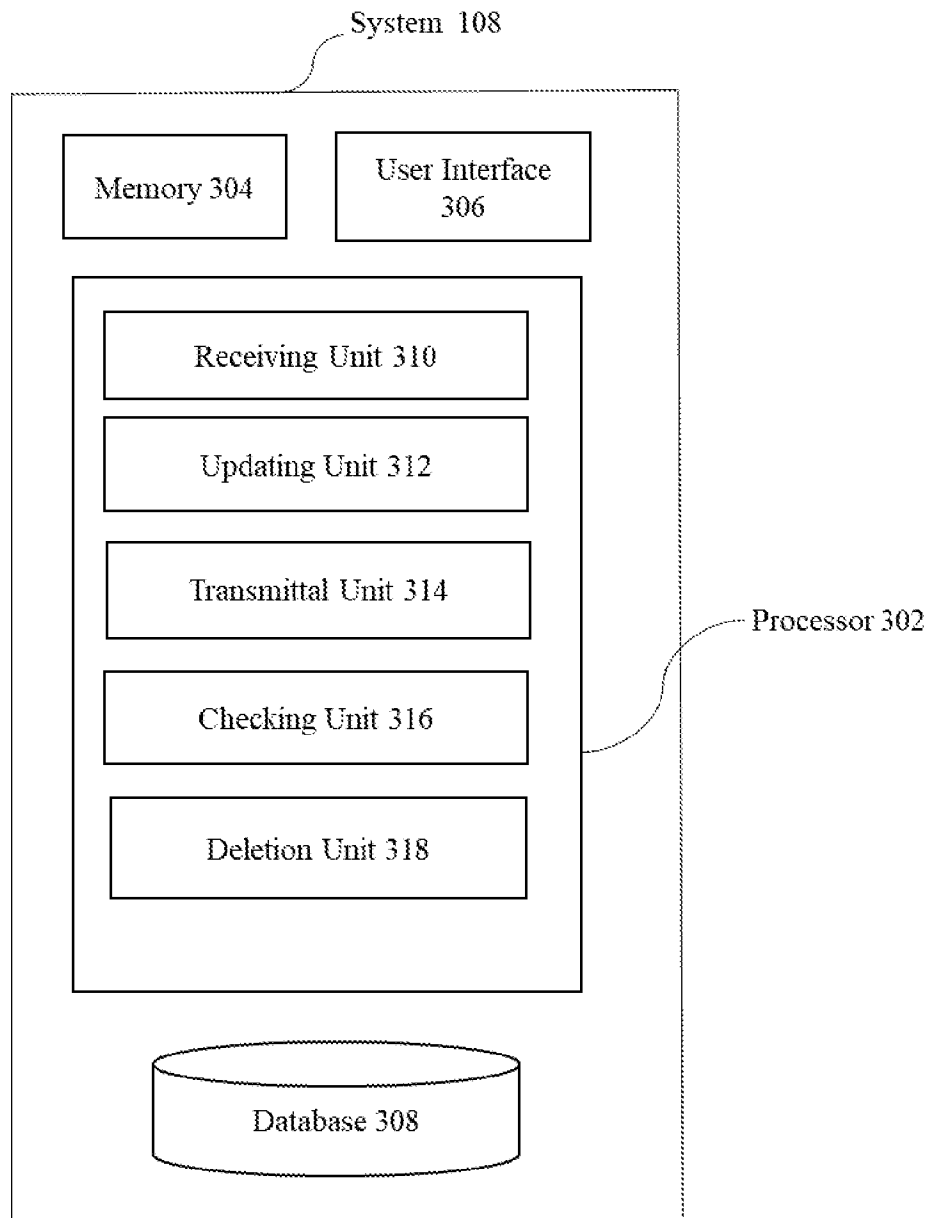


FIG.3

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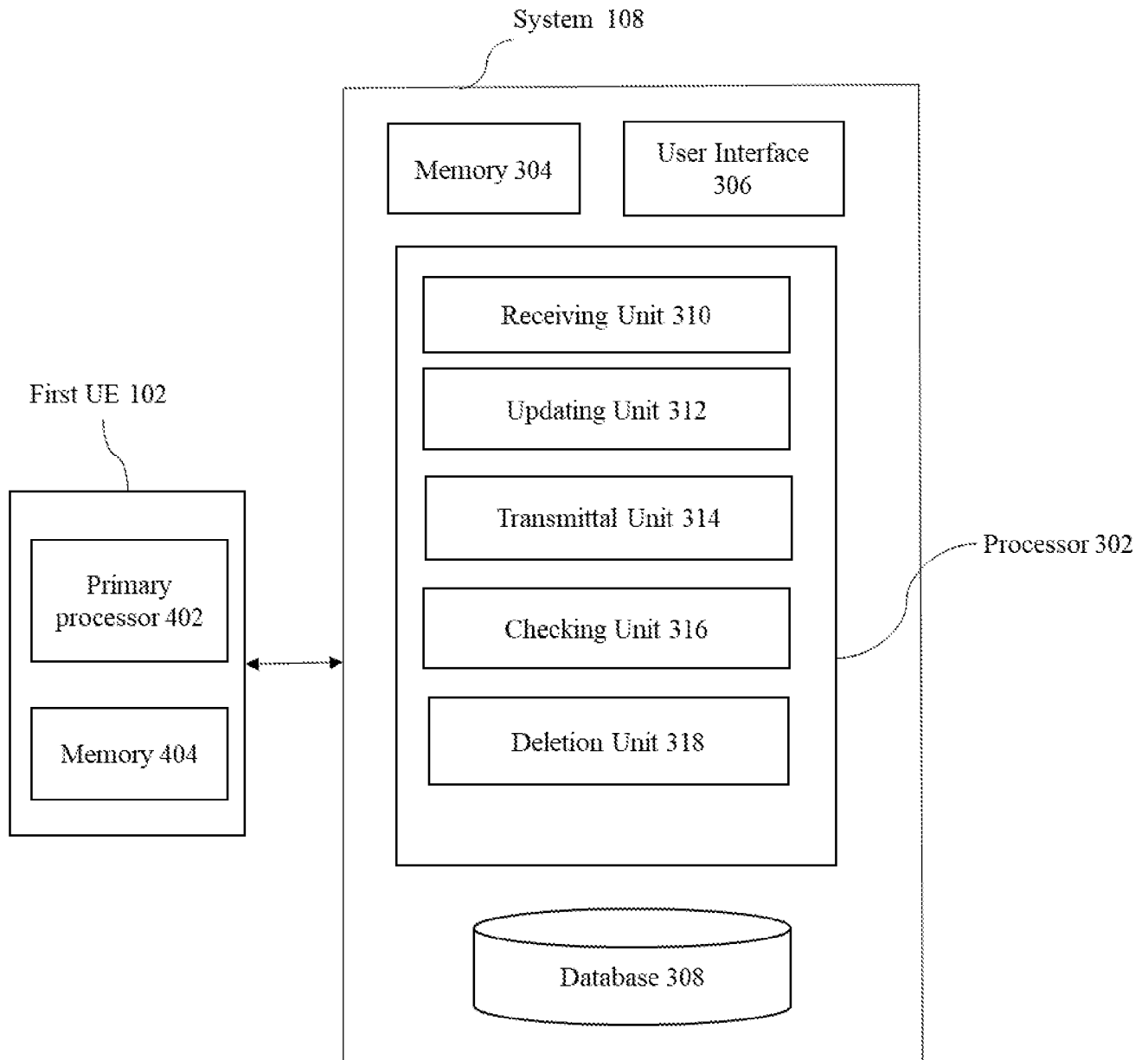


FIG.4

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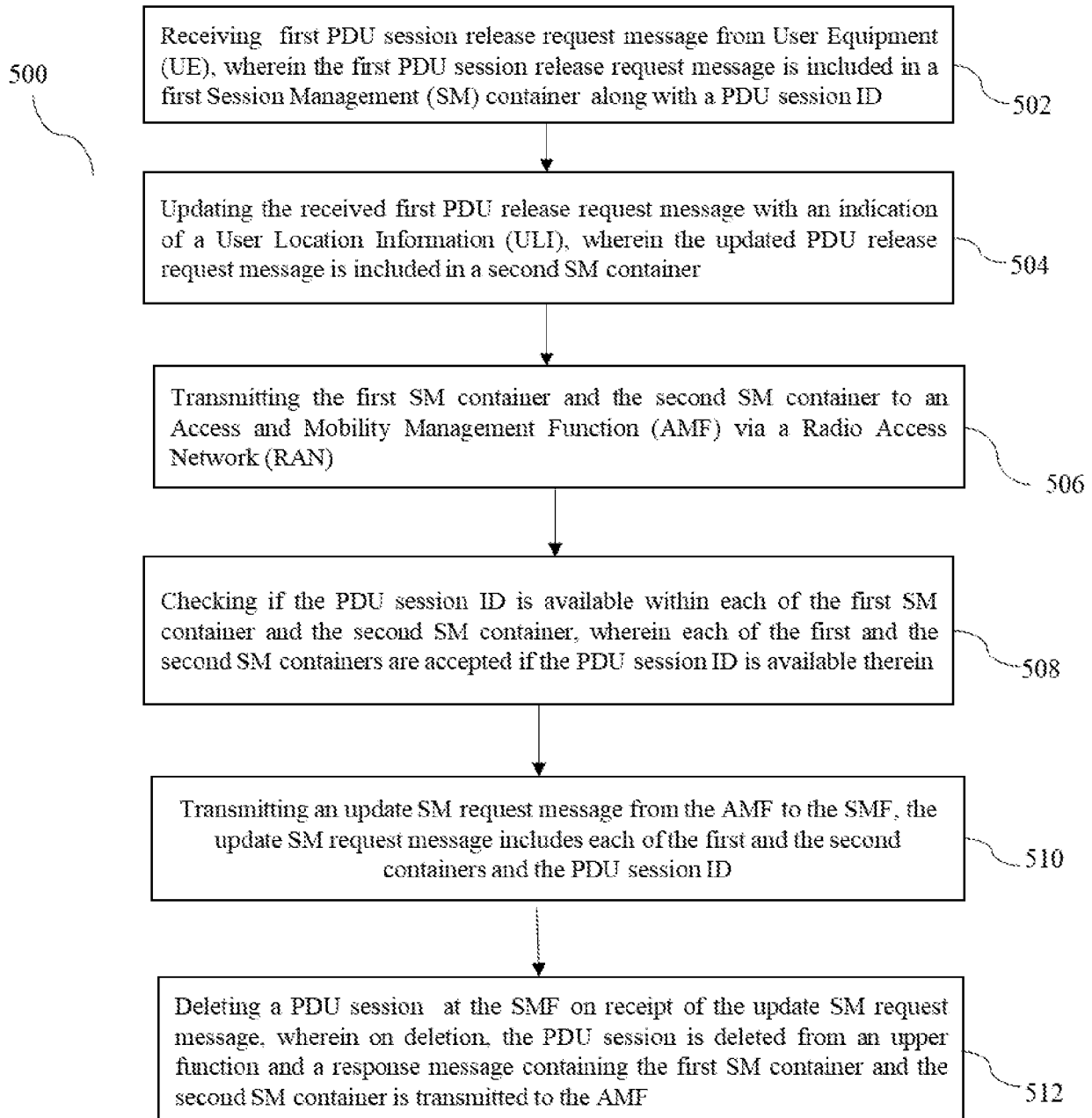


FIG. 5

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IN2024/050929

## A. CLASSIFICATION OF SUBJECT MATTER

H04W76/10, H04W80/10, H04W76/30 Version=2024.01

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W

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

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

Databases- PatSeer, IPO Internal Database

Searched Keyword - Deletion, PDU, location, AMF, Session ID, Container

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                               | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | US 20220132454 A1 (LG ELECTRONICS INC.),<br>28-04-2022 (24 April, 2022) Whole Document                                                                                                                                                           | 1-14                  |
| A         | US 20180198867 A1 (HUAWEI TECHNOLOGIES CO LTD ),<br>12-07-2018 (12 July, 2018) Whole Document                                                                                                                                                    | 1-14                  |
| A         | 3rd Generation Partnership Project; Technical<br>Specification Group Core Network and Terminals;<br>5G System; Session Management Services; Stage 3<br>(Release 15) (3GPP TS 29.502 V15.9.0), 25-09-2020<br>(25 September, 2020) Section 5.2.2.8 | 1-14                  |



Further documents are listed in the continuation of Box C.



See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

28-10-2024

Date of mailing of the international search report

28-10-2024

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT  
Information on patent family members

International application No.  
PCT/IN2024/050929

| Citation          | Pub.Date   | Family           | Pub.Date   |
|-------------------|------------|------------------|------------|
| US 20220132454 A1 | 28-04-2022 | EP 4395451 A3    | 10-07-2024 |
|                   |            | CN 113574962 B   | 13-02-2024 |
|                   |            | WO 2020184956 A1 | 17-09-2020 |
| US 20180198867 A1 | 12-07-2018 | WO 2018127191 A1 | 12-07-2018 |
|                   |            | JP 6896850 B2    | 30-06-2021 |
|                   |            | CN 113225782 B   | 29-04-2022 |