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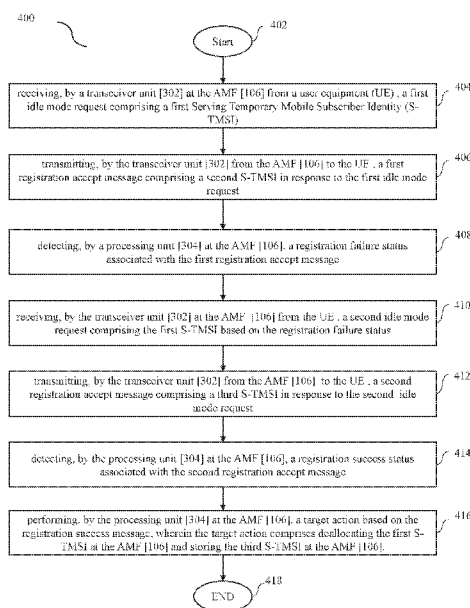


FIG. 4

(57) Abstract: The present disclosure relates to a method and a system for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF). The method comprising receiving, by a transceiver unit [302], a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI); transmitting, by the transceiver unit [302], a first registration accept message comprising a second S-TMSI; detecting, by a processing unit [304], a registration failure status; receiving, by the transceiver unit [302], a second idle mode request comprising the first S-TMSI; transmitting, by the transceiver unit [302], a second registration accept message comprising a third S-TMSI; detecting, by the processing unit [304], a registration success status; and performing, by the processing unit [304], a target action comprising deallocating the first S-TMSI at the AMF [106] and storing the third S-TMSI at the AMF [106].

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METHOD AND SYSTEM FOR PERFORMING TIMEOUT HANDLING IN IDLE MODE PROCEDURE

TECHNICAL FIELD

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[0001] Embodiments of the present disclosure generally relate to network performance management systems. More particularly, embodiments of the present disclosure relate to methods and systems for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF).

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BACKGROUND

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[0002] The following description of the related art is intended to provide background information pertaining to the field of the disclosure. This section may include certain aspects of the art that may be related to various features of the present disclosure. However, it should be appreciated that this section is used only to enhance the understanding of the reader with respect to the present disclosure, and not as admissions of the prior art.

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[0003] Wireless communication technology has rapidly evolved over the past few decades, with each generation bringing significant improvements and advancements. The first generation of wireless communication technology was based on analog technology and offered only voice services. However, with the advent of the second-generation (2G) technology, digital communication and data services became possible, and text messaging was introduced. 3G technology marked the introduction of high-speed internet access, mobile video calling, and location-based services. The fourth-generation (4G) technology revolutionized wireless communication with faster data speeds, better network coverage, and improved security. Currently, the fifth generation (5G) technology is being deployed, promising even faster data speeds, low latency, and the ability to connect multiple devices simultaneously. With each generation, wireless communication technology has become more advanced, sophisticated, and capable of delivering more services to its users.

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[0004] Further, in the field of wireless communication technology, a registration process involves the User Equipment (UE) signalling its presence and capabilities to the network. This registration process generally involves transmission of an initial registration request from the UE to the network and transmission of acceptance or rejection to the request from the network to the UE.

The registration completes when both the UE and the network exchange necessary messages to establish the UE's connection to the network. However, if the network does not receive the expected registration complete message from the UE within a predefined time frame after sending the registration acceptance message, it indicates a failure in the registration process. This type of failure may be due to various reasons such as communication errors, decoding issues, or network congestion.

[0005] Furthermore, the network follows a specific procedure when the UE fails to complete the registration process. Initially, when the UE initiates an Idle mode procedure to transition to the connected state, the Access and Mobility Management Function (AMF) allocates a new S-Temporary Mobile Subscriber Identity (S-TMSI) in the registration accept message.

[0006] However, if the UE does not receive the registration accept message or encounters decoding errors, it does not acquire the new S-TMSI. Consequently, the AMF retains both the old and new S-TMSI, as it awaits the Registration Complete message from the UE.

[0007] When the UE retries the Idle mode procedure with the older S-TMSI, the standard requirement mandates the AMF to deliver the newer S-TMSI using a Configuration Update Command (CUC) before processing the new Idle mode procedure. However, this action of sending CUC before registration or service acceptance does not serve any practical purpose and only adds unnecessary signalling messages to the existing call flow. This inefficiency leads to the wastage of resources, burdens the network with futile transactions, and causes delays for the UE.

[0008] Therefore, there is a need to provide a method and system for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF).

SUMMARY

[0009] This section is provided to introduce certain aspects of the present disclosure in a simplified form that are further described below in the detailed description. This summary is not intended to identify the key features or the scope of the claimed subject matter.

[0010] An aspect of the present disclosure may relate to a method for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF). The method comprises receiving, by a transceiver unit at the AMF from a user equipment (UE), a first idle

mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI). The method comprises transmitting, by the transceiver unit from the AMF to the UE, a first registration accept message comprising a second S-TMSI in response to the first idle mode request. The method comprises detecting, by a processing unit at the AMF, a registration failure status associated with the first registration accept message. The method comprises receiving, by the transceiver unit at the AMF from the UE, a second idle mode request comprising the first S-TMSI based on the registration failure status. The method comprises transmitting, by the transceiver unit from the AMF to the UE, a second registration accept message comprising a third S-TMSI in response to the second idle mode request. The method comprises detecting, by the processing unit at the AMF, a registration success status associated with the second registration accept message. The method comprises performing, by the processing unit at the AMF, a target action based on the registration success message, wherein the target action comprises deallocating the first S-TMSI at the AMF and storing the third S-TMSI at the AMF.

[0011] In an exemplary aspect of the present disclosure, each of the first idle mode request and the second idle mode request is one of a Mobility Request (MR), a Periodic Request (PR) and a Service Request (SR).

[0012] In an exemplary aspect of the present disclosure, the registration failure status is detected by the processing unit at the AMF, in an event, receiving by the UE the first registration accept message is unsuccessful.

[0013] In an exemplary aspect of the present disclosure, the receiving by the processing unit at the AMF from the UE the second idle mode request comprising the first S-TMSI based on the registration failure status further comprises at least deallocating by the processing unit the second S-TMSI at the AMF and allocating the third S-TMSI by the AMF based on deallocating the second S-TMSI at the AMF.

[0014] In an exemplary aspect of the present disclosure, detecting by the processing unit at the AMF the registration success status associated with the second registration accept message further comprises detecting at the AMF deallocation of the first S-TMSI from the UE and storing the third S-TMSI at the UE based on transmitting the second registration accept message.

[0015] Another aspect of the present disclosure may relate to a system for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF). The

system comprises a transceiver unit configured to receive, at the AMF from a user equipment (UE), a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI). The transceiver unit is further configured to transmit, from the AMF to the UE, a first registration accept message comprising a second S-TMSI in response to the first idle mode request.

- 5 The system comprises of a processing unit that is connected to the transceiver unit and the processing unit is configured to detect, at the AMF, a registration failure status associated with the first registration accept message. The transceiver unit is further configured to receive, at the AMF from the UE, a second idle mode request comprising the first S-TMSI based on the registration failure status associated with the first registration accept message. The transceiver unit is further
10 configured to transmit, from the AMF to the UE, a second registration accept message comprising a third S-TMSI in response to the second idle mode request. The processing unit is configured to detect, at the AMF, a registration success status associated with the second registration accept message. The processing unit is configured to perform, at the AMF, a target action based on the registration success message, wherein the target action comprises deallocating the first S-TMSI at
15 the AMF and storing the third S-TMSI at the AMF.

[0016] Yet another aspect of the present disclosure may relate to a user equipment for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF), the user equipment comprises: a memory; a processor coupled to the memory, the
20 processor is configured to transmitting, to a system, a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI), receiving, from the system a first registration accept message comprising a second S-TMSI in response to the first idle mode request, transmitting, to the system, a second idle mode request comprising the first S-TMSI based on a registration failure status, receiving, from the system, a second registration accept message
25 comprising a third S-TMSI in response to the second idle mode request, and detecting, a target action performance based on a registration success message, wherein the target action comprises deallocating the first S-TMSI at the AMF and storing the third S-TMSI at the AMF.

[0017] Yet another aspect of the present disclosure may relate to a non-transitory computer
30 readable storage medium storing instructions for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF), the instructions include executable code which, when executed by a one or more units of a system, causes: a transceiver unit of the system to receive from a user equipment (UE), a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI), the transceiver unit to transmit to
35 the UE, a first registration accept message comprising a second S-TMSI in response to the first

idle mode request, a processing unit of the system to detect, a registration failure status associated with the first registration accept message, the transceiver unit of the system to receive from the UE, a second idle mode request comprising the first S-TMSI based on the registration failure status, the transceiver unit of the system to transmit to the UE, a second registration accept message comprising a third S-TMSI in response to the second idle mode request, the processing unit of the system to detect, a registration success status associated with the second registration accept message, and the processing unit of the system to perform, a target action based on the registration success message, wherein the target action comprises deallocating the first S-TMSI at the AMF and storing the third S-TMSI at the AMF.

10 OBJECTS OF THE INVENTION

[0018] Some of the objects of the present disclosure, which at least one embodiment disclosed herein satisfies are listed herein below.

15 [0019] It is an object of the present disclosure to provide a method and system for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF).

20 [0020] It is another object of the present disclosure to provide a method and system for enhancing the efficiency of the idle mode procedure handling within the network by eliminating unnecessary signalling transactions.

[0021] It is another object of the present disclosure to provide a method and system for optimizing one or more signalling resources by reducing the burden on the network infrastructure.

25 [0022] It is yet another object of the present disclosure to provide a method and system for saving one or more network resources, including bandwidth and processing power, by eliminating redundant signalling messages.

30 DESCRIPTION OF THE DRAWINGS

[0023] 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. Also, the embodiments shown in the figures are not to be construed as limiting the disclosure, but the possible variants of the method and system according to the disclosure are illustrated herein to highlight the advantages of the disclosure. It will be appreciated by those skilled in the art that disclosure of such drawings includes disclosure of electrical components or circuitry commonly used to implement such components.

[0024] FIG. 1 illustrates an exemplary block diagram representation of 5th generation core (5GC) network architecture.

[0025] FIG. 2 illustrates an exemplary block diagram of a computing device upon which the features of the present disclosure may be implemented in accordance with exemplary implementation of the present disclosure.

[0026] FIG. 3 illustrates an exemplary block diagram of a system for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF), in accordance with exemplary implementations of the present disclosure.

[0027] FIG. 4 illustrates a method flow diagram for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF) in accordance with exemplary implementations of the present disclosure.

[0028] FIG. 5 illustrates an exemplary sequence flow diagram [500] of the method for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF) in accordance with exemplary implementations of the present disclosure.

[0029] The foregoing shall be more apparent from the following more detailed description of the disclosure.

DETAILED DESCRIPTION

[0030] In the following description, for the purposes of explanation, various specific details are set forth in order to provide a thorough understanding of embodiments of the present disclosure. It will be apparent, however, that embodiments of the present disclosure may be practiced without these specific details. Several features described hereafter may each be used independently of one

another or with any combination of other features. An individual feature may not address any of the problems discussed above or might address only some of the problems discussed above.

5 [0031] The ensuing description provides exemplary embodiments only, and is not intended to limit the scope, applicability, or configuration of the disclosure. Rather, the ensuing description of the exemplary embodiments will provide those skilled in the art with an enabling description for implementing an exemplary embodiment. It should be understood that various changes may be made in the function and arrangement of elements without departing from the spirit and scope of the disclosure as set forth.

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[0032] Specific details are given in the following description to provide a thorough understanding of the embodiments. However, it will be understood by one of ordinary skill in the art that the embodiments may be practiced without these specific details. For example, circuits, systems, processes, and other components may be shown as components in block diagram form in order not to obscure the embodiments in unnecessary detail.

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[0033] Also, it is noted that individual embodiments may be described as a process which is depicted as a flowchart, a flow diagram, a data flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations may be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed but could have additional steps not included in a figure.

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[0034] The word “exemplary” and/or “demonstrative” is used herein to mean serving as an example, instance, or illustration. For the avoidance of doubt, the subject matter disclosed herein is not limited by such examples. In addition, any aspect or design described herein as “exemplary” and/or “demonstrative” is not necessarily to be construed as preferred or advantageous over other aspects or designs, nor is it meant to preclude equivalent exemplary structures and techniques known to those of ordinary skill in the art. Furthermore, to the extent that the terms “includes”, “has,” “contains,” and other similar words are used in either the detailed description or the claims, such terms are intended to be inclusive—in a manner similar to the term “comprising” as an open transition word—without precluding any additional or other elements.

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[0035] As used herein, a “processing unit” or “processor” or “operating processor” includes one or more processors, wherein processor refers to any logic circuitry for processing instructions. A

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processor may be a general-purpose processor, a special purpose processor, a conventional processor, a digital signal processor, a plurality of microprocessors, one or more microprocessors in association with a (Digital Signal Processing) DSP core, a controller, a microcontroller, Application Specific Integrated Circuits, Field Programmable Gate Array circuits, any other type of integrated circuits, etc. The processor may perform signal coding data processing, input/output processing, and/or any other functionality that enables the working of the system according to the present disclosure. More specifically, the processor or processing unit is a hardware processor.

[0036] As used herein, “a user equipment”, “a user device”, “a smart-user-device”, “a smart-device”, “an electronic device”, “a mobile device”, “a handheld device”, “a wireless communication device”, “a mobile communication device”, “a communication device” may be any electrical, electronic and/or computing device or equipment, capable of implementing the features of the present disclosure. The user equipment/device may include, but is not limited to, a mobile phone, smart phone, laptop, a general-purpose computer, desktop, personal digital assistant, tablet computer, wearable device or any other computing device which is capable of implementing the features of the present disclosure. Also, the user device may contain at least one input means configured to receive an input from at least one of a transceiver unit, a processing unit, a storage unit, a detection unit and any other such unit(s) which are required to implement the features of the present disclosure.

[0037] As used herein, “storage unit” or “memory unit” refers to a machine or computer-readable medium including any mechanism for storing information in a form readable by a computer or similar machine. For example, a computer-readable medium includes read-only memory (“ROM”), random access memory (“RAM”), magnetic disk storage media, optical storage media, flash memory devices or other types of machine-accessible storage media. The storage unit stores at least the data that may be required by one or more units of the system to perform their respective functions.

[0038] As used herein “interface” or “user interface refers to a shared boundary across which two or more separate components of a system exchange information or data. The interface may also be referred to a set of rules or protocols that define communication or interaction of one or more modules or one or more units with each other, which also includes the methods, functions, or procedures that may be called.

[0039] All modules, units, components used herein, unless explicitly excluded herein, may be software modules or hardware processors, the processors being a general-purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASIC), Field Programmable Gate Array circuits (FPGA), any other type of integrated circuits, etc.

[0040] As used herein the transceiver unit include at least one receiver and at least one transmitter configured respectively for receiving and transmitting data, signals, information or a combination thereof between units/components within the system and/or connected with the system.

[0041] As discussed in the background section, that in wireless communication networks, the registration process involves the User Equipment (UE) signalling its presence and capabilities to the network. The registration process is completed when both parties exchange necessary messages to establish the UE's connection. However, if the network does not receive the expected registration complete message from the UE within a predefined time frame, it indicates a registration failure due to various reasons. When such failures occur, the network retains both old and new S-Temporary Mobile Subscriber Identities (S-TMSI), awaiting completion. Yet, the current standard necessitates unnecessary Configuration Update Command (CUC) transmissions, adding to signalling overhead without practical benefit. This inefficiency leads to resource wastage and delays for the UE, highlighting the need for improved timeout handling methods at the Access and Mobility Management Function (AMF) and hence the current known solutions have several shortcomings. The present disclosure aims to overcome the above-mentioned and other existing problems in this field of technology by providing method and system for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF).

[0042] **FIG. 1** illustrates an exemplary block diagram representation of 5th generation core (5GC) network architecture, in accordance with exemplary implementation of the present disclosure. As shown in FIG. 1, the 5GC network architecture [100] includes a user equipment (UE) [102], a radio access network (RAN) [104], an access and mobility management function (AMF) [106], a Session Management Function (SMF) [108], a Service Communication Proxy (SCP) [110], an Authentication Server Function (AUSF) [112], a Network Slice Specific Authentication and Authorization Function (NSSAAF) [114], a Network Slice Selection Function (NSSF) [116], a Network Exposure Function (NEF) [118], a Network Repository Function (NRF) [120], a Policy Control Function (PCF) [122], a Unified Data Management (UDM) [124], an application function

(AF) [126], a User Plane Function (UPF) [128], a data network (DN) [130], wherein all the components are assumed to be connected to each other in a manner as obvious to the person skilled in the art for implementing features of the present disclosure.

5 [0043] Radio Access Network (RAN) [104] is the part of a mobile telecommunications system that connects user equipment (UE) [102] to the core network (CN) and provides access to different types of networks (e.g., 5G network). It consists of radio base stations and the radio access technologies that enable wireless communication.

10 [0044] Access and Mobility Management Function (AMF) [106] is a 5G core network function responsible for managing access and mobility aspects, such as UE registration, connection, and reachability. It also handles mobility management procedures like handovers and paging.

[0045] Session Management Function (SMF) [108] is a 5G core network function responsible for
15 managing session-related aspects, such as establishing, modifying, and releasing sessions. It coordinates with the User Plane Function (UPF) for data forwarding and handles IP address allocation and QoS enforcement.

[0046] Service Communication Proxy (SCP) [110] is a network function in the 5G core network
20 that facilitates communication between other network functions by providing a secure and efficient messaging service. It acts as a mediator for service-based interfaces.

[0047] Authentication Server Function (AUSF) [112] is a network function in the 5G core
25 responsible for authenticating UEs during registration and providing security services. It generates and verifies authentication vectors and tokens.

[0048] Network Slice Specific Authentication and Authorization Function (NSSAAF) [114] is a
network function that provides authentication and authorization services specific to network slices.
It ensures that UEs can access only the slices for which they are authorized.

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[0049] Network Slice Selection Function (NSSF) [116] is a network function responsible for selecting the appropriate network slice for a UE based on factors such as subscription, requested services, and network policies.

[0050] Network Exposure Function (NEF) [118] is a network function that exposes capabilities and services of the 5G network to external applications, enabling integration with third-party services and applications.

5 [0051] Network Repository Function (NRF) [120] is a network function that acts as a central repository for information about available network functions and services. It facilitates the discovery and dynamic registration of network functions.

[0052] Policy Control Function (PCF) [122] is a network function responsible for policy control
10 decisions, such as QoS, charging, and access control, based on subscriber information and network policies.

[0053] Unified Data Management (UDM) [124] is a network function that centralizes the management of subscriber data, including authentication, authorization, and subscription
15 information.

[0054] Application Function (AF) [126] is a network function that represents external applications interfacing with the 5G core network to access network capabilities and services.

20 [0055] User Plane Function (UPF) [128] is a network function responsible for handling user data traffic, including packet routing, forwarding, and QoS enforcement.

[0056] Data Network (DN) [130] refers to a network that provides data services to user equipment (UE) in a telecommunications system. The data services may include but are not limited to Internet
25 services, private data network related services.

[0057] **FIG. 2** illustrates an exemplary block diagram of a computing device [1000] (also referred herein as computer system [1000]) upon which the features of the present disclosure may be implemented in accordance with exemplary implementation of the present disclosure. In an
30 implementation, the computing device [1000] may also implement a method for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF) [106] utilising the system. In another implementation, the computing device [1000] itself implements the method for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF) [106] using one or more units configured within the

computing device [1000], wherein said one or more units are capable of implementing the features as disclosed in the present disclosure.

[0058] The computing device [1000] may include a bus [1002] or other communication
5 mechanism for communicating information, and a hardware processor [1004] coupled with the bus [1002] for processing information. The hardware processor [1004] may be, for example, a general-purpose microprocessor. The computing device [1000] may also include a main memory [1006], such as a random-access memory (RAM), or other dynamic storage device, coupled to the bus [1002] for storing information and instructions to be executed by the processor [1004]. The
10 main memory [1006] also may be used for storing temporary variables or other intermediate information during execution of the instructions to be executed by the processor [1004]. Such instructions, when stored in non-transitory storage media accessible to the processor [1004], render the computing device [1000] into a special-purpose machine that is customized to perform the operations specified in the instructions. The computing device [1000] further includes a read only
15 memory (ROM) [1008] or other static storage device coupled to the bus [1002] for storing static information and instructions for the processor [1004].

[0059] A storage device [1010], such as a magnetic disk, optical disk, or solid-state drive is provided and coupled to the bus [1002] for storing information and instructions. The computing
20 device [1000] may be coupled via the bus [1002] to a display [1012], such as a cathode ray tube (CRT), Liquid crystal Display (LCD), Light Emitting Diode (LED) display, Organic LED (OLED) display, etc. for displaying information to a computer user. An input device [1014], including alphanumeric and other keys, touch screen input means, etc. may be coupled to the bus [1002] for communicating information and command selections to the processor [1004]. Another type of user
25 input device may be a cursor controller [1016], such as a mouse, a trackball, or cursor direction keys, for communicating direction information and command selections to the processor [1004], and for controlling cursor movement on the display [1012]. This input device typically has two degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y), that allow the device to specify positions in a plane.

30 [0060] The computing device [1000] may implement the techniques described herein using customized hard-wired logic, one or more Application Specific Integrated Circuit (ASIC) or Field Programmable Gate Arrays (FPGA), firmware and/or program logic which in combination with the computing device [1000] causes or programs the computing device [1000] to be a special-
35 purpose machine. According to one implementation, the techniques herein are performed by the

computing device [1000] in response to the processor [1004] executing one or more sequences of one or more instructions contained in the main memory [1006]. Such instructions may be read into the main memory [1006] from another storage medium, such as the storage device [1010]. Execution of the sequences of instructions contained in the main memory [1006] causes the
5 processor [1004] to perform the process steps described herein. In alternative implementations of the present disclosure, hard-wired circuitry may be used in place of or in combination with software instructions.

[0061] The computing device [1000] also may include a communication interface [1018] coupled
10 to the bus [1002]. The communication interface [1018] provides a two-way data communication coupling to a network link [1020] that is connected to a local network [1022]. For example, the communication interface [1018] may be an integrated services digital network (ISDN) card, cable modem, satellite modem, or a modem to provide a data communication connection to a corresponding type of telephone line. As another example, the communication interface [1018]
15 may be a local area network (LAN) card to provide a data communication connection to a compatible LAN. Wireless links may also be implemented. In any such implementation, the communication interface [1018] sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information.

[0062] The computing device [1000] can send messages and receive data, including program code,
20 through the network(s), the network link [1020] and the communication interface [1018]. In the Internet example, a server [1030] might transmit a requested code for an application program through the Internet [1028], the ISP [1026], the Host [1024], the local network [1022] and the communication interface [1018]. Further the local network [1022] is connected with the host
25 [1024]. The received code may be executed by the processor [1004] as it is received, and/or stored in the storage device [1010], or other non-volatile storage for later execution.

[0063] Referring to **FIG. 3**, an exemplary block diagram of a system [300] for performing timeout
30 handling in an idle mode procedure at an Access and Mobility Management Function (AMF), is shown, in accordance with the exemplary implementations of the present disclosure. The system [300] comprises at least one transceiver unit [302] and at least one processing unit [304]. Also, all of the components/ units of the system [300] are assumed to be connected to each other unless otherwise indicated below. As shown in the figures all units shown within the system should also be assumed to be connected to each other. Also, in FIG. 3 only a few units are shown, however,

the system [300] may comprise multiple such units or the system [300] may comprise any such numbers of said units, as required to implement the features of the present disclosure.

5 [0064] The system [300] is configured for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF) [106], with the help of the interconnection between the components/units of the system [300].

[0065] Further, in accordance with the present disclosure, it is to be acknowledged that the functionality described for the various the components/units can be implemented interchangeably.
10 While specific embodiments may disclose a particular functionality of these units for clarity, it is recognized that various configurations and combinations thereof are within the scope of the disclosure. The functionality of specific units as disclosed in the disclosure should not be construed as limiting the scope of the present disclosure. Consequently, alternative arrangements and substitutions of units, provided they achieve the intended functionality described herein, are
15 considered to be encompassed within the scope of the present disclosure.

[0066] In order to perform timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF) [106], the transceiver unit [302] is configured to receive, at the AMF [106] from a user equipment (UE), a first idle mode request comprising a first Serving
20 Temporary Mobile Subscriber Identity (S-TMSI). The first idle mode request refers to an initial request made by the UE. The S-TMSI is a temporary identifier that is assigned to the UE by the AMF [106]. Further, S-TMSI protects a subscriber International Mobile Subscriber Identity (IMSI) during an interaction and identifies a Mobility Management Entity (MME) or a MME pool that is responsible for the UE.

25 [0067] The transceiver unit [302] is further configured to transmit, from the AMF [106] to the UE, a first registration accept message comprising a second S-TMSI in response to the first idle mode request. The first registration accept message refers to message that is sent from AMF [106] to the UE in response to the initial idle mode request made by the UE.

30 [0068] Further, the processing unit [304] is connected to the transceiver unit [302] and the processing unit [304] is configured to detect, at the AMF [106], a registration failure status associated with the first registration accept message. The registration failure status refers to an indication of a failure or error during registration of the UE that is detected by the processing unit
35 [304] at the AMF [106]. In other words, the registration failure indicates the error or failure at the

UE end and the failure or error is detected by the processing unit [304]. The registration may fail due to one or more reasons such as decoding error, communication failure, authentication failure, network congestion or any possible known issue.

5 [0069] The present disclosure encompasses that the registration failure status is detected by the processing unit [304] at the AMF [106], in an event, receiving by the UE the first registration accept message is unsuccessful. For example, the processing unit [304] detect the registration failure status when the UE fails to successfully receive the first registration accept message.

10 [0070] Thereafter, the transceiver unit [302] is further configured to receive, at the AMF [106] from the UE, a second idle mode request comprising the first S-TMSI based on the registration failure status associated with the first registration accept message.

[0071] The present disclosure encompasses that each of the first idle mode request and the second
15 idle mode request is one of a Mobility Request (MR), a Periodic Request (PR) and a Service Request (SR). The MR is a message that is sent by the UE to a network when there is requirement to perform one or more mobility related actions such as initiating a handover between different base stations or mobility management procedures like tracking area update. The PR is type of message that is sent by the UE at regular intervals to the network. The SR is a message that is also
20 sent by the UE to a request a specific service or resource from the network such as initiating a call setup procedure, requesting data transmission, or requesting network assistance.

[0072] Thereafter, the transceiver unit [302] is further configured to transmit, from the AMF [106]
25 to the UE, a second registration accept message comprising a third S-TMSI in response to the second idle mode request.

[0073] The processing unit [304] is further configured to detect, at the AMF [106], a registration success status associated with the second registration accept message. The registration success status refers to an indication or signal detected by the processing unit [304] at the AMF [106].
30 When the processing unit [304] detects the registration success status associated with the second registration accept message, it indicates that the UE has been successfully authenticated and has transitioned from the idle state to the connected state within the network. This status confirms that the UE is now capable of accessing one or more network services and communicating with other devices on the network.

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[0074] The processing unit [304] is further configured to perform, at the AMF [106], a target action based on the registration success message, wherein the target action comprises deallocating the first S-TMSI at the AMF and storing the third S-TMSI at the AMF [106]. The present disclosure encompasses that deallocation of the STMSI refers to release of one or more resources by one or more techniques such as memory management techniques, data structure operations, garbage collection technique.

[0075] The present disclosure encompasses that the processing unit [304] is further configured to deallocate the second S-TMSI at the AMF [106] and allocate the third S-TMSI by the AMF [106] based on deallocation of the second S-TMSI at the AMF [106].

[0076] The present disclosure encompasses that the processing unit [304] is further configured to detect at the AMF at least deallocation of the first S-TMSI from the UE and store the third S-TMSI at the UE based on transmitting the second registration accept message.

[0077] Referring to FIG. 4, an exemplary method flow diagram [400] for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF) [106] in accordance with exemplary implementations of the present disclosure is shown. In an implementation the method [400] is performed by the system [300]. Also, as shown in FIG. 4, the method [400] starts at step [402].

[0078] At step [404], the method comprises receiving, by a transceiver unit [302] at the AMF [106] from a user equipment (UE), a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI). The first idle mode request refers to an initial request made by the UE. The S-TMSI is a temporary identifier that is assigned to the UE by the AMF [106].

[0079] At step [406], the method comprises transmitting, by the transceiver unit [302] from the AMF [106] to the UE, a first registration accept message comprising a second S-TMSI in response to the first idle mode request. The first registration accept message refers to message that is sent from AMF [106] to the UE in response to the initial idle mode request made by the UE.

[0080] The present disclosure encompasses that each of the first idle mode request and the second idle mode request is one of a Mobility Request (MR), a Periodic Request (PR) and a Service Request (SR). The MR is a message that is sent by the UE to a network when there is requirement to perform one or more mobility related actions such as initiating a handover between different

base stations or mobility management procedures like tracking area update. The PR is type of message that is sent by the UE at regular intervals to the network. The SR is a message that is also sent by the UE to request a specific service or resource from the network such as initiating a call setup procedure, requesting data transmission, or requesting network assistance.

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[0081] At step [408], the method comprises detecting, by a processing unit [304] at the AMF [106], a registration failure status associated with the first registration accept message. The registration failure status refers to an indication of a failure or error during registration of the UE that is detected by the processing unit [304] at the AMF [106]. The registration may fail due to one or more reasons such as decoding error, communication failure, authentication failure, network congestion or any possible known issue.

[0082] The present disclosure encompasses that the registration failure status is detected by the processing unit [304] at the AMF [106], in an event, receiving by the UE the first registration accept message is unsuccessful. For example, the processing unit [304] detect the registration failure status when the UE fails to successfully receive the first registration accept message.

[0083] At step [410], the method comprises receiving, by the transceiver unit [302] at the AMF [106] from the UE, a second idle mode request comprising the first S-TMSI based on the registration failure status.

[0084] The present disclosure encompasses that the receiving by the processing unit [304] at the AMF [106] from the UE the second idle mode request comprising the first S-TMSI based on the registration failure status further comprises at least deallocating by the processing unit [304] the second S-TMSI at the AMF [106], and allocating the third S-TMSI by the AMF based on deallocating the second S-TMSI at the AMF [106].

[0085] At step [412], the method comprises transmitting, by the transceiver unit [302] from the AMF [106] to the UE, a second registration accept message comprising a third S-TMSI in response to the second idle mode request.

[0086] At step [414], the method comprises detecting, by the processing unit [304] at the AMF [106], a registration success status associated with the second registration accept message. The registration success status refers to an indication or signal detected by the processing unit [304] at the AMF [106]. When the processing unit [304] detects the registration success status associated

with the second registration accept message, it indicates that the UE has been successfully authenticated and has transitioned from the idle state to the connected state within the network. This status confirms that the UE is now capable of accessing one or more network services and communicating with other devices on the network.

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[0087] At step [416], the method comprises performing, by the processing unit [304] at the AMF [106], a target action based on the registration success message, wherein the target action comprises deallocating the first S-TMSI at the AMF and storing the third S-TMSI at the AMF [106]. The present disclosure encompasses that deallocation of the STMSI refers to release of one or more resources by one or more techniques such as memory management techniques, data structure operations, garbage collection technique.

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[0088] The present disclosure encompasses that detecting by the processing unit [304] at the AMF [106] the registration success status associated with the second registration accept message further comprises detecting at the AMF [106] deallocation of the first S-TMSI from the UE and storing the third S-TMSI at the UE based on transmitting the second registration accept message.

15

[0089] Referring to **FIG. 5**, an exemplary sequence flow diagram [500] of the method for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF) in accordance with exemplary implementations of the present disclosure is shown. In an implementation the method [500] is performed by the system [300].

20

[0090] At step S1, the UE sends a mobility request (Serving Temporary Mobile Subscriber Identity (first S-TMSI for ease of understanding the first S-TMSI is S-TMSI X)) to the AMF [106], in response the AMF [106] allocates a new first S-TMSI Y i.e., the second S-TMSI and keeps both the S-TMSI X and S-TMSI Y. The S-TMSI Y is the S-TMSI allocated by the AMF [106] in response to the S-TMSI X i.e., the S-TMSI associated with the mobility request from the UE the AMF [106]. In other words, when the UE sends the mobility request comprising the S-TMSI X (the first S-TMSI) to the network, i.e., to the AMF. The AMF allocates to the UE a new ID called the S-TMSI Y (the second S-TMSI), while keeping the old one, the S-TMSI X. So now the UE has two IDs. The S-TMSI Y is the new one given by the AMF based on the mobility request. Please note, the S-TMSI Y is a temporary identifier that is assigned to the UE by the AMF [106] based on the transmitted mobility request comprising the S-TMSI X from the UE to the AMF [106].

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[0091] At step S2, the registration (S-TMSI Y) is accepted and notified to the UE. However, the UE does not get new S-TMSI Y because it didn't receive reg-accept or due to some other cause.

[0092] At step S3, the mobility registration S-TMSI X is again transmitted to the AMF [106] from the UE, thereafter the AMF [106] de-allocates S-TMSI Y, allocates new S-TMSI Z and keeps both S-TMSI X and Z. Further, in a scenario when the UE sends the mobility request comprising the S-TMSI X (the first S-TMSI) to the network, i.e., to the AMF. The AMF allocates to the UE a new ID called the S-TMSI Y (the second S-TMSI), but the S-TMSI Y is not received at the UE. Now, the UE retransmits the mobility request comprising the S-TMSI X to the AMF [106], in said scenario the AMF [106] de-allocates the S-TMSI Y (i.e., the second S-TMSI), and allocated the third S-TMSI i.e., the S-TMSI Z associated with the retransmitted mobility request, further in said scenario keeps the first S-TMSI (i.e., the S-TMSI X) and the third S-TMSI (i.e., the S-TMSI Z). Please note, the S-TMSI Z is a new temporary identifier that is assigned to the UE by the AMF [106] based on the retransmitted mobility request comprising the S-TMSI X from the UE to the AMF [106].

[0093] At step S4, a registration accept S-TMSI Z is transmitted from the AMF [106] to the UE, thereafter the UE de-allocates S-TMSI X and S-TMSI Z.

[0094] At step S5, the registration of UE is completed and thereafter the AMF [106] de-allocates S-TMSI X at its end and keeps S-TMSI Z.

[0095] As an example, the method and system for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF) [106] may be implemented by a telecommunications organization. In this scenario, a mobile device (Device X) attempts to connect to a cellular network operated by a service provider. The Device X sends a request to transition from an idle state to an active state, enabling it to make calls, send messages, and use data services. This request includes a temporary identity (Identity A which is Serving Temporary Mobile Subscriber Identity (S-TMSI)) assigned by the network (i.e., AMF). The AMF [106] acknowledges Device X's request and sends a registration message back. However, due to a temporary glitch or poor network reception, Device X fails to receive this message and remains idle. Upon detecting this registration failure, the AMF [106] initiates a secondary process. It receives a new request from Device X, still using Identity A, indicating its continued attempt to connect. In response, the AMF [106] sends another registration accept message, this time assigning a new temporary identity (Identity B) to Device X. Upon successfully receiving this message,

Device X completes its registration process and transitions to the active state. The AMF [106] detects the successful registration and performs a target action, releasing Identity A and storing Identity B as Device X's current identity within the network. This method and system effectively manage the registration process, handling timeout failures to ensure seamless connectivity for UEs such as mobile devices. By reallocating temporary identities and responding to registration failures and successes in real-time, the network performance is optimized, the user experience is also enhanced.

[0096] The present disclosure further discloses a user equipment for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF), the user equipment comprises: a memory; a processor coupled to the memory, the processor is configured to transmitting, to a system [300], a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI), receiving, from the system [300] a first registration accept message comprising a second S-TMSI in response to the first idle mode request, transmitting, to the system [300], a second idle mode request comprising the first S-TMSI based on a registration failure status, receiving, from the system [300], a second registration accept message comprising a third S-TMSI in response to the second idle mode request, and detecting, a target action performance based on a registration success message, wherein the target action comprises deallocating the first S-TMSI at the AMF [106] and storing the third S-TMSI at the AMF [106].

[0097] The present disclosure further discloses a non-transitory computer readable storage medium storing instructions for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF), the instructions include executable code which, when executed by a one or more units of a system [300], causes: a transceiver unit [302] of the system [300] to receive from a user equipment (UE), a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI), the transceiver unit [302] to transmit to the UE, a first registration accept message comprising a second S-TMSI in response to the first idle mode request, a processing unit [304] of the system [300] to detect, a registration failure status associated with the first registration accept message, the transceiver unit [302] of the system [300] to receive from the UE, a second idle mode request comprising the first S-TMSI based on the registration failure status, the transceiver unit [302] of the system [300] to transmit to the UE, a second registration accept message comprising a third S-TMSI in response to the second idle mode request, the processing unit [304] of the system [300] to detect, a registration success status associated with the second registration accept message, and the processing unit [304] of the system [300] to perform, a target action based on the registration success message,

wherein the target action comprises deallocating the first S-TMSI at the AMF [106] and storing the third S-TMSI at the AMF [106].

5 [0098] As is evident from the above, the present disclosure provides a technically advanced solution for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF) within wireless communication networks. The present solution eliminates the need to deliver one or more configuration update commands (CUC) for Mobility Request (MR), Periodic Request (PR), or Service Request (SR) procedures, due to which the present solution streamlines the process and reduces unnecessary signalling transactions. The
10 elimination of unnecessary signalling transactions not only reduced the complexity of the communication flow of the network but also minimizes the signalling overhead. Hence, the present solution represents a significant technological advancement by simplifying and optimizing the idle mode procedure, thereby improving the performance and efficiency of wireless communication networks.

15 [0099] While considerable emphasis has been placed herein on the disclosed implementations, it will be appreciated that many implementations can be made and that many changes can be made to the implementations without departing from the principles of the present disclosure. These and other changes in the implementations of the present disclosure will be
20 apparent to those skilled in the art, whereby it is to be understood that the foregoing descriptive matter to be implemented is illustrative and non-limiting.

We Claim:

1. A method [400] for performing a timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF), the method comprising:
 - 5 - receiving, by a transceiver unit [302] at the AMF [106] from a user equipment (UE), a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI);
 - transmitting, by the transceiver unit [302] from the AMF [106] to the UE, a first registration accept message comprising a second S-TMSI in response to the first idle mode request;
 - 10 - detecting, by a processing unit [304] at the AMF [106], a registration failure status associated with the first registration accept message;
 - receiving, by the transceiver unit [302] at the AMF [106] from the UE, a second idle mode request comprising the first S-TMSI based on the registration failure status;
 - 15 - transmitting, by the transceiver unit [302] from the AMF [106] to the UE, a second registration accept message comprising a third S-TMSI in response to the second idle mode request;
 - detecting, by the processing unit [304] at the AMF [106], a registration success status associated with the second registration accept message; and
 - 20 - performing, by the processing unit [304] at the AMF [106], a target action based on the registration success status, wherein the target action comprises deallocating the first S-TMSI at the AMF [106] and storing the third S-TMSI at the AMF [106].
2. The method as claimed in claim 1, wherein each of the first idle mode request and the second idle mode request is one of a Mobility Request (MR), a Periodic Request (PR) and a Service Request (SR).
- 25 3. The method as claimed in claim 1, wherein the registration failure status is detected by the processing unit [304] at the AMF [106], in an event, receiving by the UE the first registration accept message is unsuccessful.
- 30 4. The method as claimed in claim 1, wherein the receiving by the processing unit [304] at the AMF [106] from the UE the second idle mode request comprising the first S-TMSI based on the registration failure status further comprises at least deallocating by the processing unit

[304] the second S-TMSI at the AMF [106], and allocating the third S-TMSI by the AMF [106] based on deallocating the second S-TMSI at the AMF [106].

- 5 5. The method as claimed in claim 1, wherein detecting by the processing unit [304] at the AMF [106] the registration success status associated with the second registration accept message further comprises detecting at the AMF [106] deallocation of the first S-TMSI from the UE and storing the third S-TMSI at the UE based on transmitting the second registration accept message.
- 10 6. A system [300] for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF), the system [300] comprises:
- a transceiver unit [302], wherein the transceiver unit [302] is configured to:
 - receive, at the AMF [106] from a user equipment (UE), a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI);
 - transmit, from the AMF [106] to the UE, a first registration accept message comprising a second S-TMSI in response to the first idle mode request;
 - a processing unit [304] connected to the transceiver unit [302], wherein the processing unit [304] is configured to:
 - detect, at the AMF [106], a registration failure status associated with the first registration accept message;
- wherein the transceiver unit [302] is further configured to:
- receive, at the AMF [106] from the UE, a second idle mode request comprising the first S-TMSI based on the registration failure status associated with the first registration accept message;
 - transmit, from the AMF [106] to the UE, a second registration accept message comprising a third S-TMSI in response to the second idle mode request;
- wherein the processing unit [304] is further configured to:
- detect, at the AMF [106], a registration success status associated with the second registration accept message; and
 - perform, at the AMF [106], a target action based on the registration success message, wherein the target action comprises deallocating the first S-TMSI at the AMF [106] and storing the third S-TMSI at the AMF [106].

7. The system [300] as claimed in claim 6, each of the first idle mode request and the second idle mode request is one of a Mobility Request (MR), a Periodic Request (PR) and a Service Request (SR).
- 5 8. The system [300] as claimed in claim 6, wherein the registration failure status is detected by the processing unit [304] at the AMF [106], in an event, receiving by the UE the first registration accept message is unsuccessful.
- 10 9. The system [300] as claimed in claim 6, wherein the processing unit [304] is further configured to deallocate the second S-TMSI at the AMF [106] and allocate the third S-TMSI by the AMF [106] based on deallocation of the second S-TMSI at the AMF [106].
- 15 10. The system [300] as claimed in claim 6, wherein the processing unit [304] is further configured to detect at the AMF [106] at least deallocation of the first S-TMSI from the UE and store the third S-TMSI at the UE based on transmitting the second registration accept message.
- 20 11. A user equipment for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function (AMF), the user equipment comprises:
a memory; and
a processor coupled to the memory, the processor is configured to
- transmitting, to a system, a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI),
 - receiving, from the system a first registration accept message comprising a second S-TMSI in response to the first idle mode request,
 - transmitting, to the system, a second idle mode request comprising the first S-TMSI based on a registration failure status,
 - receiving, from the system, a second registration accept message comprising a third S-TMSI in response to the second idle mode request, and
 - 30 - detecting, a target action performance based on a registration success message, wherein the target action comprises deallocating the first S-TMSI at the AMF [106] and storing the third S-TMSI at the AMF [106].
- 35 12. A non-transitory computer readable storage medium storing instructions for performing timeout handling in an idle mode procedure at an Access and Mobility Management Function

(AMF), the instructions include executable code which, when executed by one or more units of a system, causes:

- a transceiver unit [302] to receive from a user equipment (UE), a first idle mode request comprising a first Serving Temporary Mobile Subscriber Identity (S-TMSI),
- 5 the transceiver unit [302] to transmit to the UE, a first registration accept message comprising a second S-TMSI in response to the first idle mode request,
- a processing unit [304] to detect, a registration failure status associated with the first registration accept message,
- the transceiver unit [302] to receive from the UE, a second idle mode request
- 10 comprising the first S-TMSI based on the registration failure status,
- the transceiver unit [302] to transmit to the UE, a second registration accept message comprising a third S-TMSI in response to the second idle mode request,
- the processing unit [304] to detect, a registration success status associated with the second registration accept message, and
- 15 the processing unit [304] to perform, a target action based on the registration success message, wherein the target action comprises deallocating the first S-TMSI at the AMF [106] and storing the third S-TMSI at the AMF [106].

20

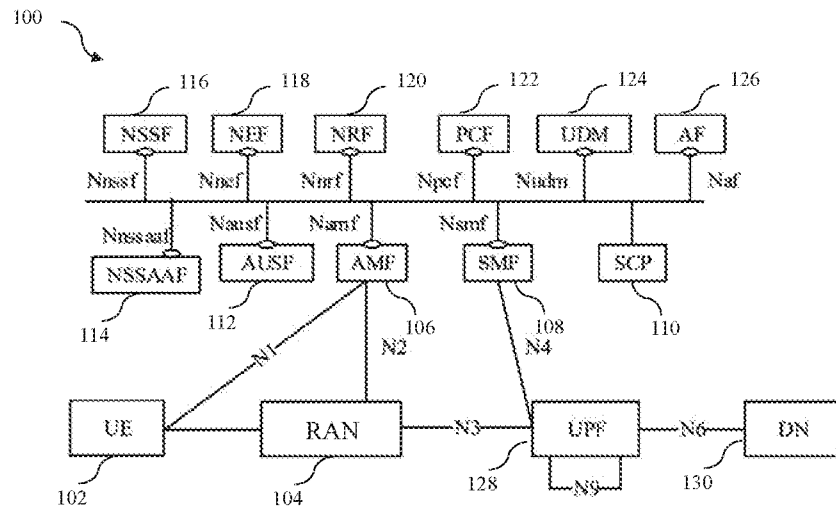


FIG. 1

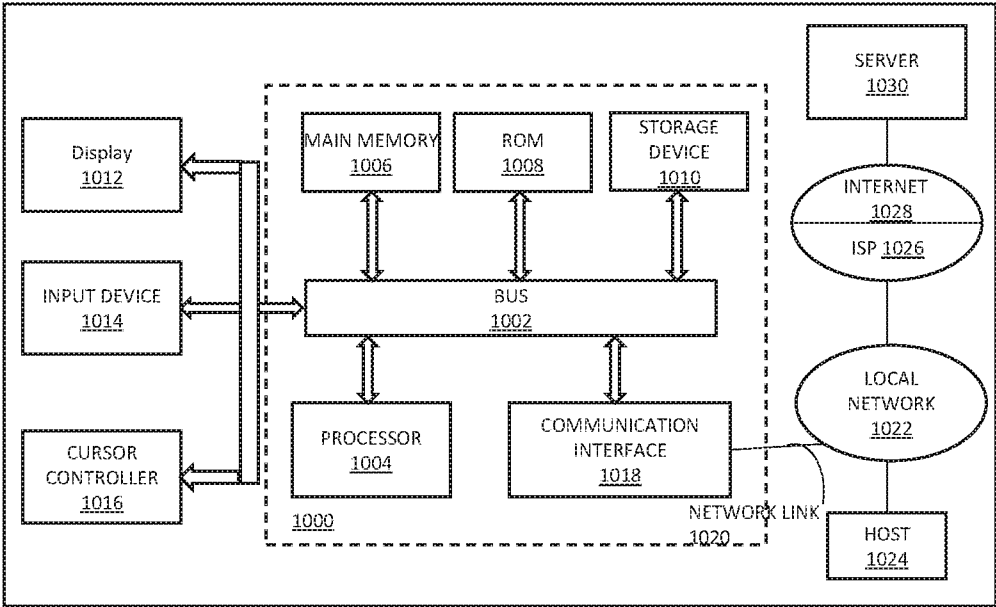


FIG. 2

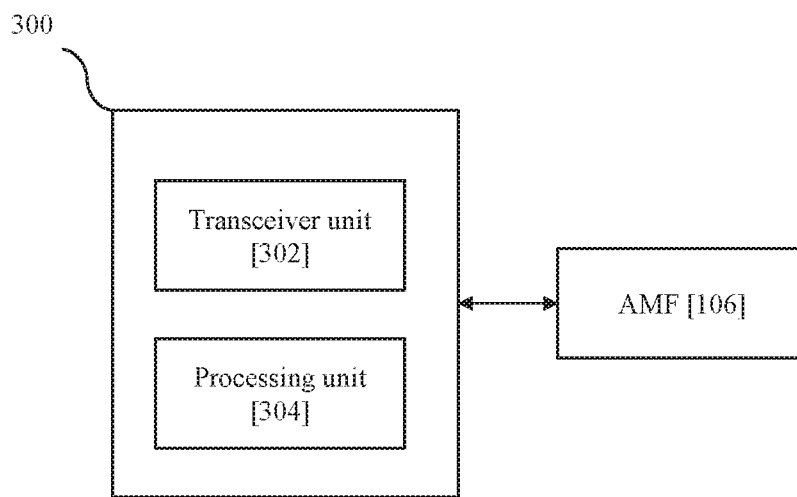


FIG. 3

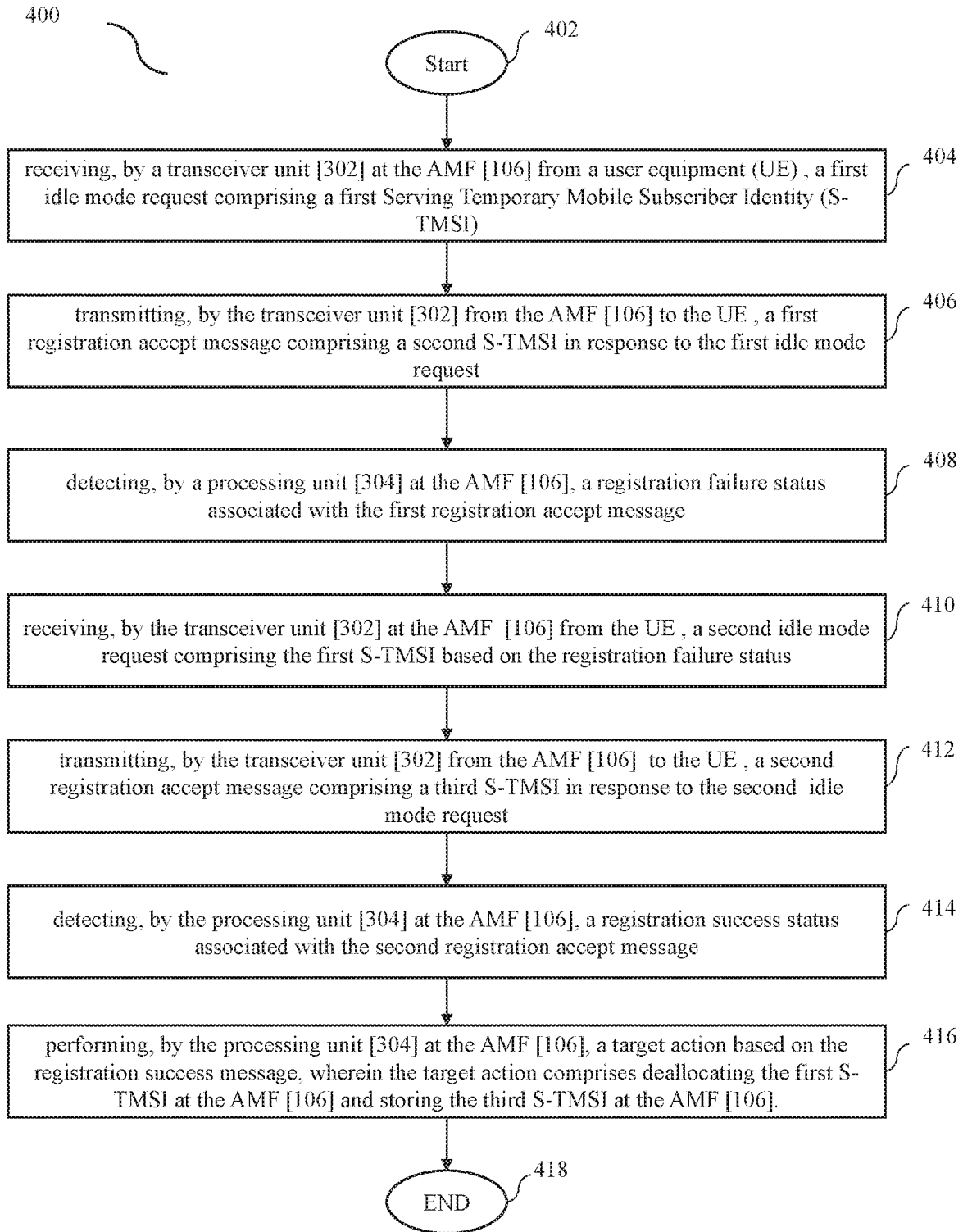


FIG. 4

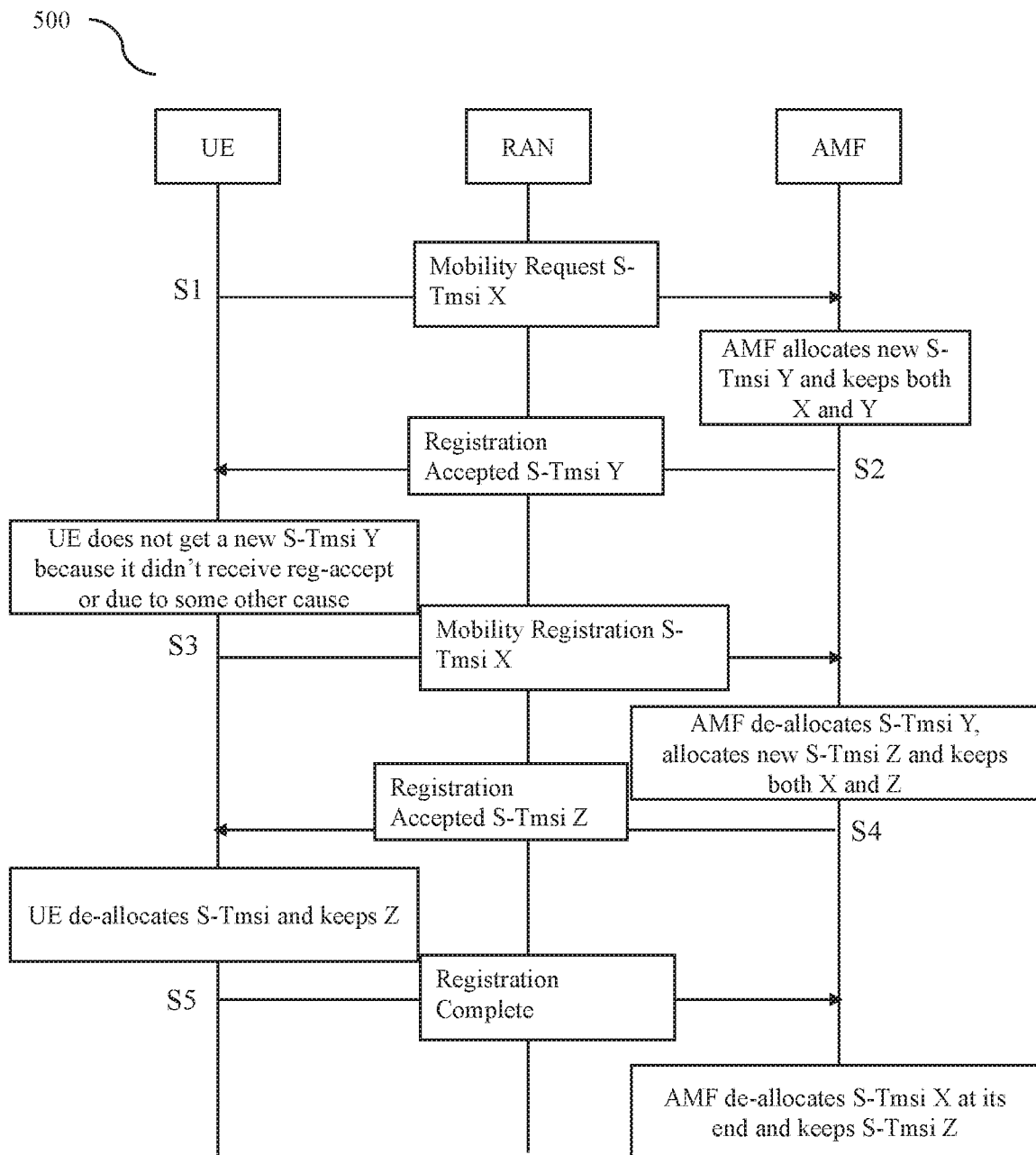


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IN2024/050799

A. CLASSIFICATION OF SUBJECT MATTER

H04W60/04, H04W76/27, H04W68/02, H04W48/18 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

Keywords: TMSI reallocation, Connection failure, Abnormal case

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Email Discussion on support of MT-EDT for 5GC; 5G_CIoT rapporteur; Pre SA2#138E e-meeting Email Discussion; Publication Date: 28 Apr 2020 (28-04-2020) section 1.1.1.2; comments by NEC, Qualcomm in section 1.1.2 -----	1-12
Y	3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Mobile radio interface Layer 3 specification; Core network protocols; Stage 3 (Release 16); (3GPP TS 24.008 version 16.7.0 Release 16); Publication Date: 01 Apr 2021 (01-04-2021) section 4.3.1.3; section 4.3.1.4	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"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

"&" document member of the same patent family

Date of the actual completion of the international search

17-10-2024

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