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**Yu**

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(54) **METHOD AND USER EQUIPMENT FOR ACTIVATING ACCESS STRATUM LAYER UPON COMING OUT OF THE UNAVAILABILITY PERIOD**

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***H04W 8/08*** (2009.01)
***H04W 60/04*** (2009.01)

(52) **U.S. Cl.**
CPC ..... ***H04W 60/04*** (2013.01); ***H04W 8/08*** (2013.01)

(58) **Field of Classification Search**
CPC ..... H04W 4/02; H04W 4/029; H04W 8/00; H04W 8/02; H04W 8/04; H04W 8/06; H04W 8/08; H04W 60/00; H04W 60/02; H04W 60/04
See application file for complete search history.

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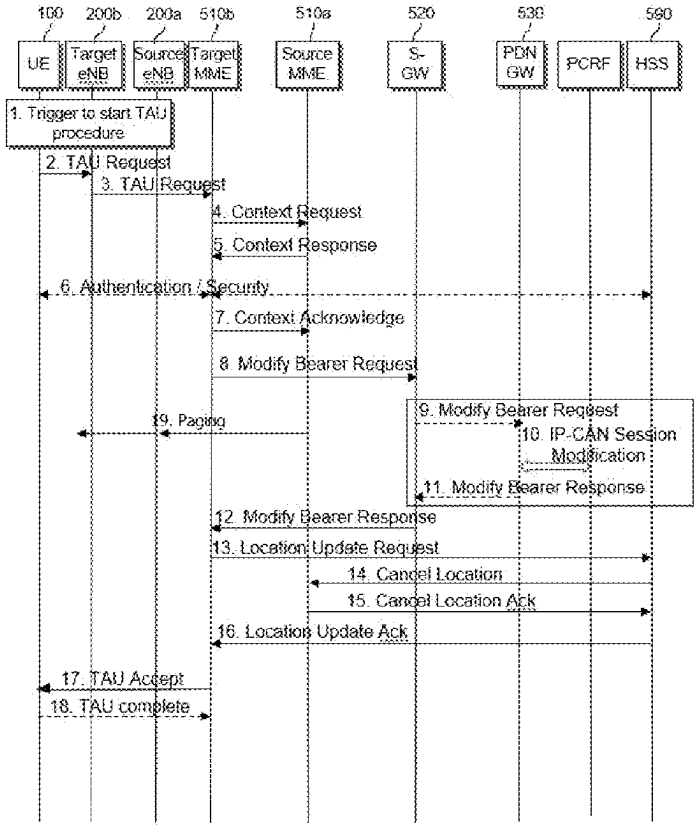
(57) **ABSTRACT**

According to one embodiment of this specification, there is provided an operation method of user equipment (UE). The method may comprise: triggering a tracking area update (TAU) procedure when an unavailability period has ended and a discontinuous coverage maximum time offset timer has expired; starting a first timer at completion of the tracking area update procedure if the UE has included unavailability information and has not included a start of the unavailability period in a tracking area update request message; and upon coming out of the unavailability period, activating an access stratum (AS) layer.

**12 Claims, 10 Drawing Sheets**



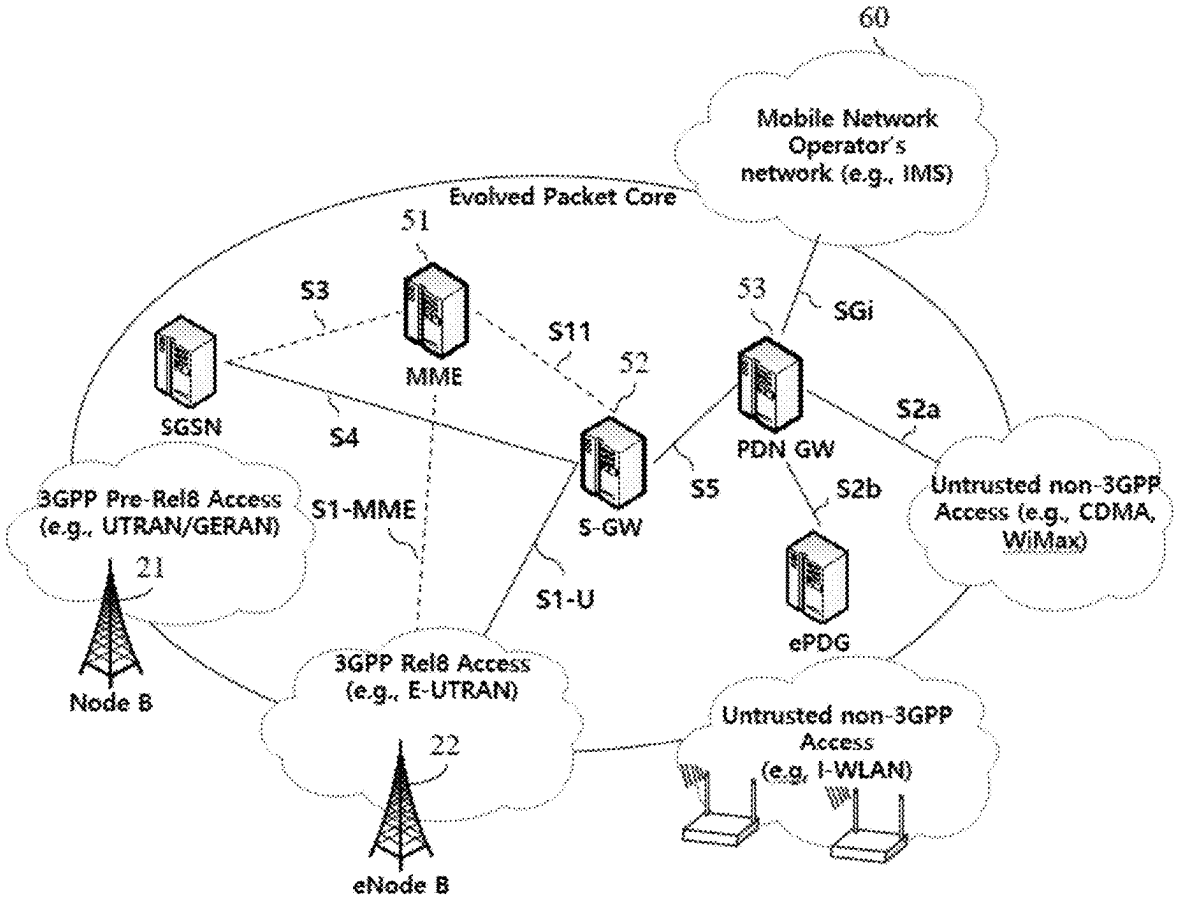



FIG. 1

PRIOR ART

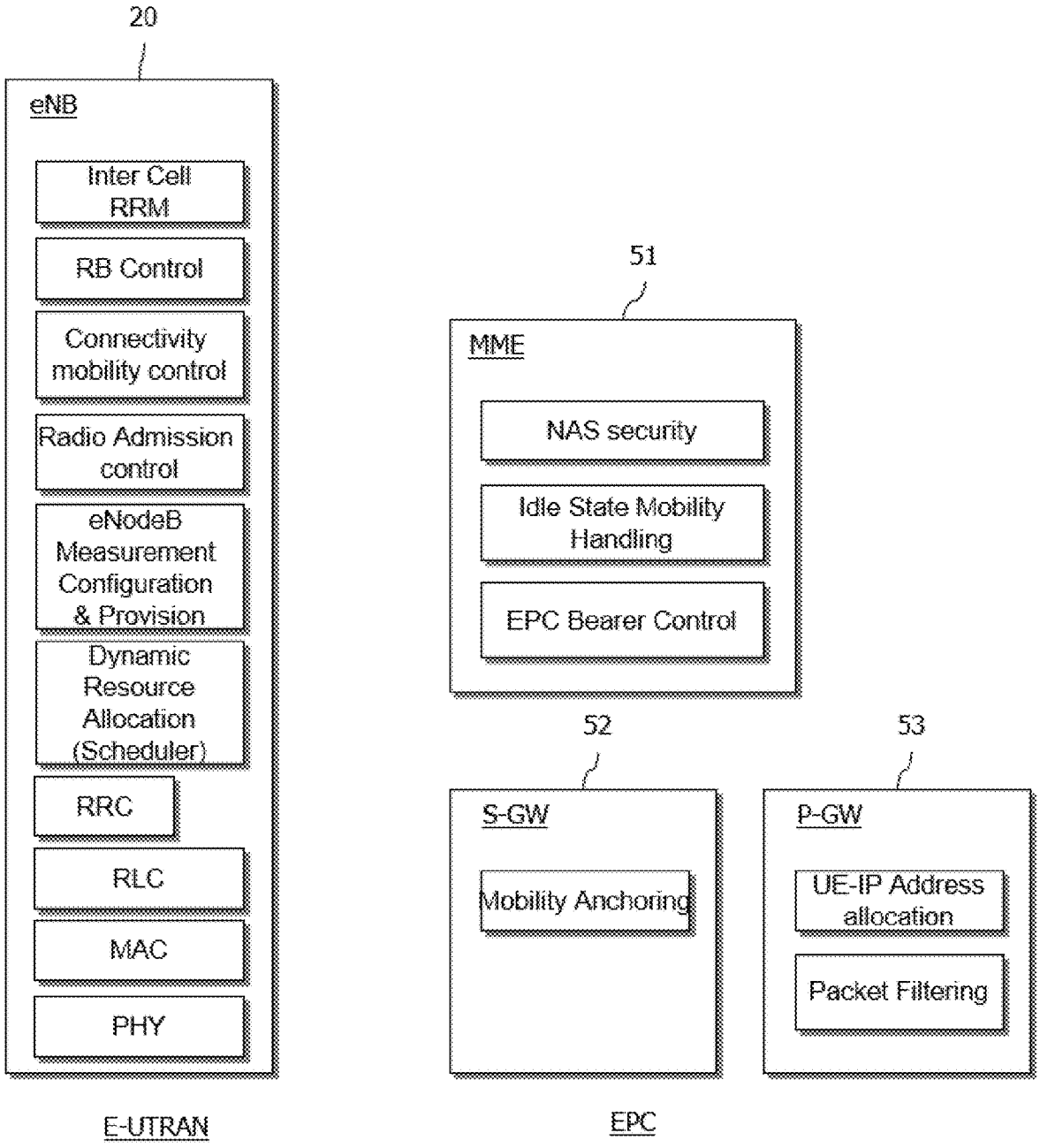

20
eNB
Inter Cell RRM
RB Control
Connectivity mobility control
Radio Admission control
eNodeB Measurement Configuration & Provision
Dynamic Resource Allocation (Scheduler)
RRC
RLC
MAC
PHY
E-UTRAN
51
MME
NAS security
Idle State Mobility Handling
EPC Bearer Control
52
S-GW
Mobility Anchoring
53
P-GW
UE-IP Address allocation
Packet Filtering
EPC

FIG. 2

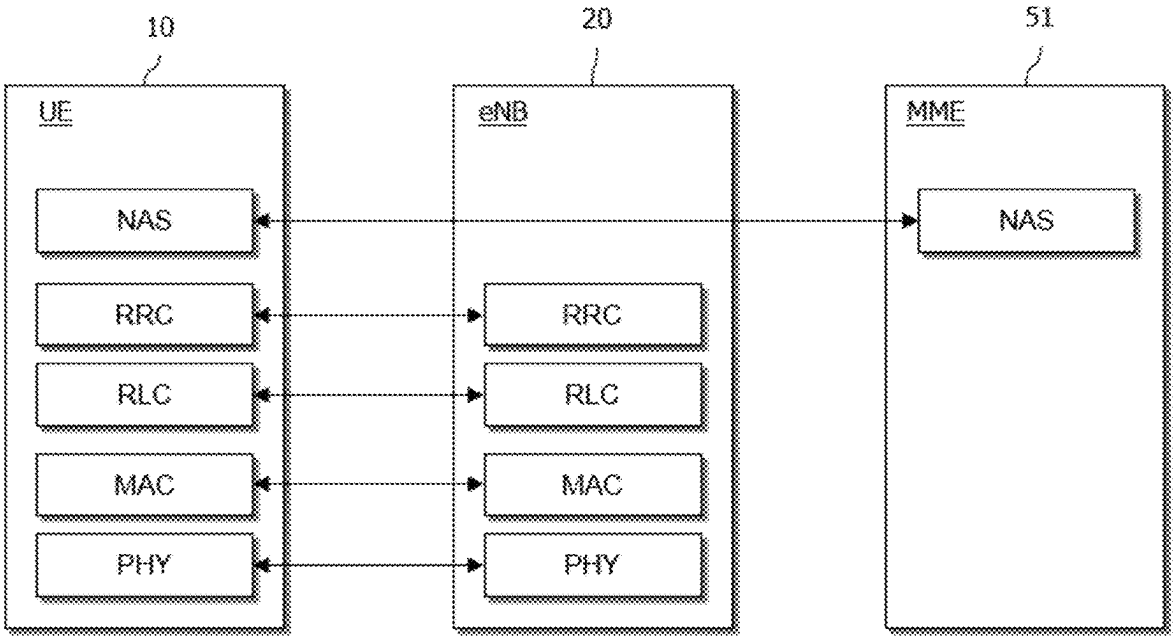



FIG. 3

PRIOR ART

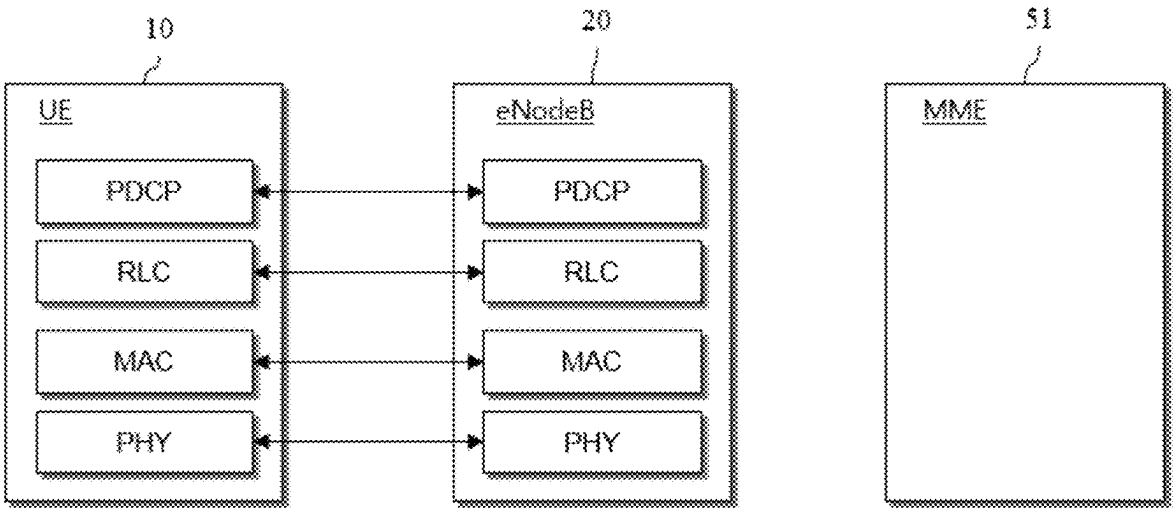



FIG. 4

PRIOR ART

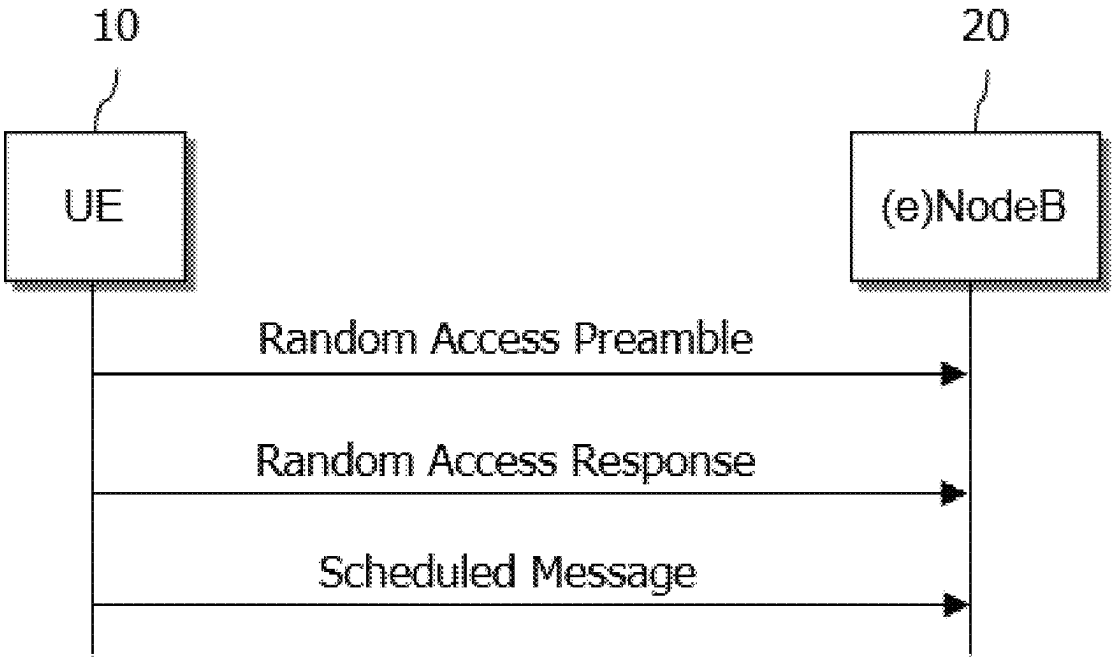

10
20
UE
(e)NodeB
Random Access Preamble
Random Access Response
Scheduled Message

FIG. 5

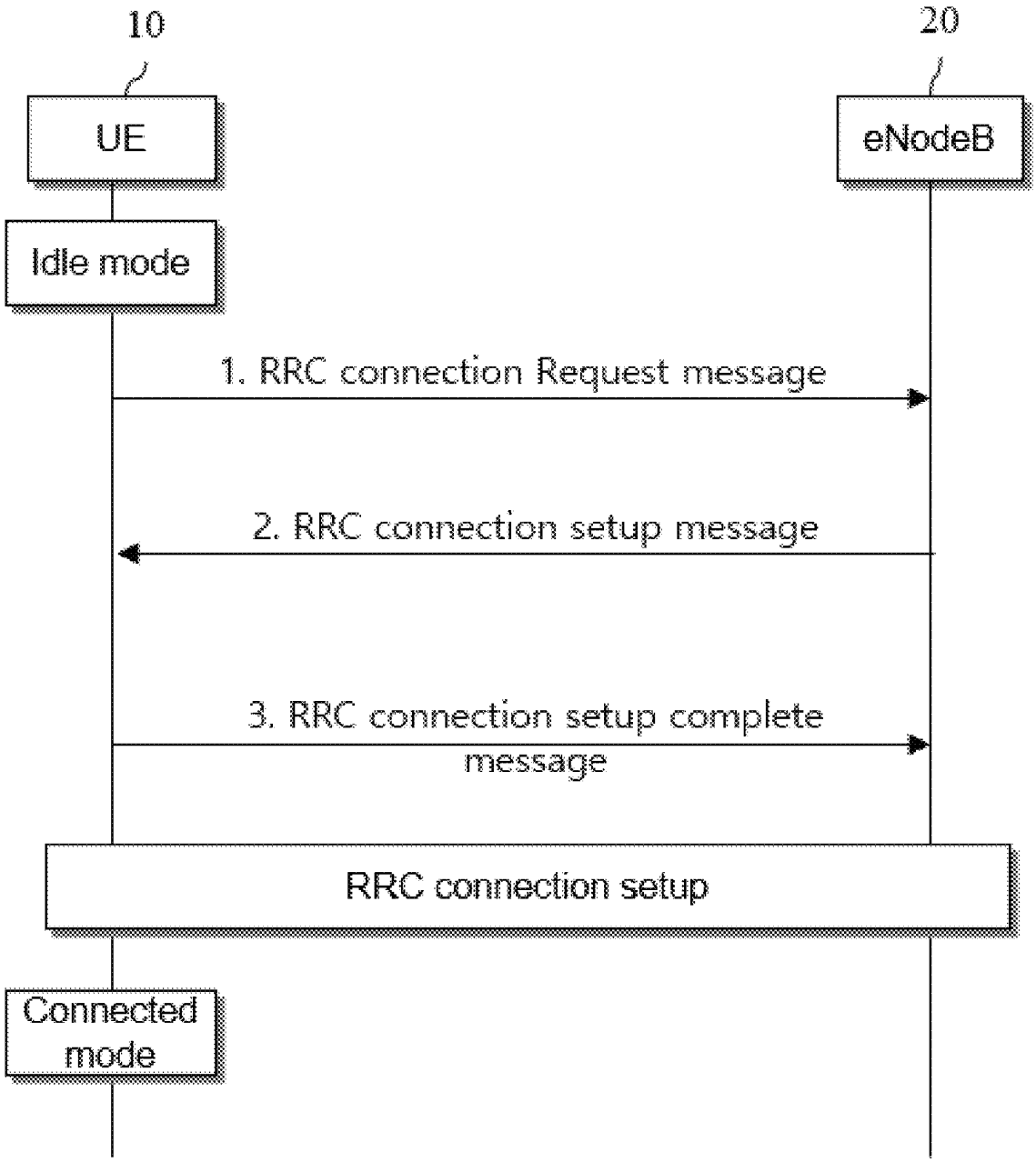

10
20
UE
eNodeB
Idle mode
1. RRC connection Request message
2. RRC connection setup message
3. RRC connection setup complete message
RRC connection setup
Connected mode

FIG. 6

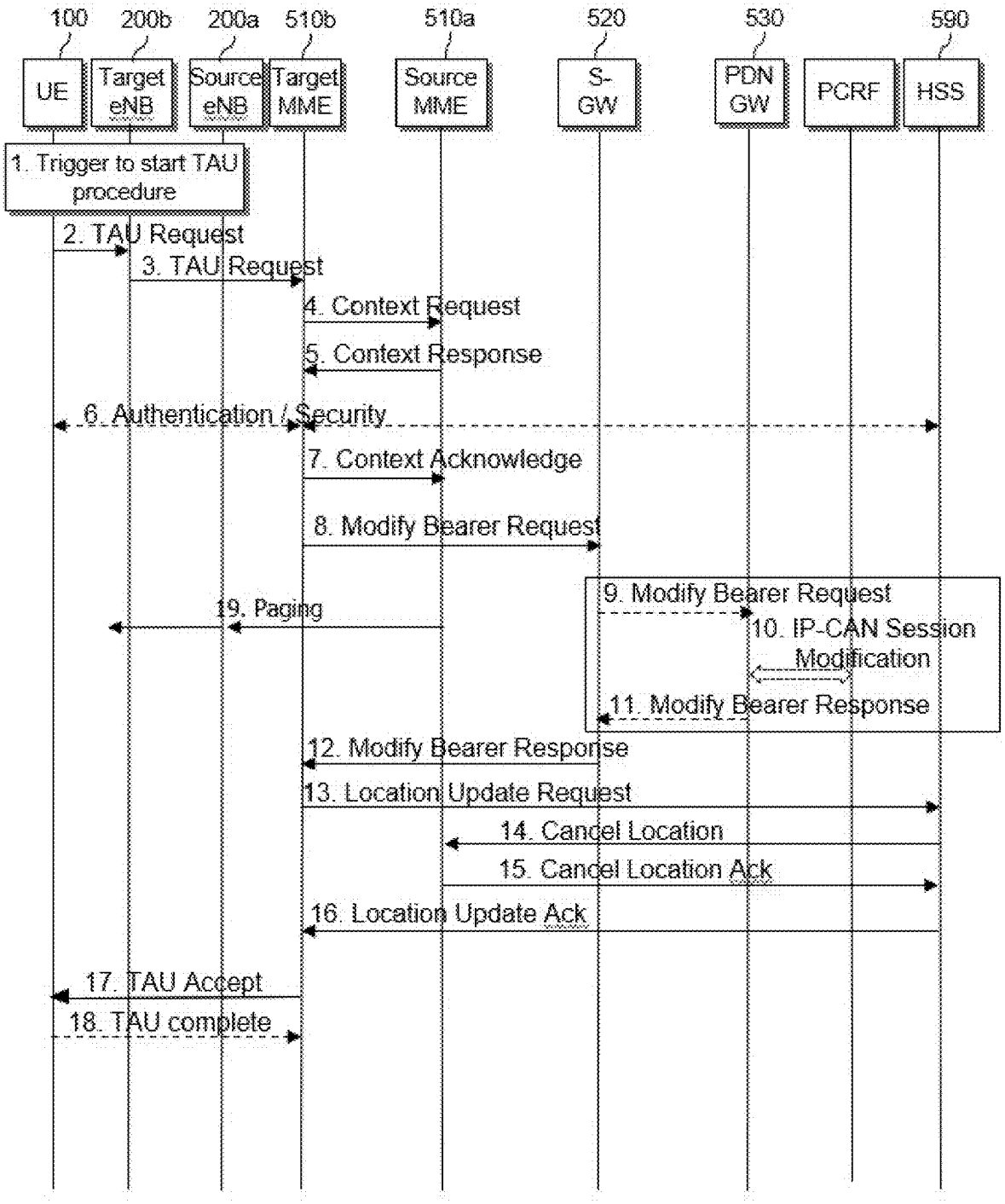

100
200b
200a
510b
510a
520
530
590
UE
Target eNB
Source eNB
Target MME
Source MME
S-GW
PDN GW
PCRF
HSS
1. Trigger to start TAU procedure
2. TAU Request
3. TAU Request
4. Context Request
5. Context Response
6. Authentication / Security
7. Context Acknowledge
8. Modify Bearer Request
9. Modify Bearer Request
10. IP-CAN Session Modification
11. Modify Bearer Response
19. Paging
12. Modify Bearer Response
13. Location Update Request
14. Cancel Location
15. Cancel Location Ack
16. Location Update Ack
17. TAU Accept
18. TAU complete

FIG. 7

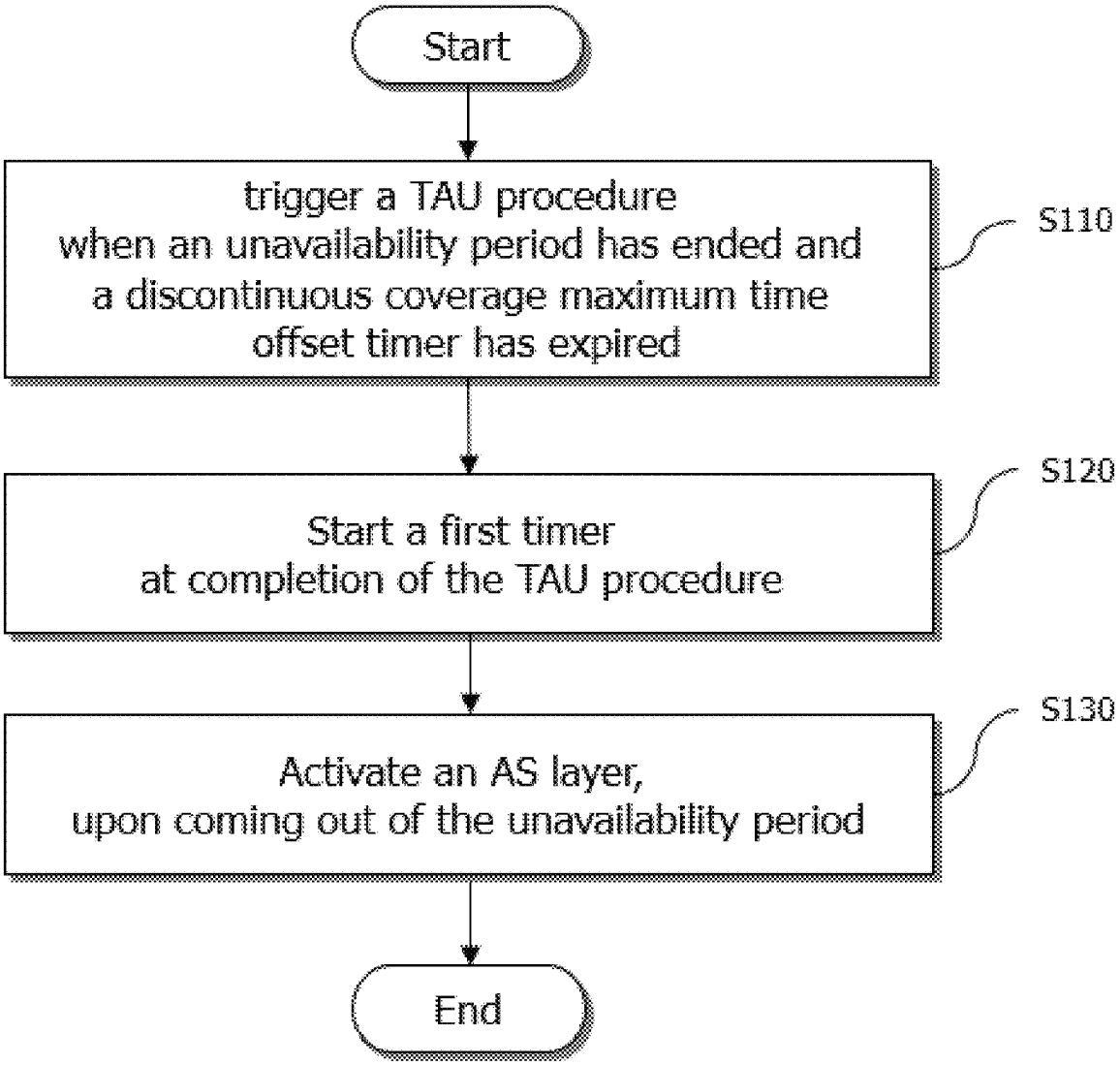

Start
trigger a TAU procedure when an unavailability period has ended and a discontinuous coverage maximum time offset timer has expired
S110
Start a first timer at completion of the TAU procedure
S120
Activate an AS layer, upon coming out of the unavailability period
S130
End

FIG. 8

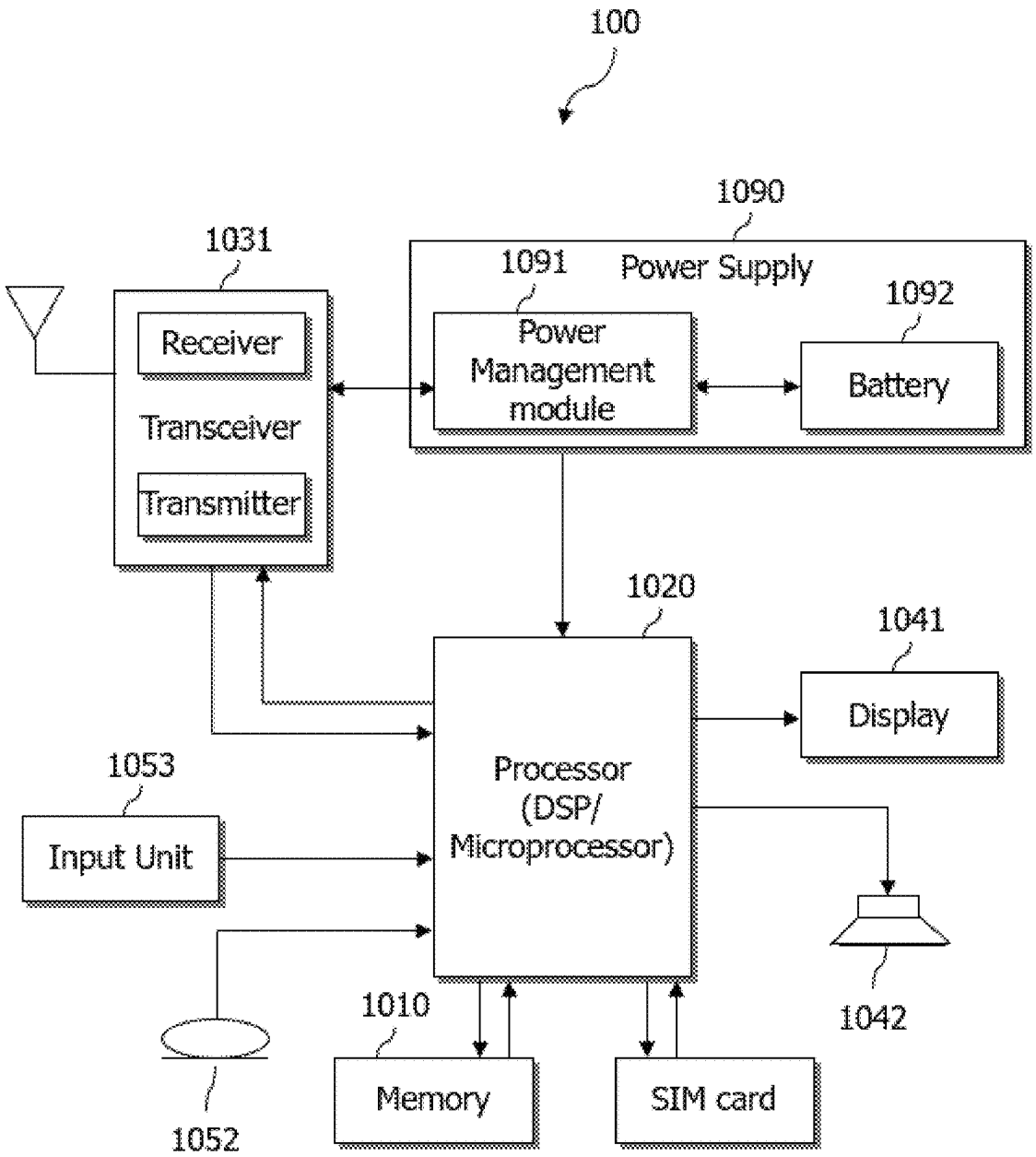

100
1090
1031
1091
Power Supply
1092
Receiver
Power Management module
Battery
Transceiver
Transmitter
1020
1041
Display
1053
Processor (DSP/ Microprocessor)
Input Unit
1042
1010
Memory
SIM card
1052

FIG. 9

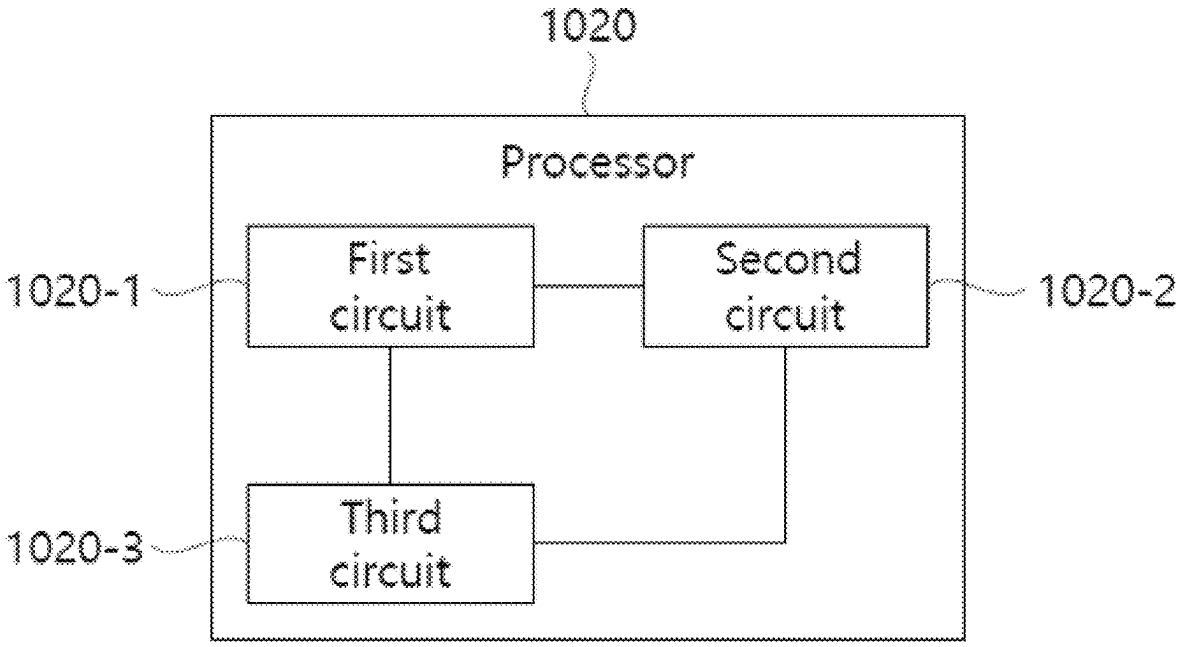

1020
Processor
First circuit
Second circuit
Third circuit
1020-1
1020-2
1020-3

FIG. 10

# METHOD AND USER EQUIPMENT FOR ACTIVATING ACCESS STRATUM LAYER UPON COMING OUT OF THE UNAVAILABILITY PERIOD

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the priority of Korean Patent Applications No. 10-2024-0118072 filed on Aug. 30, 2024 and No. 10-2025-0033814 filed on Mar. 17, 2025, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

## BACKGROUND OF THE DISCLOSURE

### Field of the Disclosure

The present specification relates to a 3GPP wireless communication system.

### Related Art

In 3GPP in which technical standards for mobile communication systems are established, in order to handle 4th generation communication and several related forums and new technologies, research on Long Term Evolution/System Architecture Evolution (LTE/SAE) technology has started as part of efforts to optimize and improve the performance of 3GPP technologies from the end of the year 2004.

SAE that has been performed based on 3GPP SA WG2 is research regarding network technology that aims to determine the structure of a network and to support mobility between heterogeneous networks in line with an LTE task of a 3GPP TSG RAN and is one of recent important standardization issues of 3GPP. SAE is a task for developing a 3GPP system into a system that supports various radio access technologies based on an IP, and the task has been carried out for the purpose of an optimized packet-based system which minimizes transmission delay with a more improved data transmission capability.

An Evolved Packet System (EPS) higher level reference model defined in 3GPP SA WG2 includes a non-roaming case and roaming cases having various scenarios, and for details therefor, reference can be made to 3GPP standard documents TS 23.401 and TS 23.402. A network configuration of FIG. **1** has been briefly reconfigured from the EPS higher level reference model.

FIG. **1** shows the configuration of an evolved mobile communication network.

An Evolved Packet Core (EPC) may include various elements. FIG. **1** illustrates a Serving Gateway (S-GW) **52**, a Packet Data Network Gateway (PDN GW) **53**, a Mobility Management Entity (MME) **51**, a Serving General Packet Radio Service (GPRS) Supporting Node (SGSN), and an enhanced Packet Data Gateway (ePDG) that correspond to some of the various elements.

The S-GW **52** is an element that operates at a boundary point between a Radio Access Network (RAN) and a core network and has a function of maintaining a data path between an eNodeB **22** and the PDN GW **53**. Furthermore, if a terminal (or User Equipment (UE) moves in a region in which service is provided by the eNodeB **22**, the S-GW **52** plays a role of a local mobility anchor point. That is, for mobility within an E-UTRAN (i.e., a Universal Mobile Telecommunications System (Evolved-UMTS) Terrestrial Radio Access Network defined after 3GPP release-8), packets can be routed through the S-GW **52**. Furthermore, the S-GW **52** may play a role of an anchor point for mobility with another 3GPP network (i.e., a RAN defined prior to 3GPP release-8, for example, a UTRAN or Global System for Mobile communication (GSM) (GERAN)/Enhanced Data rates for Global Evolution (EDGE) Radio Access Network).



The PDN GW (or P-GW) **53** corresponds to the termination point of a data interface toward a packet data network. The PDN GW **53** can support policy enforcement features, packet filtering, charging support, etc. Furthermore, the PDN GW (or P-GW) **53** can play a role of an anchor point for mobility management with a 3GPP network and a non-3GPP network (e.g., an unreliable network, such as an Interworking Wireless Local Area Network (I-WLAN), a Code Division Multiple Access (CDMA) network, or a reliable network, such as WiMax).

In the network configuration of FIG. **1**, the S-GW **52** and the PDN GW **53** have been illustrated as being separate gateways, but the two gateways may be implemented in accordance with a single gateway configuration option.

The MME **51** is an element for performing the access of a terminal to a network connection and signaling and control functions for supporting the allocation, tracking, paging, roaming, handover, etc. of network resources. The MME **51** controls control plane functions related to subscribers and session management. The MME **51** manages numerous eNodeBs **22** and performs conventional signaling for selecting a gateway for handover to another 2G/3G networks. Furthermore, the MME **51** performs functions, such as security procedures, terminal-to-network session handling, and idle terminal location management.

The SGSN handles all packet data, such as a user's mobility management and authentication for different access 3GPP networks (e.g., a GPRS network and an UTRAN/GERAN).

The ePDG plays a role of a security node for an unreliable non-3GPP network (e.g., an I-WLAN and a Wi-Fi hotspot).

As described with reference to FIG. **1**, a terminal (or UE) having an IP capability can access an IP service network (e.g., IMS), provided by a service provider (i.e., an operator), via various elements within an EPC based on non-3GPP access as well as based on 3GPP access.

Furthermore, FIG. **1** shows various reference points (e.g., S1-U and S1-MME). In a 3GPP system, a conceptual link that connects two functions that are present in the different function entities of an E-UTRAN and an EPC is called a reference point. Table 1 below defines reference points shown in FIG. **1**. In addition to the reference points shown in the example of Table 1, various reference points may be present depending on a network configuration.

TABLE 1

| REFERENCE POINT | DESCRIPTION |
|---|---|
| S1-MME | A reference point for a control plane protocol between the E-UTRAN and the MME |
| S1-U | A reference point between the E-UTRAN and the S-GW for path switching between eNodeBs during handover and user plane tunneling per bearer |
| S3 | A reference point between the MME and the SGSN that provides the exchange of pieces of user and bearer information for mobility between 3GPP access networks in idle and/or activation state. This reference point can be used intra-PLMN or inter-PLMN (e.g. in the case of Inter-PLMN HO). |
| S4 | A reference point between the SGW and the SGSN that |

TABLE 1-continued

| REFERENCE POINT | DESCRIPTION |
|---|---|
| | provides related control and mobility support between the 3GPP anchor functions of a GPRS core and the S-GW. Furthermore, if a direct tunnel is not established, the reference point provides user plane tunneling. |
| S5 | A reference point that provides user plane tunneling and tunnel management between the S-GW and the PDN GW. The reference point is used for S-GW relocation due to UE mobility and if the S-GW needs to connect to a non-collocated PDN GW for required PDN connectivity |
| S11 | A reference point between the MME and the S-GW |
| SGi | A reference point between the PDN GW and the PDN. The PDN may be a public or private PDN external to an operator or may be an intra-operator PDN, e.g., for the providing of IMS services. This reference point corresponds to Gi for 3GPP access. |

Among the reference points shown in FIG. **1**, S2*a* and S2*b* correspond to non-3GPP interfaces. S2*a* is a reference point providing the user plane with related control and mobility support between a PDN GW and a reliable non-3GPP access. S2*b* is a reference point providing the user plane with mobility support and related control between a PDN GW and an ePDG.

## SUMMARY OF THE DISCLOSURE

The disclosure of this specification aims to provide a method and user equipment for activating an access stratum (AS) layer upon coming out of the unavailability period.

According to one embodiment of this specification, there is provided an operation method of user equipment (UE). The method may comprise: triggering a tracking area update (TAU) procedure when an unavailability period has ended and a discontinuous coverage maximum time offset timer has expired; starting a first timer at completion of the tracking area update procedure if the UE has included unavailability information and has not included a start of the unavailability period in a tracking area update request message; and upon coming out of the unavailability period, activating an access stratum (AS) layer.

According to one embodiment of this specification, there is also provided a user equipment (UE). The UE may comprise: at least one processor; and at least one computer memory operably connectable to the at least one processor and storing instructions that, when executed by the at least one processor, perform operations comprising: triggering a tracking area update (TAU) procedure when an unavailability period has ended and a discontinuous coverage maximum time offset timer has expired; starting a first timer at completion of the tracking area update procedure if the UE has included unavailability information and has not included a start of the unavailability period in a tracking area update request message; and upon coming out of the unavailability period, activating an access stratum (AS) layer.

According to one embodiment of this specification, there is also provided a semiconductor chipset. The semiconductor chipset may comprise: at least one processor; and at least one memory capable of storing instructions and being connected electrically to the at least one processor operably. Operations, performed when the instructions are executed by the at least one processor, may comprise: triggering a tracking area update (TAU) procedure when an unavailability period has ended and a discontinuous coverage maximum time offset timer has expired; starting a first timer at completion of the tracking area update procedure if the UE has included unavailability information and has not included a start of the unavailability period in a tracking area update request message; and upon coming out of the unavailability period, activating an access stratum (AS) layer.

According to one embodiment of this specification, there is also provided a non-volatile computer-readable storage medium recording instructions. The instructions, when executed by one or more processors, instruct the one or more processors to perform operations comprising: triggering a tracking area update (TAU) procedure when an unavailability period has ended and a discontinuous coverage maximum time offset timer has expired; starting a first timer at completion of the tracking area update procedure if the UE has included unavailability information and has not included a start of the unavailability period in a tracking area update request message; and upon coming out of the unavailability period, activating an access stratum (AS) layer.

The method and/or operations may further comprise: if the first timer is not running and if the UE has included the unavailability information and has not included a start of the unavailability period in the tracking area update request message, locally releasing the NAS signalling connection at completion of the tracking area update procedure.

The method and/or operations may further comprise: entering a registered state.

The tracking area update request message may include the unavailability information, but does not include the start of the unavailability period.

The method and/or operations may further comprise: transmitting the tracking area update request message which includes the unavailability information, but does not include the start of the unavailability period.

If a discontinuous coverage maximum time offset has been stored, and if a last TRACKING AREA UPDATE ACCEPT message includes an end of unavailability report bit, which is set to "UE needs to report end of unavailability period", upon returning in coverage after being out of coverage due to discontinuous coverage, the UE may set the discontinuous coverage maximum time offset value to a random value up to and including the stored discontinuous coverage maximum time offset for this PLMN and satellite E-UTRAN access and start this timer.

According to the disclosure of this specification, the UE may activate an access stratum (AS) layer upon coming out of the unavailability period.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a view illustrating the structure of an evolved mobile communication network.

FIG. **2** is an exemplary view illustrating functions of main nodes of a common E-UTRAN and a common EPC.

FIG. **3** is an exemplary view illustrating the structure of a radio interface protocol in a control plane between a UE and an eNodeB.

FIG. **4** is another exemplary view illustrating the structure of a radio interface protocol in a user plane between a UE and a base station.

FIG. **5** is a flowchart illustrating a random access procedure in 3GPP LTE.

FIG. **6** illustrates a connection process in a radio resource control (RRC) layer.

FIG. **7** is an exemplary view illustrating a Tracking Area Update (TAU) procedure.

FIG. **8** is an example diagram illustrating a procedure according to one embodiment of this specification.

FIG. **9** is a block diagram showing a structure of a UE **100** according to an embodiment.

FIG. **10** illustrates a block diagram of a processor in which the present disclosure is implemented.

## DESCRIPTION OF EXEMPLARY EMBODIMENTS

The present invention is described in light of UMTS (Universal Mobile Telecommunication System) and EPC (Evolved Packet Core), but not limited to such communication systems, and may be rather applicable to all communication systems and methods to which the technical spirit of the present invention may apply.

The technical terms used herein are used to merely describe specific embodiments and should not be construed as limiting the present invention. Further, the technical terms used herein should be, unless defined otherwise, interpreted as having meanings generally understood by those skilled in the art but not too broadly or too narrowly. Further, the technical terms used herein, which are determined not to exactly represent the spirit of the invention, should be replaced by or understood by such technical terms as being able to be exactly understood by those skilled in the art. Further, the general terms used herein should be interpreted in the context as defined in the dictionary, but not in an excessively narrowed manner.

The expression of the singular number in the specification includes the meaning of the plural number unless the meaning of the singular number is definitely different from that of the plural number in the context. In the following description, the term 'include' or 'have' may represent the existence of a feature, a number, a step, an operation, a component, a part or the combination thereof described in the specification, and may not exclude the existence or addition of another feature, another number, another step, another operation, another component, another part or the combination thereof.

The terms 'first' and 'second' are used for the purpose of explanation about various components, and the components are not limited to the terms 'first' and 'second'. The terms 'first' and 'second' are only used to distinguish one component from another component. For example, a first component may be named as a second component without deviating from the scope of the present invention.

It will be understood that when an element or layer is referred to as being "connected to" or "coupled to" another element or layer, it can be directly connected or coupled to the other element or layer or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly connected to" or "directly coupled to" another element or layer, there are no intervening elements or layers present.

Hereinafter, exemplary embodiments of the present invention will be described in greater detail with reference to the accompanying drawings. In describing the present invention, for ease of understanding, the same reference numerals are used to denote the same components throughout the drawings, and repetitive description on the same components will be omitted. Detailed description on well-known arts which are determined to make the gist of the invention unclear will be omitted. The accompanying drawings are provided to merely make the spirit of the invention readily understood, but not should be intended to be limiting of the invention. It should be understood that the spirit of the invention may be expanded to its modifications, replacements or equivalents in addition to what is shown in the drawings.

In the drawings, user equipments (UEs) are shown for example. The UE may also be denoted a terminal or mobile equipment (ME). The UE may be a laptop computer, a mobile phone, a PDA, a smartphone, a multimedia device, or other portable device, or may be a stationary device such as a PC or a car mounted device.

## DEFINITION OF TERMS

For a better understanding, the terms used herein are briefly defined before going to the detailed description of the invention with reference to the accompanying drawings.

UMTS: stands for Universal Mobile Telecommunication System and means a 3rd generation mobile communication network.

UE/MS: User Equipment/Mobile Station. Means a terminal device.

EPC: stands for Evolved Packet Core and means a core network supportive of a long term evolution (LTE) network. An evolved version of UMTS

EPS: stands for Evolved Packet System and means a mobile communication system including a UE, an access network including LTE, and an EPC

PDN (Public Data Network): an independent network in which a service providing server is located

PDN connection: connection from UE to PDN, i.e., association (connection) between a UE represented with an IP address and a PDN represented with an APN (access point name)

PDN-GW (Packet Data Network Gateway): a network node of an EPS network performing functions such as UE IP address allocation, packet screening & filtering, and charging data collection

Serving GW (Serving Gateway): a network node of an EPS network performing functions such as mobility anchor, packet routing, idle mode packet buffering, and triggering MME to page UE

PCRF (Policy and Charging Rule Function): an EPS network node performing policy decision for dynamically applying QoSs and billing policies differentiated per service flow

APN (Access Point Name): name of an access point managed by a network, provided from a UE, i.e., a character string for denoting a PDN or distinguishing a PDN from another. Accessing a requested service or network (PDN) gets through a corresponding P-GW, and an APN is a name (e.g., internet.mnc012.mcc345.gprs) pre-defined in the network to be able to discover the P-GW.

TEID (Tunnel Endpoint Identifier): End point ID of a tunnel configured between nodes in a network. A TEID is configured per section by the bearer of each UE.

NodeB: a UMTS network base station. A NodeB is installed outdoors and corresponds in cell coverage size to a macro cell.

eNodeB: an EPS (Evolved Packet System) base station and is installed outdoors. An eNodeB corresponds in cell coverage size to a macro cell.

(e) NodeB: collectively denotes NodeB and eNodeB

MME: stands for Mobility Management Entity and plays a role to control each entity in an EPS to provide mobility and session for a UE.

Session: a pathway for data transmission. The unit of session may include PDN, bearer, and IP flow which respectively correspond the unit of the overall target network (unit

of APN or PDN), the unit distinguished by QoS therein (unit of bearer), and unit of destination IP address.

PDN connection: a connection from a UE to a PDN, i.e., an association (connection) between a UE represented with an IP address and a PDN represented with an APN. This means a connection (UE-PDN GW) between entities in a core network to form a session.

UE Context: information on UE's context used to manage UE in network, i.e., context information consisting of UE id, mobility (e.g., current location), and session attribute (QoS, or priority)

OMA DM (Open Mobile Alliance Device Management): a protocol designed for managing mobile devices such as mobile phones, PDAs, or portable computers and performs functions such as device configuration, firmware upgrade, and error reporting.

OAM (Operation Administration and Maintenance): denotes a group of network management functions displaying network faults and providing capability information, diagnosis and data.

NAS configuration MO (Management Object): MO (Management Object) used to configure in UE parameters associated with NAS functionality

Hereinafter, the present disclosure is described with reference to the accompanying drawings.

In 3GPP in which technical standards for mobile communication systems are established, in order to handle 4th generation communication and several related forums and new technologies, research on Long Term Evolution/System Architecture Evolution (LTE/SAE) technology has started as part of efforts to optimize and improve the performance of 3GPP technologies from the end of the year 2004.

SAE that has been performed based on 3GPP SA WG2 is research regarding network technology that aims to determine the structure of a network and to support mobility between heterogeneous networks in line with an LTE task of a 3GPP TSG RAN and is one of recent important standardization issues of 3GPP. SAE is a task for developing a 3GPP system into a system that supports various radio access technologies based on an IP, and the task has been carried out for the purpose of an optimized packet-based system which minimizes transmission delay with a more improved data transmission capability.

An Evolved Packet System (EPS) higher level reference model defined in 3GPP SA WG2 includes a non-roaming case and roaming cases having various scenarios, and for details therefor, reference can be made to 3GPP standard documents TS 23.401 and TS 23.402. A network configuration of FIG. **1** has been briefly reconfigured from the EPS higher level reference model.

FIG. **2** is an exemplary diagram showing the architecture of a common E-UTRAN and a common EPC.

As shown in FIG. **2**, the eNodeB **20** can perform functions, such as routing to a gateway while RRC connection is activated, the scheduling and transmission of a paging message, the scheduling and transmission of a broadcast channel (BCH), the dynamic allocation of resources to UE in uplink and downlink, a configuration and providing for the measurement of the eNodeB **20**, control of a radio bearer, radio admission control, and connection mobility control. The EPC can perform functions, such as the generation of paging, the management of an LTE_IDLE state, the ciphering of a user plane, control of an EPS bearer, the ciphering of NAS signaling, and integrity protection.

FIG. **3** is an exemplary diagram showing the structure of a radio interface protocol in a control plane between UE and an eNodeB, and FIG. **4** is another exemplary diagram showing the structure of a radio interface protocol in a control plane between UE and an eNodeB.

The radio interface protocol is based on a 3GPP radio access network standard. The radio interface protocol includes a physical layer, a data link layer, and a network layer horizontally, and it is divided into a user plane for the transmission of information and a control plane for the transfer of a control signal (or signaling).

The protocol layers may be classified into a first layer (L1), a second layer (L2), and a third layer (L3) based on three lower layers of the Open System Interconnection (OSI) reference model that is widely known in communication systems.

The layers of the radio protocol of the control plane shown in FIG. **3** and the radio protocol in the user plane of FIG. **4** are described below.

The physical layer PHY, that is, the first layer, provides information transfer service using physical channels. The PHY layer is connected to a Medium Access Control (MAC) layer placed in a higher layer through a transport channel, and data is transferred between the MAC layer and the PHY layer through the transport channel. Furthermore, data is transferred between different PHY layers, that is, PHY layers on the sender side and the receiver side, through the PHY layer.

A physical channel is made up of multiple subframes on a time axis and multiple subcarriers on a frequency axis. Here, one subframe is made up of a plurality of symbols and a plurality of subcarriers on the time axis. One subframe is made up of a plurality of resource blocks, and one resource block is made up of a plurality of symbols and a plurality of subcarriers. A Transmission Time Interval (TTI), that is, a unit time during which data is transmitted, is 1 ms corresponding to one subframe.

In accordance with 3GPP LTE, physical channels that are present in the physical layer of the sender side and the receiver side can be divided into a Physical Downlink Shared Channel (PDSCH) and a Physical Uplink Shared Channel (PUSCH), that is, data channels, and a Physical Downlink Control Channel (PDCCH), a Physical Control Format Indicator Channel (PCFICH), a Physical Hybrid-ARQ Indicator Channel (PHICH), and a Physical Uplink Control Channel (PUCCH), that is, control channels.

A PCFICH that is transmitted in the first OFDM symbol of a subframe carries a Control Format Indicator (CFI) regarding the number of OFDM symbols (i.e., the size of a control region) used to send control channels within the subframe. A wireless device first receives a CFI on a PCFICH and then monitors PDCCHs.

Unlike a PDCCH, a PCFICH is transmitted through the fixed PCFICH resources of a subframe without using blind decoding.

A PHICH carries positive-acknowledgement (ACK)/negative-acknowledgement (NACK) signals for an uplink (UL) Hybrid Automatic Repeat reQuest (HARQ). ACK/NACK signals for UL data on a PUSCH that is transmitted by a wireless device are transmitted on a PHICH.

A Physical Broadcast Channel (PBCH) is transmitted in four former OFDM symbols of the second slot of the first subframe of a radio frame. The PBCH carries system information that is essential for a wireless device to communicate with an eNodeB, and system information transmitted through a PBCH is called a Master Information Block (MIB). In contrast, system information transmitted on a PDSCH indicated by a PDCCH is called a System Information Block (SIB).

A PDCCH can carry the resource allocation and transport format of a downlink-shared channel (DL-SCH), information about the resource allocation of an uplink shared channel (UL-SCH), paging information for a PCH, system information for a DL-SCH, the resource allocation of an upper layer control message transmitted on a PDSCH, such as a random access response, a set of transmit power control commands for pieces of UE within a specific UE group, and the activation of a Voice over Internet Protocol (VOIP). A plurality of PDCCHs can be transmitted within the control region, and UE can monitor a plurality of PDCCHs. A PDCCH is transmitted on one Control Channel Element (CCE) or an aggregation of multiple contiguous CCEs. A CCE is a logical allocation unit used to provide a PDCCH with a coding rate according to the state of a radio channel. A CCE corresponds to a plurality of resource element groups. The format of a PDCCH and the number of bits of a possible PDCCH are determined by a relationship between the number of CCEs and a coding rate provided by CCEs.

Control information transmitted through a PDCCH is called Downlink Control Information (DCI). DCI can include the resource allocation of a PDSCH (also called a downlink (DL) grant)), the resource allocation of a PUSCH (also called an uplink (UL) grant), a set of transmit power control commands for pieces of UE within a specific UE group, and/or the activation of a Voice over Internet Protocol (VOIP).

Several layers are present in the second layer. First, a Medium Access Control (MAC) layer functions to map various logical channels to various transport channels and also plays a role of logical channel multiplexing for mapping multiple logical channels to one transport channel. The MAC layer is connected to a Radio Link Control (RLC) layer, that is, a higher layer, through a logical channel. The logical channel is basically divided into a control channel through which information of the control plane is transmitted and a traffic channel through which information of the user plane is transmitted depending on the type of transmitted information.

The RLC layer of the second layer functions to control a data size that is suitable for sending, by a lower layer, data received from a higher layer in a radio section by segmenting and concatenating the data. Furthermore, in order to guarantee various types of QoS required by radio bearers, the RLC layer provides three types of operation modes: a Transparent Mode (TM), an Un-acknowledged Mode (UM), and an Acknowledged Mode (AM). In particular, AM RLC performs a retransmission function through an Automatic Repeat and Request (ARQ) function for reliable data transmission.

The Packet Data Convergence Protocol (PDCP) layer of the second layer performs a header compression function for reducing the size of an IP packet header containing control information that is relatively large in size and unnecessary in order to efficiently send an IP packet, such as IPv4 or IPv6, in a radio section having a small bandwidth when sending the IP packet. Accordingly, transmission efficiency of the radio section can be increased because only essential information is transmitted in the header part of data. Furthermore, in an LTE system, the PDCP layer also performs a security function. The security function includes ciphering for preventing the interception of data by a third party and integrity protection for preventing the manipulation of data by a third party.

A Radio Resource Control (RRC) layer at the highest place of the third layer is defined only in the control plane and is responsible for control of logical channels, transport channels, and physical channels in relation to the configuration, re-configuration, and release of Radio Bearers (RBs). Here, the RB means service provided by the second layer in order to transfer data between UE and an E-UTRAN.

If an RRC connection is present between the RRC layer of UE and the RRC layer of a wireless network, the UE is in an RRC_CONNECTED state. If not, the UE is in an RRC_IDLE state.

An RRC state and an RRC connection method of UE are described below. The RRC state means whether or not the RRC layer of UE has been logically connected to the RRC layer of an E-UTRAN. If the RRC layer of UE is logically connected to the RRC layer of an E-UTRAN, it is called the RRC_CONNECTED state. If the RRC layer of UE is not logically connected to the RRC layer of an E-UTRAN, it is called the RRC_IDLE state. Since UE in the RRC_CONNECTED state has an RRC connection, an E-UTRAN can check the existence of the UE in a cell unit, and thus control the UE effectively. In contrast, if UE is in the RRC_IDLE state, an E-UTRAN cannot check the existence of the UE, and a core network is managed in a Tracking Area (TA) unit, that is, an area unit greater than a cell. That is, only the existence of UE in the RRC_IDLE state is checked in an area unit greater than a cell. In such a case, the UE needs to shift to the RRC_CONNECTED state in order to be provided with common mobile communication service, such as voice or data. Each TA is classified through Tracking Area Identity (TAI). UE can configure TAI through Tracking Area Code (TAC), that is, information broadcasted by a cell.

When a user first turns on the power of UE, the UE first searches for a proper cell, establishes an RRC connection in the corresponding cell, and registers information about the UE with a core network. Thereafter, the UE stays in the RRC_IDLE state. The UE in the RRC_IDLE state (re) selects a cell if necessary and checks system information or paging information. This process is called camp on. When the UE in the RRC_IDLE state needs to establish an RRC connection, the UE establishes an RRC connection with the RRC layer of an E-UTRAN through an RRC connection procedure and shifts to the RRC_CONNECTED state. A case where the UE in the RRC_IDLE state needs to establish with an RRC connection includes multiple cases. The multiple cases may include, for example, a case where UL data needs to be transmitted for a reason, such as a call attempt made by a user and a case where a response message needs to be transmitted in response to a paging message received from an E-UTRAN.

A Non-Access Stratum (NAS) layer placed over the RRC layer performs functions, such as session management and mobility management.

The NAS layer shown in FIG. **3** is described in detail below.

Evolved Session Management (ESM) belonging to the NAS layer performs functions, such as the management of default bearers and the management of dedicated bearers, and ESM is responsible for control that is necessary for UE to use PS service from a network. Default bearer resources are characterized in that they are allocated by a network when UE first accesses a specific Packet Data Network (PDN) or accesses a network. Here, the network allocates an IP address available for UE so that the UE can use data service and the QoS of a default bearer. LTE supports two types of bearers: a bearer having Guaranteed Bit Rate (GBR) QOS characteristic that guarantees a specific bandwidth for the transmission and reception of data and a non-GBR bearer having the best effort QoS characteristic without guaranteeing a bandwidth. A default bearer is assigned a

non-GBR bearer, and a dedicated bearer may be assigned a bearer having a GBR or non-GBR QOS characteristic.

In a network, a bearer assigned to UE is called an Evolved Packet Service (EPS) bearer. When assigning an EPS bearer, a network assigns one ID. This is called an EPS bearer ID. One EPS bearer has QoS characteristics of a Maximum Bit Rate (MBR) and a Guaranteed Bit Rate (GBR) or an Aggregated Maximum Bit Rate (AMBR).

FIG. **5** is a flowchart illustrating a random access process in 3GPP LTE.

The random access process is used for UE **10** to obtain UL synchronization with a base station, that is, an eNodeB **20**, or to be assigned UL radio resources.

The UE **10** receives a root index and a physical random access channel (PRACH) configuration index from the eNodeB **20**. **64** candidate random access preambles defined by a Zadoff-Chu (ZC) sequence are present in each cell. The root index is a logical index that is used for the UE to generate the **64** candidate random access preambles.

The transmission of a random access preamble is limited to specific time and frequency resources in each cell. The PRACH configuration index indicates a specific subframe on which a random access preamble can be transmitted and a preamble format.

The UE **10** sends a randomly selected random access preamble to the eNodeB **20**. Here, the UE **10** selects one of the **64** candidate random access preambles. Furthermore, the UE selects a subframe corresponding to the PRACH configuration index. The UE **10** sends the selected random access preamble in the selected subframe.

The eNodeB **20** that has received the random access preamble sends a Random Access Response (RAR) to the UE **10**. The random access response is detected in two steps. First, the UE **10** detects a PDCCH masked with a random access-RNTI (RA-RNTI). The UE **10** receives a random access response within a Medium Access Control (MAC) Protocol Data Unit (PDU) on a PDSCH that is indicated by the detected PDCCH.

FIG. **6** illustrates a connection process in a radio resource control (RRC) layer.

FIG. **6** shows an RRC state depending on whether there is an RRC connection. The RRC state denotes whether the entity of the RRC layer of UE **10** is in logical connection with the entity of the RRC layer of eNodeB **20**, and if yes, it is referred to as RRC connected state, and if no as RRC idle state.

In the connected state, UE **10** has an RRC connection, and thus, the E-UTRAN may grasp the presence of the UE on a cell basis and may thus effectively control UE **10**. In contrast, UE **10** in the idle state cannot grasp eNodeB **20** and is managed by a core network on the basis of a tracking area that is larger than a cell. The tracking area is a set of cells. That is, UE **10** in the idle state is grasped for its presence only on a larger area basis, and the UE should switch to the connected state to receive a typical mobile communication service such as voice or data service.

When the user turns on UE **10**, UE **10** searches for a proper cell and stays in idle state in the cell. UE **10**, when required, establishes an RRC connection with the RRC layer of eNodeB **20** through an RRC connection procedure and transits to the RRC connected state.

There are a number of situations where the UE staying in the idle state needs to establish an RRC connection, for example, when the user attempts to call or when uplink data transmission is needed, or when transmitting a message responsive to reception of a paging message from the EUTRAN.

In order for the idle UE **10** to be RRC connected with eNodeB **20**, UE **10** needs to perform the RRC connection procedure as described above. The RRC connection procedure generally comes with the process in which UE **10** transmits an RRC connection request message to eNodeB **20**, the process in which eNodeB **20** transmits an RRC connection setup message to UE **10**, and the process in which UE **10** transmits an RRC connection setup complete message to eNodeB **20**. The processes are described in further detail with reference to FIG. **6**.

1) The idle UE **10**, when attempting to establish an RRC connection, e.g., for attempting to call or transmit data or responding to paging from eNodeB **20**, sends an RRC connection request message to eNodeB **20**.
2) When receiving the RRC connection message from UE **10**, eNodeB **20** accepts the RRC connection request from UE **10** if there are enough radio resources, and eNodeB **20** sends a response message, RRC connection setup message, to UE **10**.
3) When receiving the RRC connection setup message, UE **10** transmits an RRC connection setup complete message to eNodeB **20**. If UE **10** successfully transmits the RRC connection setup message, UE **10** happens to establish an RRC connection with eNodeB **20** and switches to the RRC connected state.

FIG. **7** shows an exemplary Tracking Area Update (TAU) procedure.

1) In idle mode, the UE **100** moves into the coverage of the target eNodeB **200***b*. Accordingly, a Tracking Area Update (TAU) procedure is determined to start.
2) Then, the UE **100** sends a TAU request message to the target eNodeB **200***b*.
3) Then, the target eNodeB **200***b* determines a responsible MME. In this case, assume, for example, that the target MME **510***b* is determined as a proper responsible MME. The target eNodeB **200***b* transfers the TAU request message to the target MME **510***b*. In this case, assume that the S-GW **520** is not changed.

4-5) Then, the target MME **510***b* sends the UE's context request (e.g., Context Request) to the source MME **510***a*, and in response, receives a context response (e.g., Context Response). This is a process to obtain PDN connection-related information and EPS bearer-related information from the source MME **510***a*.

6) The UE **100** conducts an authentication/security procedure with the target MME **510***b*, and the target MME **510***b* conducts a security procedure with the HSS **590**.
7) Meanwhile, the target MME **510***b* transmits to the source MME **510***a* a context acknowledge (e.g., Context Acknowledge) message in response to obtaining the context.
8) Subsequently, the target MME **510***b*, since the S-GW **520** is not changed by the TAU, transmits to the S-GW **520** a bearer modification request message (e.g., Modify Bearer Request), not a session creation request message (e.g., Create Session Request).

9-11) Then, the S-GW **520** transmits a bearer modification request message to the PDN-GW **530** as necessary. The PDN-GW **530** performs an IP-CAN session modification procedure as necessary. The PDN-GW **530** transmits a bearer modification response message (e.g., Modify Bearer Response) to the S-GW **520**.

12) Then, the S-GW **520** transmits a bearer modification response message to the target MME **510***b*.
13) Then, the target MME **510***b* transmits to the HSS **590** a location update request message (e.g., Update Location Request).

14-15) Then, the HSS **590** transmits a location cancel message (e.g., Cancel Location) to the source MME **510***a*, and the source MME **510***a* transmits a location cancel acknowledgement message (e.g., Cancel Location Ack) to the HSS **590**.

16) Then, the HSS **590** transmits a location update acknowledgement message (e.g., Update Location Ack) to the target MME **510***b*.

17-18) Then, the target MME **510***b* transmits a TAU accept message (e.g., TAU accept) to the UE **100** through the target eNodeB **200***b*, and the UE **100** transmits a TAU complete message (e.g., TAU Complete) to the target MME **510***b* as necessary.

Hereinafter, the following Table 2 to Table 9 show the messages used in each process.

First, the TAU request message may contain one or more pieces of information as shown in Table 2.

TABLE 2

| |
|---|
| Protocol discriminator |
| Security header type |
| Tracking area update request message identity |
| EPS update type |
| NAS key set identifier |
| Old GUTI |
| Non-current native NAS key set identifier |
| GPRS ciphering key sequence number |
| Old P-TMSI signature |
| Additional GUTI |
| NonceUE |
| UE network capability |
| Last visited registered TAI |
| DRX parameter |
| UE radio capability information update needed |
| EPS bearer context status |
| MS network capability |
| Old location area identification |
| TMSI status |
| Mobile station classmark 2 |
| Mobile station classmark 3 |
| Supported Codecs |
| Additional update type |
| Voice domain preference and UE's usage setting |
| Old GUTI type |
| Device properties |
| MS network feature support |
| TMSI based NRI container |

The EPC Update type information element shown in Table 2 above may contain the following bits.

TABLE 3

| EPC Update Type Value |
|---|
| 000: indicates TAU |
| 001: indicates joint update of TAU/LA(Location Area) |
| 010: indicates joint update of TAU/LA (Location Area) together with IMSI attach |
| 011: indicates periodic update |
| 100: unused (if used, interpreted as TAU) |
| 101: unused (if used, interpreted as TAU) |
| "Active" flag (octet 1, bit 4) |
| 0: bearer creation not requested |
| 1: bearer creation requested |

Meanwhile, the above-described context request message may contain the information elements shown in the following Table 4.

TABLE 4

| Information elements | Conditions/descriptions |
|---|---|
| IMSI | should be included in case UE successfully authenticated |
| GUTI | A new target MME should include over S10 interface may be included if SRVCC procedure from UTRAN/GERN to E-UTRAN is available |
| Complete TAU request message | a new target MME may include if previous source MME needs it for acknowledgement of no decision |
| RAT Type | indicates what radio access technology is in use |
| Target PLMN ID | if available, may be included for previous MME to determine whether unused authentication vector is to be distributed |
| MME node name | is transferred by a new target MME if the new target MME and associated S-GW both support SR |

Meanwhile, the context response message may contain the information elements shown in the following Table 5.

TABLE 5

| Information element | Conditions/descriptions |
|---|---|
| IMSI | IMSI necessarily included except emergency even when UE does not have UICC |
| MME/SGSN UE EPS PDN Connections | Included in case at least one PDN connection is present for UE. |
| SGW node name | Indicates the identifier that has been used to identify S-GW by previous source MME |
| Trace Information | may be included in case session tracking is activated |
| Subscribed RESP Index | May be included during mobility procedure between MMEs |
| UE Time Zone | Included by source MME |
| MME node name | Transmitted by previous source MME in case previous MME and associated S-GW both support ISR |

The information on the PDN connection in the context response message may contain the information elements shown in the following Table 6.

TABLE 6

| | |
|---|---|
| APN Restriction | Indicates limitations on combinations of APN types for APNs related to bearer context. Target MME or SGSN may determine the largest APN limitation using the APN limitations. |
| Linked EPS Bearer ID | Indicates basic bearer of PDN connection |
| PGW node name | may be included in case source MME has the overall name (e.g., FQDN) of PDN GW |
| Bearer Contexts | a number of pieces of information of such type may be included |
| Charging characteristics | May be included in case billing information is offered by HSS to MME |
| Change Reporting Action | May be included whenever available by source MME |

The bearer context information included in the PDN connection information in the context response may contain the information shown in the following Table 7.

TABLE 7

| Information elements | Conditions/descriptions |
|---|---|
| PGW S5/S8 IP Address and TEID for user plane | May be included for GTP-based S5/S8 |

TABLE 7-continued

| Information elements | Conditions/descriptions |
|---|---|
| Bearer Level QoS | |
| BSS Container | MME may include packet flow ID, radio priority, SAPI, PS handover XID parameter in TAU/RAU/ handover procedure-related message |
| Transaction Identifier | may be transmitted over S3/S10/S16 in case UE supports A/Gb and/or Iu mode |

The TAU accept message may contain the information shown in the following Table 8.

TABLE 8

| Information | Description |
|---|---|
| TAU accept message identifier | message identifier |
| TAU result | indicate result of update, e.g. success or fail |
| T3412 value | timer value for periodic TAU |
| T3402 value | timer starting upon TAU failure |
| T3412 extended value | extended value of T3412 for further lengthening periodic TAU |

In Table 8 above, the T3412 value is a value for allowing the UE **100** to conduct periodic TAU. In order to reduce network load by such periodic TAU, the T3412 extended value is present which allows TAU to be conducted at a longer period. The T3412 extended value may be set up in the MME or may be retained as subscriber information in the HSS **540**.

<The Disclosure of the Present Specification>

FIG. **8** is an example diagram illustrating a procedure according to one embodiment of this specification.

Referring to FIG. **8**, a user equipment (UE) may trigger a tracking area update (TAU) procedure **S110** when an unavailability period has ended and a discontinuous coverage maximum time offset timer has expired.

The UE may start a first timer **S120** at completion of the tracking area update procedure if the UE has included unavailability information and has not included a start of the unavailability period in a tracking area update request message

Also, the UE may activate an access stratum (AS) layer **S130**, upon coming out of the unavailability period.

If the first timer is not running and if the UE has included the unavailability information and has not included a start of the unavailability period in the tracking area update request message, the UE may locally release the NAS signalling connection at completion of the tracking area update procedure.

The UE may enter a registered state.

The tracking area update request message may include the unavailability information, but does not include the start of the unavailability period.

The UE may transmit the tracking area update request message which includes the unavailability information, but does not include the start of the unavailability period.

If a discontinuous coverage maximum time offset has been stored, and if a last TRACKING AREA UPDATE ACCEPT message includes an end of unavailability report bit, which is set to "UE needs to report end of unavailability period", upon returning in coverage after being out of coverage due to discontinuous coverage, the UE may set the discontinuous coverage maximum time offset value to a random value up to and including the stored discontinuous coverage maximum time offset for this PLMN and satellite E-UTRAN access and start this timer.

Summary of the Embodiments of this Specification

I. Support for Enhanced Discontinuous Coverage

If the UE and network support enhanced discontinuous coverage, the UE may provide unavailability information to the network in the tracking area updating procedure if the UE is registered over satellite E-UTRAN access. The unavailability information includes the unavailability period duration if known, and the start of the unavailability period if known. The support for the enhanced discontinuous coverage is negotiated in the attach procedure or the tracking area updating procedure. The MME may consider the unavailability period duration if provided by the UE to determine the unavailability period duration of the UE. The MME may consider the start of the unavailability period if provided by the UE to determine the start of the unavailability period of the UE. The MME may provide the unavailability period duration or the start of the unavailability period or both to the UE in the TRACKING AREA UPDATE ACCEPT message or the ATTACH ACCEPT message.

If the UE provided unavailability information in the last tracking area updating procedure, the MME considers the UE unreachable until the UE registers for normal service without providing unavailability information. If the UE did not include a start of the unavailability period, the MME shall consider the start of the unavailability period to be the time at which MME received the TRACKING AREA UPDATE REQUEST message from the UE. The MME may determine the values of the periodic tracking area update timer (T3412), extended idle mode DRX cycle parameters and PSM mode configuration parameters provided to the UE based on the discontinuous coverage maximum time offset, the unavailability period duration and the start of the unavailability period, if available. The MME releases the NAS signalling connection after the completion of the tracking area updating procedure in which the UE provided unavailability information without providing the start of the unavailability period.

If for discontinuous coverage the UE has stored a discontinuous coverage maximum time offset, the UE shall set the discontinuous coverage maximum time offset value to a random value up to and including the stored discontinuous coverage maximum time offset for this PLMN and satellite E-UTRAN access, determine a time point equal to the time when the UE is about to lose satellite coverage minus the discontinuous coverage maximum time offset value, and send the TRACKING AREA UPDATE REQUEST message to the MME to indicate start of unavailability.

If for discontinuous coverage the UE has stored a discontinuous coverage maximum time offset, and in the last TRACKING AREA UPDATE ACCEPT message the End of unavailability report bit in Unavailability configuration IE value was set to "UE needs to report end of unavailability period", upon returning in coverage after being out of coverage due to discontinuous coverage, the UE sets the discontinuous coverage maximum time offset value to a random value up to and including the stored discontinuous coverage maximum time offset for this PLMN and satellite E-UTRAN access and starts this timer. The UE shall not initiate any NAS signalling on that satellite E-UTRAN access and PLMN combination while the discontinuous coverage maximum time offset timer is running. The UE shall stop the discontinuous coverage maximum time offset

timer and initiate NAS signalling if the UE receives a paging message, has pending emergency services, is establishing an emergency PDN connection, is performing emergency services fallback procedure, when the UE enters a new tracking area or if the UE is allowed to use exception data reporting and the UE has to transmit user data related to an exceptional event.

If the MME sets the End of unavailability report bit in Unavailability configuration IE value to "UE does not need to report end of unavailability", then upon returning to coverage to a TAI in the TAI list, the UE is not required to trigger the tracking area update procedure when the unavailability period duration has ended. If the MME does not provide the Unavailability configuration IE or the MME sets the End of unavailability report bit in Unavailability configuration IE value to "UE needs to report end of unavailability", the UE should trigger tracking area update procedure when the unavailability period duration has ended and the discontinuous coverage maximum time offset timer has expired, if any.

If unavailability period is activated due to discontinuous coverage, all NAS timers are stopped and associated procedures aborted except for T3412, T3324, T3346, T3396, T3444, T3445, T3447, T3448, any backoff timers, T3245, T3247, the timer T controlling the periodic search for HPLMN or EHPLMN (if EHPLMN list is present) or higher prioritized PLMNs, the timer TSENSE controlling the periodic search for PLMNs satisfying the operator controlled signal level threshold, the timer TD, the timer TE, the timer TH and the timer instance associated with the entry in the list of "PLMNs not allowed to operate at the present UE location", the UE shall reset the attach attempt counter, tracking area updating attempt counter and service request attempt counter and the UE may deactivate access stratum.

When the UE provides unavailability information using the tracking area updating procedure without providing the start of the unavailability period, then after successful completion of the procedure the UE may deactivate the access stratum and enter the state EMM-REGISTERED.NO-CELL-AVAILABLE. Otherwise, if the UE provided the start of unavailability period, the UE may deactivate the access stratum and enter the state EMM-REGISTERED.NO-CELL-AVAILABLE only after the start of the unavailability period.

When the UE comes out of the unavailability period the UE shall activate the AS layer if deactivated and may perform tracking area update procedure.

II. Release of the NAS Signalling Connection

The signalling procedure for the release of the NAS signalling connection is initiated by the network.

In S1 mode, when the RRC connection has been released, the UE shall enter EMM-IDLE mode and consider the NAS signalling connection released.

If the UE is configured for eCall only mode then:

- if the NAS signalling connection that was released had been established for eCall over IMS, the UE shall start timer T3444; and
- if the NAS signalling connection that was released had been established for a call to an HPLMN designated non-emergency MSISDN or URI for test or terminal reconfiguration service, the UE shall start timer T3445.

The UE shall start the SGC timer T3447 with the service gap time value available in the UE when the NAS signalling connection is released if:

- the UE supports SGC feature, and the service gap timer value is available in the UE and does not indicate zero; and
- the NAS signalling connection that was released had been established for mobile originated request for transfer of uplink data.

If the UE receives the "Extended wait time" from the lower layers when no attach, tracking area updating or service request procedure is ongoing, the UE shall ignore the "Extended wait time".

To allow the network to release the NAS signalling connection, the UE:

a) shall start the timer T3440 if the UE receives any of the EMM cause values #11, #12, #13, #14 (not applicable to the service request procedure), #15, #25, #31, #35, 42 or #78;

a1) may start timer T3440 if the UE receives a SERVICE REJECT message, case e) in clause 5.6.1.6 is applicable and the procedure was started from EMM-IDLE mode;

b) shall start the timer T3440 if:

- the UE receives a TRACKING AREA UPDATE ACCEPT message which does not include a UE radio capability ID deletion indication IE;
- the UE has not set the "active" flag in the TRACKING AREA UPDATE REQUEST message;
- the UE has not set the "signalling active" flag in the TRACKING AREA UPDATE REQUEST message;
- the tracking area updating or combined tracking area updating procedure has been initiated in EMM-IDLE mode, or the UE has set Request type to "NAS signalling connection release" in the UE request type IE in the TRACKING AREA UPDATE REQUEST message and the NAS signalling connection release bit is set to "NAS signalling connection release supported" in the EPS network feature support IE of the TRACKING AREA UPDATE ACCEPT message; and
- the user plane radio bearers have not been set up;

b1) may start the timer T3440 at completion of the tracking area update procedure if the UE has included unavailability information and has not included a start of the unavailability period in the TRACKING AREA UPDATE REQUEST message;

c) shall start the timer T3440 if the UE receives a DETACH ACCEPT message and the UE has set the detach type to "IMSI detach" in the DETACH REQUEST message and user plane radio bearers have not been set up;

d) shall start the timer T3440 if the UE receives a TRACKING AREA UPDATE REJECT message indicating:

- any of the EMM cause values #9 or #10 and the UE has no CS fallback emergency call, CS fallback call, 1×CS fallback emergency call, or 1×CS fallback call pending; or
- the EMM cause values #40, the TRACKING AREA UPDATE message was not triggered due to receiving a paging for CS fallback or a paging for 1×CS fallback, and the UE has no CS fallback emergency call, CS fallback call, 1×CS fallback emergency call, or 1×CS fallback call pending;

e) shall start the timer T3440 if the UE receives a SERVICE REJECT message indicating any of the EMM cause values #9, #10 or #40 as a response to a SERVICE REQUEST message CONTROL PLANE SERVICE REQUEST message, or an EXTENDED SERVICE REQUEST message with service type set to "packet services via S1";

f) may start the timer T3440 if the UE receives any of the EMM cause values #3, #6, #7 or #8 or if it receives an AUTHENTICATION REJECT message;

g) shall start the timer T3440 if the UE receives a SERVICE REJECT message indicating the EMM cause value #39 and the UE has initiated EXTENDED SERVICE REQUEST in EMM-IDLE and the user plane radio bearers have not been set up;

h) shall start the timer T3440 if the UE receives a SERVICE REJECT, SERVICE ACCEPT, ATTACH ACCEPT or TRACKING AREA UPDATE ACCEPT message with control plane data back-off timer;

i) shall start the timer T3440 if the UE receives the EMM cause value #22 along with a T3346 value, and the value indicates that the timer T3346 is neither zero nor deactivated;

j) shall start the timer T3440 if the UE receives a SERVICE ACCEPT message and the UE has set Request type to "NAS signalling connection release" or to "Rejection of paging" in the UE request type IE in the EXTENDED SERVICE REQUEST or CONTROL PLANE SERVICE REQUEST message;

k) shall start the timer T3440 if the UE receives a SERVICE ACCEPT message, the UE has set the Control plane service type of the CONTROL PLANE SERVICE REQUEST message to "mobile terminating request" and the "active" flag in the Control plane service type IE to 0, the user plane radio bearers have not been set up, and the CONTROL PLANE SERVICE REQUEST message was sent from EMM-IDLE mode;

l) shall start the timer T3440 if the UE receives a DETACH ACCEPT message and the UE has set the detach type to "EPS detach" or "combined EPS/IMSI detach" in the DETACH REQUEST message; or

m) shall start the timer T3440 after the completion of the DETACH procedure, if the UE receives a DETACH REQUEST message and the detach type indicates "re-attach required".

Upon expiry of T3440,

in cases a, a1, b, b1), c, f, h, i, j and **1**, the UE shall locally release the established NAS signalling connection;

in cases d and e, the UE shall locally release the established NAS signalling connection and the UE shall initiate the attach procedure; or

in case m), the UE shall locally release the established NAS signalling connection and initiate the attach procedure.

In cases b, c and g,

upon an indication from the lower layers that the user plane radio bearers are set up, the UE shall stop timer T3440 and may send uplink signalling via the existing NAS signalling connection or user data via the user plane bearers. If the uplink signalling is for CS fallback for emergency call, or for establishing a PDN connection for emergency bearer services, the UE shall send the uplink signalling via the existing NAS signalling connection; or

In cases b, c, g and j,

upon receipt of a DETACH REQUEST message, the UE shall stop timer T3440 and respond to the network initiated detach.

In case b, j and k,

upon receiving a request from upper layers to send NAS signalling not associated with establishing either a CS emergency call or a PDN connection for emergency bearer services, the UE shall wait for the local release of the established NAS signalling connection upon expiry of timer T3440 or T3440 being stopped before proceeding;

upon receiving a request from upper layers to establish either a CS emergency call or a PDN connection for emergency bearer services, the UE shall stop timer T3440 and shall locally release the NAS signalling connection, before proceeding;

upon receipt of ESM DATA TRANSPORT message, as an implementation option, the UE may reset and restart timer T3440;

upon receipt of a DOWNLINK NAS TRANSPORT or DOWNLINK GENERIC NAS TRANSPORT message, the UE which is in EMM-REGISTERED without PDN connections shall stop timer T3440 and may send uplink signalling via the existing NAS signalling connection;

upon receipt of an ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST, MODIFY EPS BEARER CONTEXT REQUEST, DEACTIVATE EPS BEARER CONTEXT REQUEST, DOWNLINK NAS TRANSPORT or DOWNLINK GENERIC NAS TRANSPORT message, if the UE is using control plane CIoT EPS optimization, the UE shall stop timer T3440 and may send uplink signalling via the existing NAS signalling connection; or

upon initiation of tracking area updating procedure or combined tracking area updating procedure due to detecting the current TAI is not in the TAI list for cases e, i, j, clause 5.5.3.2.2 for case a or clause 5.5.3.3.2 for case a, the UE shall stop timer T3440.

In case c,

upon receiving a request from upper layers to send NAS signalling not associated with establishing a PDN connection for emergency bearer services, the UE shall wait for the local release of the established NAS signalling connection upon expiry of timer T3440 or T3440 being stopped before proceeding; or

upon receiving a request from upper layers to establish a PDN connection for emergency bearer services, the UE shall stop timer T3440 and shall locally release the NAS signalling connection, before proceeding.

In cases d and e,

upon an indication from the lower layers that the RRC connection has been released, the UE shall stop timer T3440 and perform a new attach procedure; or

upon receiving a request from upper layers to establish a PDN connection for emergency bearer services, the UE shall stop timer T3440 and shall locally release the NAS signalling connection, before proceeding.

In cases a and f,

upon receiving a request from upper layers to establish a PDN connection for emergency bearer services, the UE shall stop timer T3440 and shall locally release the NAS signalling connection, before proceeding.

In case g,

upon receiving a request from upper layers to send NAS signalling not associated with establishing either a CS emergency call or a PDN connection for emergency bearer services, the UE shall wait for the local release of the established NAS signalling connection upon expiry of timer T3440 or T3440 being stopped before proceeding; or

upon receiving a request from upper layers to establish either a CS emergency call or a PDN connection for emergency bearer services, the UE shall stop timer

T3440 and shall locally release the NAS signalling connection, before proceeding.

In case h,

upon an indication from the lower layers that the user plane radio bearers are set up or upon receiving a request from upper layers to send NAS signalling not associated with ESM DATA TRANSPORT, the UE shall stop timer T3440; or

the UE shall not send ESM DATA TRANSPORT message until expiry of timer T3440 or times T3440 being stopped.

In EMM-CONNECTED mode, if the UE moves to EMM-SERVICE-REQUEST-INITIATED state upon receipt of a CS SERVICE NOTIFICATION message, the UE shall stop timer T3440.

In **S101** mode, when the cdma2000® HRPD radio access connection has been released, the UE shall enter EMM-IDLE mode and consider the **S101** mode NAS signalling connection released.

If the timer is not running when the UE enters state T3440 EMM-DEREGISTERED.PLMN-SEARCH or EMM-REGISTERED.PLMN-SEARCH, the UE may locally release the NAS signalling connection.

If the timer T3440 is not running and the UE has included unavailability information and has not included the start of unavailability period in the TRACKING AREA UPDATE REQUEST message, then at completion of the tracking area update procedure the UE shall locally release the NAS signalling connection and enter EMM-REGISTERED.NO-CELL-AVAILABLE state.

FIG. **9** is a block diagram showing a structure of a UE **100** according to an embodiment.

A UE **100** includes a memory **1010**, a processor **1020**, a transceiver **1031**, a power management module **1091**, a battery **1092**, a display **1041**, an input unit **1053**, a speaker **1042**, a microphone **1052**, a subscriber identification module (SIM) card, and one or more antennas.

The processor **1020** may be configured to implement the proposed functions, procedures, and/or methods described in the present specification. Layers of a radio interface protocol may be implemented in the processor **1020**. The processor **1020** may include application-specific integrated circuits (ASICs), other chipsets, logic circuits, and/or data processing units. The processor **1020** may be an application processor (AP). The processor **1020** may include at least one of a digital signal processor (DSP), a central processing unit (CPU), a graphics processing unit (GPS), and a modulator and demodulator (modem). An example of the processor **1020** may include an SNAPDRAGON™ series processor manufactured by Qualcomm®, an EXYNOS™ series processor manufactured by Samsung®, an A series processor manufactured by Apple®, a HELIO™ series processor manufactured by MediaTek®, an ATOM™ series processor manufactured by INTEL®, or a corresponding next-generation processor.

The power management module **1091** manages power for the processor **1020** and/or the transceiver **1031**. The battery **1092** supplies power to the power management module **1091**. The display **1041** outputs a result processed by the processor **1020**. The input unit **1053** receives an input to be used by the processor **1020**. The input unit **1053** may be displayed on the display **1041**. The SIM card is an integrated circuit used to safely store an international mobile subscriber identity (IMSI) used to identify and authenticate a subscriber and a key related thereto in a portable phone and a portable phone device such as a computer. Contacts information may be stored in many SIM cards.

The memory **1010** is operatively coupled to the processor **1020**, and stores a variety of information for operating the processor **1020**. The memory **1010** may include a read-only memory (ROM), a random access memory (RAM), a flash memory, a memory card, a storage medium, and/or other equivalent storage devices. When the embodiment is implemented in software, the techniques explained in the present specification can be implemented with a module (i.e., procedure, function, etc.) for performing the functions explained in the present specification. The module may be stored in the memory **1010** and may be performed by the processor **1020**. The memory **1010** may be implemented inside the processor **1020**. Alternatively, the memory **1010** may be implemented outside the processor **1020**, and may be coupled to the processor **1020** in a communicable manner by using various well-known means.

The transceiver **1031** is operatively coupled to the processor **1020**, and transmits and/or receives a radio signal. The transceiver **1031** includes a transmitter and a receiver. The transceiver **1031** may include a baseband signal for processing a radio frequency signal. The transceiver controls one or more antennas to transmit and/or receive a radio signal. In order to initiate communication, the processor **1020** transfers command information to the transceiver **1031**, for example, to transmit a radio signal constituting voice communication data. The antenna serves to transmit and receive a radio signal. When the radio signal is received, the transceiver **1031** may transfer a signal to be processed by the processor **1020**, and may convert the signal into a baseband signal. The processed signal may be converted into audible or readable information which is output through the speaker **1042**.

The speaker **1042** outputs a result related to a sound processed by the processor **1020**. The microphone **1052** receives a sound-related input to be used by the processor **1020**.

A user presses (or touches) a button of the input unit **1053** or drives voice (activates voice) by using the microphone **1052** to input command information such as a phone number or the like. The processor **1020** receives the command information, and performs a proper function such as calling the phone number or the like. Operational data may be extracted from the SIM card or the memory **1010**. In addition, the processor **1020** may display command information or operational information on the display **1041** for user's recognition and convenience.

FIG. **10** illustrates a block diagram of a processor in which the present disclosure is implemented.

As may be seen from FIG. **10**, the processor **1020** in which the present disclosure is implemented may include a plurality of circuitry to implement functions, procedures and/or methods described in the present disclosure. For example, the processor **1020** may include a first circuit **1020-1**, a second circuit **1020-2**, and a third circuit **1020-3**. Also, although not shown in the figure, the processor **1020** may include more circuits. Each circuit may include a plurality of transistors.

The first circuit **1020-1** may trigger a tracking area update (TAU) procedure when an unavailability period has ended and a discontinuous coverage maximum time offset timer has expired.

The second circuit **1020-2** may start a first timer at completion of the tracking area update procedure if the UE has included unavailability information and has not included a start of the unavailability period in a tracking area update request message

The third circuit **1020-3** may activate an access stratum (AS) layer, upon coming out of the unavailability period.

The processor **1020** may be called Application-Specific Integrated Circuit (ASIC) or Application Processor (AP) and may include at least one of a Digital Signal Processor (DSP), a Central Processing Unit (CPU), and a Graphics Processing Unit (GPU).

The processor may be equipped in the UE.

In the above, preferred embodiments have been described by way of example, but the disclosure of the present specification is not limited to these specific embodiments, and may be modified, changed, or modified in various forms within the scope described in the spirit and claims of the present specification. It can be improved.

In the example system described above, the methods are described on the basis of a flow chart as a series of steps or blocks, but the order of steps described is not limited, and some steps may occur simultaneously or in a different order than other steps as described above. there is. Additionally, those skilled in the art will understand that the steps shown in the flowchart are not exclusive and that other steps may be included or one or more steps in the flowchart may be deleted without affecting the scope of rights.

The claims set forth herein may be combined in various ways. For example, the technical features of the method claims of this specification may be combined to implement a device, and the technical features of the device claims of this specification may be combined to implement a method. Additionally, the technical features of the method claims of this specification and the technical features of the device claims may be combined to implement a device, and the technical features of the method claims of this specification and technical features of the device claims may be combined to implement a method.

What is claimed is:

**1**. An operation method of user equipment (UE), comprising

receiving an unavailability configuration including an end of unavailability period report (EUPR) bit which is set to either "UE needs to report end of unavailability period" or "UE does not need to report end of unavailability";

triggering a tracking area update (TAU) procedure when an unavailability period has ended and if the EUPR bit is set to "UE needs to report end of unavailability", wherein a discontinuous coverage maximum time offset timer has expired;

starting a T3440 timer at completion of the tracking area update procedure if a tracking area update request message includes unavailability information, but if the tracking area update request message does not include a start of the unavailability period;

if the T3440 timer is not running when the UE enters a first state of an Evolved packet system Mobility Management (EMM)-DEREGISTERED and Public Land Mobile Network (PLMN)-SEARCH or a second state of an EMM-REGISTERED and PLMN-SEARCH, locally releasing a non-access stratum (NAS) signaling connection; and

upon coming out of the unavailability period, activating an access stratum (AS) layer.

**2**. The method of claim **1**, further comprising:

if the T3440 timer is not running and if the tracking area update request message includes the unavailability information, but if the tracking area update request message does not include the start of the unavailability period, locally releasing the NAS signaling connection at completion of the tracking area update procedure.

**3**. The method of claim **2**, further comprising:

if the T3440 timer is not running and if the tracking area update request message includes the unavailability information, but if the tracking area update request message does not include the start of the unavailability period, entering a registered state at completion of the tracking area update procedure.

**4**. The method of claim **1**, further comprising:

transmitting the tracking area update request message which includes the unavailability information, but does not include the start of the unavailability period.

**5**. A user equipment (UE), the UE comprising:

at least one processor; and

at least one computer memory operably connectable to the at least one processor and storing instructions that, when executed by the at least one processor, perform operations comprising:

receiving an unavailability configuration including an end of unavailability period report (EUPR) bit which is set to either "UE needs to report end of unavailability period" or "UE does not need to report end of unavailability";

triggering a tracking area update (TAU) procedure when an unavailability period has ended and if the EUPR bit is set to "UE needs to report end of unavailability", wherein a discontinuous coverage maximum time offset timer has expired;

starting a T3440 timer at completion of the tracking area update procedure if a tracking area update request message includes unavailability information, but if tracking area update request message does not include a start of the unavailability period;

if the T3440 timer is not running when the UE enters a first state of an Evolved packet system Mobility Management (EMM)-DEREGISTERED and Public Land Mobile Network (PLMN)-SEARCH or a second state of an EMM-REGISTERED and PLMN-SEARCH, locally releasing a non-access stratum (NAS) signaling connection; and

upon coming out of the unavailability period, activating an access stratum (AS) layer.

**6**. The UE of claim **5**, wherein the operations may further comprise:

if the T3440 timer is not running and if the tracking area update request message includes the unavailability information, but if the tracking area update request message does not include a start of the unavailability period in the tracking area update request message, locally releasing the NAS signaling connection at completion of the tracking area update procedure.

**7**. The UE of claim **5**, wherein the operations may further comprise:

if the T3440 timer is not running and if the tracking area update request message includes the unavailability information, but if the tracking area update request message does not include the start of the unavailability period, entering a registered state at completion of the tracking area update procedure.

**8**. The UE of claim **5**, wherein the operations may further comprise:

transmitting the tracking area update request message which includes the unavailability information, but does not include the start of the unavailability period.

**9**. A semiconductor chipset, comprising:

at least one processor; and

at least one memory capable of storing instructions and being connected electrically to the at least one processor operably,

wherein operations, performed when the instructions are executed by the at least one processor, includes:

receiving an unavailability configuration including an end of unavailability period report (EUPR) bit which is set to either "UE needs to report end of unavailability period" or "UE does not need to report end of unavailability";

triggering a tracking area update (TAU) procedure when an unavailability period has ended and if the EUPR bit is set to "UE needs to report end of unavailability", wherein a discontinuous coverage maximum time offset timer has expired;

starting a T3440 timer at completion of the tracking area update procedure if a tracking area update request message includes unavailability information, but if the tracking area update request message does not include a start of the unavailability period;

if the T3440 timer is not running when the UE enters a first state of an Evolved packet system Mobility Management (EMM)-DEREGISTERED and Public Land Mobile Network (PLMN)-SEARCH or a second state of an EMM-REGISTERED and PLMN-SEARCH, locally releasing a non-access stratum (NAS) signaling connection; and

upon coming out of the unavailability period, activating an access stratum (AS) layer.

**10**. The semiconductor chipset of claim **9**, wherein the operations may further comprise:

if the T3440 timer is not running and if the tracking area update request message includes the unavailability information, but if the tracking area update request message does not include a start of the unavailability period, locally releasing the NAS signaling connection at completion of the tracking area update procedure.

**11**. The semiconductor chipset of claim **9**, wherein the operations may further comprise:

if the T3440 timer is not running and if the tracking area update request message includes the unavailability information, but if the tracking area update request message does not include the start of the unavailability period, entering a registered state at completion of the tracking area update procedure.

**12**. The semiconductor chipset of claim **9**, wherein the operations may further comprise:

transmitting the tracking area update request message which includes the unavailability information, but does not include the start of the unavailability period.

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