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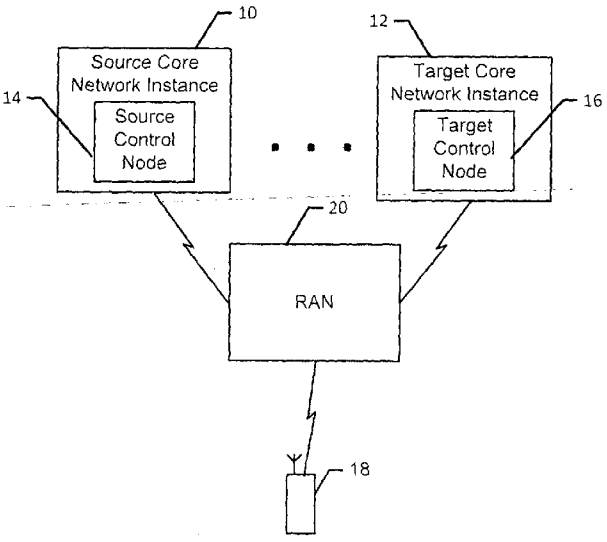

Figure 1

(57) Abstract: A method, apparatus and computer program product redirect a user equipment (UE) in a manner that is transparent to the radio access network and the UE. A first global identifier of the UE is received during an attachment process to a mobility control node. The first global identifier includes a globally unique identifier of the mobility control node and a local identifier field for the UE within the mobility control node. If the local identifier field has a predefined flag value, the UE is determined to have been redirected from a different control node. If the UE has been redirected from the different control node, a reallocation command is caused to be transmitted to the UE. The reallocation command includes a second global identifier of the UE including the globally unique identifier of the mobility control node and the local identifier field having a first locally unique UE identifier.

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METHOD AND APPARATUS FOR REDIRECTING USER EQUIPMENT TO ANOTHER MOBILITY CONTROL NODE

TECHNICAL FIELD

[0001] An example embodiment relates generally to a method, apparatus and computer program product for the attachment of user equipment to a core network and, more particularly, for redirecting the user equipment during the attachment process.

BACKGROUND

[0002] In order to obtain packet-switched services, a user equipment (UE) commonly attaches to a packet core network. More specifically, the user equipment attaches to a mobility management entity (MME) of an evolved packet core (EPC) in order to obtain second generation (2G), third generation (3G), fourth generation (4G) and fifth generation (5G) services. In the context of 5G, the UE may alternatively attach to an access and mobility management function (AMF) or a 5G core (5GC) to obtain 4G, 5G and non-3rd generation partnership project (3GPP) services. The term mobility control node will be used to include both an MME and AMF. The term core network will be used to denote both an EPC and a 5GC. In some instances, it is required to redirect the UE to a different control node than the control to which the UE originally attempted to attach.

[0003] Redirection may occur in various situations. For example, the public land mobile network (PLMN) may include a new EPC (supporting enhancements for 5G as specified by 3GPP) overlay to a legacy EPC, with the new EPC intended to serve 5G-capable UEs and the legacy EPC limited to serving legacy, non-5G UEs. In this situation, a legacy UE may attempt to attach to the EPC overlay and may be redirected to the legacy EPC. As another example, the PLMN network may include mobility management functions provided by different vendors supporting specialized services provided by the different vendors. In this situation, a UE may attempt to attach to an MME of a first vendor and, as a result, may be redirected to the MME of a second vendor. In another situation, multiple virtualized packet core network instances are deployed in the same PLMN, and the mobile network operator (MNO) wishes to dedicate certain instances to groups of UEs. In yet another case, the EPC instances may be operated by different organizations. Even within a single EPC instance, load rebalancing may be required between the

various MMEs of the core network and, as a result, may redirect UEs from the MME to the other MMEs in the PLMN.

[0004] The 3GPP has provided techniques, such as a multiple operator core network (MOCN) to provide for redirection to a core network serving a different PLMN identifier (ID). MOCN requires multiple PLMN IDs to be supported by the radio access network (RAN) and specific subscription data to be provisioned in the HSS (for UEs to access the different core networks). 3GPP dedicated core networks (DECOR) and evolved DECOR (eDECOR) are techniques that provide redirection to a different EPC instance within a single PLMN. However, they require specific subscription information to be provisioned in the home subscription server (HSS) or 5G unified data management function (UDM) and to be interpreted by the RAN to select the appropriate core network. Additionally, although DECOR is transparent to the UE, eDECOR requires UE support.

BRIEF SUMMARY

[0005] A method, apparatus and computer program product are provided in accordance with an example embodiment in order to redirect a user equipment (UE) in a manner that is transparent to the radio access network (RAN) and that does not require that any subscription information be provisioned in the home subscription service (HSS) nor the unified data management (UDM). As such, the method, apparatus and computer program product of an example embodiment may be readily implemented in order to redirect the UE in any of a variety of different situations. For example, the method, apparatus and computer program product of an example embodiment permit redirection of the UE from an evolved packet core (EPC) supporting enhancements for 5G to a legacy EPC, such as in an instance in which the UE does not support 5G service. Additionally, the method, apparatus and computer program product of another example embodiment are configured to redirect a UE that is attempting to attach to an MME of a first vendor to the MME of a second vendor that supports specialized services sought by the UE. In a situation in which multiple virtualized packet core network instances are deployed in the same PLMN, the method, apparatus and computer program product of an example embodiment may redirect a UE to the virtualized packet core network instance dedicated by the mobile network operator (MNO) to a group of UEs that includes the UE in question. In yet another case, the method, apparatus and computer program product may redirect a UE to an EPC instance

operated by a different organization. Further, the method, apparatus and computer program product of an example embodiment are configured to redirect the UE in order to rebalance the load imposed upon the plurality of MMEs of the core network. In each of these situations, the method, apparatus and computer program product of an example embodiment are configured to provide for the desired redirection of the UE a manner that is transparent to and requires no reconfiguration of the RAN and that does not require provisioning of any specific subscription information in the HSS or the UDM.

[0006] In an example embodiment, a method is provided that includes receiving a first global identifier of a user equipment during an attachment process to a mobility control node of a core network. The first global identifier includes a globally unique identifier of the mobility control node and a local identifier field for the user equipment within the mobility control node. In a case in which the local identifier field has a predefined flag value, such as a null value or a specifically reserved value, the method determines that the user equipment has been redirected from a different control node. In a case in which the user equipment has been redirected from the different control node, the method causes a reallocation command to be transmitted to the user equipment. The reallocation command comprises a second global identifier of the user equipment including the globally unique identifier of the mobility control node and the local identifier field having a first locally unique user equipment identifier, different than the predefined flag value.

[0007] The method of an example embodiment may also include receiving a third global identifier of the user equipment during the attachment process. The third global identifier comprises a globally unique identifier of the different control node and the local identifier field having a second locally unique user equipment identifier. The method of this example embodiment also includes determining, based upon the first and second globally unique identifiers of the mobility control node, whether the mobility control node and the different control node are members of a common control node group. In a case in which the mobility control node and a different control node are members of the common control node group, the method obtains context information relating to the user equipment from the different control node. In an example embodiment, the second and third global identifiers of the user equipment include different global unique temporary identities of the user equipment. In an example embodiment in which the mobility control node of the core network includes a mobility

management entity (MME), the globally unique identifiers of the mobility control node and the different control node are different globally unique MME identifiers (GUMMEIs) and the first and second locally unique user equipment identifiers includes different MME temporary mobile subscriber identities (M-TMSIs). In another example embodiment in which the mobility control node of the core network includes an access and mobility management function (AMF), the globally unique identifiers of the mobility control node and the different control node are different globally unique AMF identifiers (GUAMIs) and the first and second locally unique user equipment identifiers include different fifth generation temporary mobile subscriber identities (5G-TMSIs).

[0008] In another example embodiment, an apparatus is provided that includes means for receiving a first global identifier of a user equipment during an attachment process to the apparatus. The first global identifier includes a globally unique identifier of the apparatus and a local identifier field for the user equipment within the apparatus. The apparatus also includes the means for determining, in a case in which the local identifier field has a predefined flag value, such as a null value or a specifically reserved value, that the user equipment has been redirected from a different control node. The apparatus further includes means for causing a reallocation command to be transmitted to the user equipment in a case in which the user equipment has been redirected from the different control node. The reallocation command comprises a second global identifier of the user equipment including the globally unique identifier of the apparatus and the local identifier field having a first locally unique user equipment identifier, different than the predefined flag value.

[0009] The apparatus of an example embodiment also includes means for receiving a third global identifier of the user equipment during the attachment process. The third global identifier comprises a globally unique identifier of the different control node and the local identifier field has a second locally unique user equipment identifier. The apparatus of this example embodiment also includes means for determining, based upon the first and second globally unique identifiers of the mobility control node, whether the apparatus and the different control node are members of a common control node group. The apparatus of this example embodiment also includes means for obtaining context information relating to the user equipment from the different control node in a case in which the apparatus and the different control node are members of the common control node group. In an example embodiment, the second and third

global identifiers of the user equipment include different globally unique temporary identities of the user equipment. In an embodiment in which the apparatus comprises a mobility management entity (MME), the globally unique identifiers of the apparatus and the different control node are different globally unique MME identifiers (GUMMEIs) and the first and second locally unique user equipment identifiers are different MME temporary mobile subscriber identities (M-TMSIs). In another example embodiment in which the apparatus comprises an access and mobility management function (AMF), the globally unique identifiers of the mobility control node and the different control node are different globally unique AMF identifiers (GUAMIs) and the first and second locally unique user equipment identifiers include different fifth generation temporary mobile subscriber identities (5G-TMSIs).

[0010] In a further example embodiment, an apparatus is provided that includes at least one processor and at least one memory including computer program code for one or more programs with the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to receive a first global identifier of a user equipment during an attachment process to the apparatus. The first global identifier includes a globally unique identifier of the apparatus and a local identifier field for the user equipment within the apparatus. In a case in which the local identifier field has a predefined flag value, such as a null value or a specifically reserved value, the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to determine that the user equipment has been redirected from a different control node. In a case in which the user equipment has been redirected from the different control node, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apprantus to cause a reallocation command to be transmitted to the user equipment. The reallocation command comprises a second global identifier of the user equipment including the globally unique identifier of the apparatus and the local identifier field having a first locally unique user equipment identifier, different than the predefined flag value.

[0011] The at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus of an example embodiment to receive a third global identifier of the user equipment during the attachment process. The third global identifier comprises a globally unique identifier of the different control node and the local identifier field has a second locally unique user equipment identifier. The at least one memory and the

computer program code are further configured to, with the at least one processor, cause the apparatus of this example embodiment to determine whether the apparatus and the different control node are members of a common node group and, in a case in which the apparatus and the different control node are members of a common control node group, to obtain context information relating to the user equipment from the different control node. In an example embodiment, the second and third global identifiers of the user equipment include different globally unique temporary identities of the user equipment. In an embodiment in which the apparatus comprises a mobility management entity (MME), the globally unique identifiers of the apparatus and the different control node are different globally unique MME identifiers (GUMMEIs) and the first and second locally unique user equipment identifiers include different MME temporary mobile subscriber identities (M-TMSIs). In another example embodiment in which the apparatus comprises an access and mobility management function (AMF), the globally unique identifiers of the mobility control node and the different control node are different globally unique AMF identifiers (GUAMIs) and the first and second locally unique user equipment identifiers include different fifth generation temporary mobile subscriber identities (5G-TMSIs).

[0012] In yet another example embodiment, a computer program product is provided that includes at least one non-transitory computer-readable storage medium having computer executable program code instructions stored therein with the computer executable program code instructions including program code instructions configured, upon execution, to receive a first global identifier of a user equipment during an attachment process to a mobility control node of a core network. The first global identifier includes a globally unique identifier of the mobility control node and a local identifier field for the user equipment within the mobility control node. A computer-executable program code instructions also include program code instructions configured, upon execution, to determine, in a case in which the local identifier field has a predefined flag value, such as a null value or a specifically reserved value, that the user equipment has been redirected from a different control node. The computer-executable program code instructions also include program code instructions configured, upon execution, to cause a reallocation command to be transmitted to the user equipment in a case in which the user equipment has been redirected from the different control node. The reallocation command comprises a second global identifier of the user equipment including the globally unique

identifier of the mobility control node and the local identifier field having a first locally unique user equipment identifier, different than the predefined flag value.

[0013] The computer-executable program code instructions of an example embodiment also include program code instructions configured, upon execution, to receive a third global identifier of the user equipment during the attachment process. The third global identifier comprises a globally unique identifier of the different control node and the local identifier field having a second locally unique user equipment identifier. The computer-executable program code instructions of this example embodiment also include program code instructions configured, upon execution, to determine, based upon the first and second globally unique identifiers of the mobility control node whether the mobility control node and the different control node are members of a common control node group and, in a case in which the mobility control node and the different control node are members of the common control node group, to obtain context information relating to the user equipment from the different control node. In an example embodiment, the second and third global identifiers of the user equipment include different globally unique temporary identities of the user equipment. In an embodiment in which the mobility control node of the core network includes a mobility management entity (MME), the globally unique identifiers of the mobility control node and the different control node are different globally unique MME identifiers (GUMMEIs) and the first and second locally unique user equipment identifiers include different MME temporary mobile subscriber identities (M-TMSIs). In another example embodiment in which the mobility control node of the core network includes an access and mobility management function (AMF), the globally unique identifiers of the mobility control node and the different control node are different globally unique AMF identifiers (GUAMIs) and the first and second locally unique user equipment identifiers include different fifth generation temporary mobile subscriber identities (5G-TMSIs).

[0014] In an example embodiment, a method is provided that includes receiving, at a user equipment, a non-access stratum reject message. The non-access stratum reject message comprises a target tracking area identifier. The non-access stratum reject message also comprises either an attach reject message or a tracking area update reject message. The non-access stratum reject message of an example embodiment indicates to the user equipment that the use equipment is being redirected. The method also includes creating a non-access stratum request message. The non-access stratum request message includes the target tracking area

identifier. The non-access stratum request message also comprises either an attach request message or a tracking area update message. The method further includes causing the non-access stratum request message to be sent toward a mobility control node of a core network. In one example embodiment, causing the non-access stratum request message to be sent toward the mobility control node of the core network provides for cell re-selection within the same public land mobile network based on the target tracking area identifier.

[0015] In another example embodiment, an apparatus is provided that includes means for receiving, at a user equipment, a non-access stratum reject message. The non-access stratum reject message comprises a target tracking area identifier. The non-access stratum reject message also comprises either an attach reject message or a tracking area update reject message. The non-access stratum reject message of an example embodiment indicates to the user equipment that the use equipment is being redirected. The apapratus also includes means for creating a non-access stratum request message. The non-access stratum request message includes the target tracking area identifier. The non-access stratum request message also comprises either an attach request message or a tracking area update message. The apparatus further includes means for causing the non-access stratum request message to be sent toward a mobility control node of a core network. In one example embodiment, causing the non-access stratum request message to be sent toward the mobility control node of the core network provides for cell re-selection within the same public land mobile network based on the target tracking area identifier.

[0016] In a further example embodiment, an apparatus is provided that includes at least one processor and at least one memory including computer program code for one or more programs with the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to receive, at a user equipment, a non-access stratum reject message. The non-access stratum reject message comprises a target tracking area identifier. The non-access stratum reject message also comprises either an attach reject message or a tracking area update reject message. The non-access stratum reject message of an example embodiment indicates to the user equipment that the use equipment is being redirected. The at least one memory and the computer program code are also configured to, with the at least one processor, cause the apparatus to create a non-access stratum request message. The non-access stratum request message includes the target tracking area identifier. The non-access stratum request

message also comprises either an attach request message or a tracking area update message. The at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to cause the non-access stratum request message to be sent toward a mobility control node of a core network. In one example embodiment, causing the non-access stratum request message to be sent toward the mobility control node of the core network provides for cell re-selection within the same public land mobile network based on the target tracking area identifier.

[0017] In yet another example embodiment, a computer program product is provided that includes at least one non-transitory computer-readable storage medium having computer executable program code instructions stored therein with the computer executable program code instructions including program code instructions configured, upon execution, to receive, at a user equipment, a non-access stratum reject message. The non-access stratum reject message comprises a target tracking area identifier. The non-access stratum reject message also comprises either an attach reject message or a tracking area update reject message. The non-access stratum reject message of an example embodiment indicates to the user equipment that the use equipment is being redirected. The computer executable program code instructions also include program code instructions configured, upon execution, to create a non-access stratum request message. The non-access stratum request message includes the target tracking area identifier. The non-access stratum request message also comprises either an attach request message or a tracking area update message. The computer executable program code instructions further include program code instructions configured, upon execution, to cause the non-access stratum request message to be sent toward a mobility control node of a core network. In one example embodiment, causing the non-access stratum request message to be sent toward the mobility control node of the core network provides for cell re-selection within the same public land mobile network based on the target tracking area identifier.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Having thus described certain example embodiments of the present disclosure in general terms, reference will hereinafter be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

[0019] Figure 1 depicts a network configuration that may be configured to redirect a UE in accordance with an example embodiment of the present disclosure;

[0020] Figure 2 is a block diagram of an apparatus configured in accordance with an example embodiment in order to redirect a UE to a mobility control node of a core network;

[0021] Figure 3 illustrates operations performed, such as by the apparatus of Figure 2, in order to redirect the UE to a mobility control node of a core network in accordance with a example embodiment of the present disclosure;

[0022] Figure 4 is a signal flow diagram including the operations depicted in the flowchart of Figure 3 in order to redirect a UE to a mobility control node of the core network in accordance with an example embodiment of the present disclosure;

[0023] Figure 5 illustrates operations performed, such as by the apparatus of Figure 2, in order to redirect the UE to a mobility control node of a core network in accordance with another example embodiment of the present disclosure; and

[0024] Figure 6 is a signal flow diagram including the operations depicted in the flowchart of Figure 5 in which a UE is redirected to a mobility control node of a core network in accordance with a different example embodiment of the present disclosure.

DETAILED DESCRIPTION

[0025] Some embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all, embodiments of the invention are shown. Indeed, various embodiments of the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like reference numerals refer to like elements throughout. As used herein, the terms "data," "content," "information," and similar terms may be used interchangeably to refer to data capable of being transmitted, received and/or stored in accordance with embodiments of the present invention. Thus, use of any such terms should not be taken to limit the spirit and scope of embodiments of the present invention.

[0026] Additionally, as used herein, the term 'circuitry' refers to (a) hardware-only circuit implementations (e.g., implementations in analog circuitry and/or digital circuitry); (b) combinations of circuits and computer program product(s) comprising software and/or firmware

instructions stored on one or more computer readable memories that work together to cause an apparatus to perform one or more functions described herein; and (c) circuits, such as, for example, a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation even if the software or firmware is not physically present. This definition of 'circuitry' applies to all uses of this term herein, including in any claims. As a further example, as used herein, the term 'circuitry' also includes an implementation comprising one or more processors and/or portion(s) thereof and accompanying software and/or firmware. As another example, the term 'circuitry' as used herein also includes, for example, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in a server, a cellular network device, other network device, field programmable gate array, and/or other computing device.

[0027] As defined herein, a "computer-readable storage medium," which refers to a physical storage medium (e.g., volatile or non-volatile memory device), may be differentiated from a "computer-readable transmission medium," which refers to an electromagnetic signal.

[0028] A method, apparatus and computer program product are provided in order to provide for redirection of a user equipment (UE) attempting to attach to a core node of a particular instance of a core network to a different control node, such as the control node of a different instance of the core network. The redirection of the UE may be performed for various purposes. For example, one or more of the core network instances, such as a legacy evolved packet core (EPC), may be configured to service legacy, non-5G UEs, such as UEs configured to operate in accordance with fourth generation (4G) networks or the like, while one or more core network instances, such as a new EPC overlay, supporting enhancements for 5G as specified by 3GPP, to the legacy EPC, may be configured to service 5G-capable UEs, that is, UEs configured to communicate via 5G networks. Thus, in an instance in which a legacy, non-5G UE, such as a UE configured to be served by 4G network, attempts to attach to an EPC overlay, the legacy non-5G UE may be redirected to the legacy EPC. In another scenario, the public land mobile network (PLMN) may include mobility management entity functions provided by different vendors supporting specialized services provided by the different vendors. As such, a UE attempting to attach to the mobility management entity (MME) of a first vendor may be redirected to the MME of a second vendor that provides the specialized service sought by the UE. In another situation, multiple virtualized packet core network instances are deployed in the

same PLMN and the mobile network operator (MNO) may dedicate certain instances to groups of UEs and/or certain EPC instances may be operated by different organizations. Thus, a UE of a group of UEs, such as the UEs affiliated with a respective organization, may be redirected to the packet core network instance dedicated to the group of UEs of which the UE is a member, such as by being redirected to the packet core network instance operated by the organization with which the UE is affiliated. Still further, even within a single EPC instance, redirection of a UE between the various MMEs of the core network may be performed in order to re-balance the load supported by the plurality of MMEs, such as from more heavily loaded MMEs to more lightly loaded MMEs in order to balance the load and to provide more uniform and consistent service to the UEs. While several example scenarios that may lead to redirection are provided, these scenarios are provided by way of illustration and not of limitation, as a UE may also be redirected in any of a number of other scenarios.

[0029] Regardless of the purpose for the redirection, a network that may be configured to provide for redirection of UEs in accordance with an example embodiment is depicted in Figure 1. As shown, the network includes a plurality of core network instances of the same PLMN including a source core network instance 10 and a target core network instance 12. The source and target core network instances may be identical or may otherwise be configured to support the same generation of UEs, such as 5G-capable UEs. In this instance, the redirection between the core network instances may be performed for load management, e.g., load re-balancing. Alternatively, the core network instances may be provided by different vendors or operated by different organizations such that redirection of the UEs between the core network instances may be performed to redirect the UE from the source core network instance of a first vendor or a first organization to the target core network instance of a different vendor or different organization with which the UE is configured to be serviced. Alternatively, the core network instances may be configured to support different generations of UEs configured to operate in accordance with different cellular communications standards. For example, one or more of the core network instances, such as the source core network instance, may be a legacy core network instance, such as a legacy EPC configured to service, for example, legacy, non-5G UEs, while another core network instance, such as the target core network instance, may be a new EPC overlay to the legacy, EPC configured to service 5G-capable UEs. As such, the UE may be redirected in accordance with an example embodiment so as to be serviced by a core network

instance configured to support the particular UE, such as a legacy non-5G UE supported by the legacy EPC or a 5G-capable UE supported by the new EPC overlay. Although multiple core network instances are depicted in Figure 1, redirection may also occur in accordance with an example embodiment within a single core network instance, such as from one MME to a different MME, for load re-balancing purposes.

[0030] Referring to Figure 1, each core network instance may include one or more mobility control nodes, such as an MME or an access control and mobility management function (AMF) in a 5G core network instance, such as a 5GC overlay. For purposes of example, an MME will be discussed hereinafter, although the control node may alternatively be an AMF in other embodiments. As shown in Figure 1, the source core network instance 10 may include a source control node 14 and the target core network instance 12 may include a target control node 16. In order to facilitate communication between the user equipment 18, such as a mobile telephone, a smartphone, a laptop computer or other communication device, and the core network instances, the network also generally includes a radio access network 20, such as an evolved universal terrestrial radio access network (E-UTRAN) or the like. While the network of Figure 1 depicts a single radio access network connecting the user equipment to each of the core network instances, the network may include multiple radio access networks interconnecting the user equipment to one of the core network instances or to different ones of the core network instances.

[0031] In order to appropriately redirect the user equipment 18, an apparatus 30 is provided and as shown, for example, in Figure 2. The apparatus may be embodied by any of a variety of different components and, in one embodiment, is embodied by the mobility control node of a core network instance, such as the target control node 16 of the target core network instance 12, e.g., an MME of an EPC overlay supporting enhancements for 5G. As shown in Figure 2, the apparatus of an example embodiment includes, is associated with or is otherwise in communication with a processor 32, an associated memory 34 and a communication interface 36.

[0032] The processor 32 (and/or co-processors or any other circuitry assisting or otherwise associated with the processor) may be in communication with the memory device 34 via a bus for passing information among components of the apparatus 30. The memory device may be non-transitory and may include, for example, one or more volatile and/or non-volatile memories. In other words, for example, the memory device may be an electronic storage device (e.g., a

computer readable storage medium) comprising gates configured to store data (e.g., bits) that may be retrievable by a machine (e.g., a computing device like the processor). The memory device may be configured to store information, data, content, applications, instructions, or the like for enabling the apparatus to carry out various functions in accordance with an example embodiment of the present disclosure. For example, the memory device could be configured to buffer input data for processing by the processor. Additionally or alternatively, the memory device could be configured to store instructions for execution by the processor.

[0033] The apparatus 30 may, in some embodiments, be embodied in various computing devices as described above. However, in some embodiments, the apparatus may be embodied as a chip or chip set. In other words, the apparatus may comprise one or more physical packages (e.g., chips) including materials, components and/or wires on a structural assembly (e.g., a baseboard). The structural assembly may provide physical strength, conservation of size, and/or limitation of electrical interaction for component circuitry included thereon. The apparatus may therefore, in some cases, be configured to implement an embodiment of the present invention on a single chip or as a single "system on a chip." As such, in some cases, a chip or chipset may constitute means for performing one or more operations for providing the functionalities described herein.

[0034] The processor 32 may be embodied in a number of different ways. For example, the processor may be embodied as one or more of various hardware processing means such as a coprocessor, a microprocessor, a controller, a digital signal processor (DSP), a processing element with or without an accompanying DSP, or various other circuitry including integrated circuits such as, for example, an ASIC (application specific integrated circuit), an FPGA (field programmable gate array), a microcontroller unit (MCU), a hardware accelerator, a special-purpose computer chip, or the like. As such, in some embodiments, the processor may include one or more processing cores configured to perform independently. A multi-core processor may enable multiprocessing within a single physical package. Additionally or alternatively, the processor may include one or more processors configured in tandem via the bus to enable independent execution of instructions, pipelining and/or multithreading.

[0035] In an example embodiment, the processor 32 may be configured to execute instructions stored in the memory device 34 or otherwise accessible to the processor. Alternatively or additionally, the processor may be configured to execute hard coded

functionality. As such, whether configured by hardware or software methods, or by a combination thereof, the processor may represent an entity (e.g., physically embodied in circuitry) capable of performing operations according to an embodiment of the present disclosure while configured accordingly. Thus, for example, when the processor is embodied as an ASIC, FPGA or the like, the processor may be specifically configured hardware for conducting the operations described herein. Alternatively, as another example, when the processor is embodied as an executor of instructions, the instructions may specifically configure the processor to perform the algorithms and/or operations described herein when the instructions are executed. However, in some cases, the processor may be a processor of a specific device (e.g., an image processing system) configured to employ an embodiment of the present invention by further configuration of the processor by instructions for performing the algorithms and/or operations described herein. The processor may include, among other things, a clock, an arithmetic logic unit (ALU) and logic gates configured to support operation of the processor.

[0036] The communication interface 36 may be any means such as a device or circuitry embodied in either hardware or a combination of hardware and software that is configured to receive and/or transmit data from/to a network. In this regard, the communication interface may include, for example, an antenna (or multiple antennas) and supporting hardware and/or software for enabling communications with a wireless communication network. Additionally or alternatively, the communication interface may include the circuitry for interacting with the antenna(s) to cause transmission of signals via the antenna(s) or to handle receipt of signals received via the antenna(s). In some environments, the communication interface may alternatively or also support wired communication. As such, for example, the communication interface may include a communication modem and/or other hardware/software for supporting communication via cable, digital subscriber line (DSL), universal serial bus (USB) or other mechanisms.

[0037] The operations performed by the apparatus 30 in order to redirect the UE 18 between control nodes, such as from the control node of a source core network instance 10 to a mobility control node of a target core network instance 12 or between control nodes of the same core network instance, are depicted in a flowchart of Figure 3 and more particularly in conjunction with redirection between a source MME 14 and a target MME 16 in the signal flow diagram of Figure 4. As shown by signal flow 50 of Figure 4, the user equipment attempts to attach to a

core network instance, such as the source core network instance, such as by transmitting an attach request or a tracking area update (TAU) request to the source core network instance and, more particularly, to the source control node 14, e.g., the source MME. In an instance in which the source control node is not going to serve the UE, the source control node transmits a response, such as a reject message, to the UE as shown by signal flow 52 of Figure 4. The source control node may decline to serve the UE and may, in turn, generate the reject message for various reasons including, as described above, an attempt by a legacy non-5G UE to attach to an EPC overlay supporting enhancements for 5G, an attempt by the UE to attach to a control node of a different vendor or a different organization than that which services the UE or an attempt to attach to a control node which is overloaded relative to other control nodes with the attachment request being redirected for load management, e.g., load re-balancing, purposes.

[0038] The reject message issued by the source core network instance 10, such as the source control node 14, includes a first global identifier of the UE 18 that has been allocated by the source core network instance for the UE. As shown in signal flow 52 of Figure 4, the first global identifier of the UE may be a globally unique temporary identity (GUTI) of the UE. The first global identifier of the UE generally includes a globally unique identifier of the mobility control node to which the UE is being redirected. In an embodiment in which the core network instance is an EPC overlay supporting enhancements for 5G and the mobility control node to which the UE is redirected is embodied by an MME, the global identifier of the control node may be a globally unique MME identity (GUMMEI) of the MME.

[0039] In accordance with an example embodiment in which the UE 18 is to be redirected, the first global identifier of the UE also includes a local identifier field for the UE within the mobility control node to which the UE is being redirected. In a case in which the UE is being redirected from a different control node, that is, the source control node, to the mobility control node, the local identifier field has a predefined flag value indicative of the redirection. Although the predefined flag value may have various predefined values indicative of a redirection, one example of a predefined flag value indicative of redirection is 0x00000000.

[0040] As shown in signal flow 54 of Figure 4, upon receipt of the reject message, the UE 18 is configured to transmit an attach request or a TAU request to the target core network instance 12 that is identified by the global identifier of the target control node 16, e.g., the GUMMEI provided by the source core network instance 10 in conjunction with the reject message.

Accordingly, as shown in block 40 of Figure 3, the target core network instance, such as the target control node, receives the attach request or the TAU request including the first global identifier of the UE. The first global identifier may be in the form of a new GUTI assigned by the source core network instance that has the globally unique identifier of the target core network instance, e.g., the mobility control node, and a local identifier field for the UE within the mobility control node. As noted above, the local identifier field will have a predefined flag value, such as a null value or a specifically reserved value, in a case in which the UE is redirected to the mobility control node from a different control node, e.g., the source control node. In an example embodiment in which the apparatus is embodied by the target control node, such as a target MME, the apparatus 30 includes means, such as the processor 32, the communication interface 36 or the like, configured to receive the first global identifier of the UE 18 during the attachment process.

[0041] The target core network instance 12, such as the target control node 16, that is, the mobility control node, is configured in accordance with an example embodiment to determine whether the attach or TAU request is provided in conjunction with the redirection of the UE. In this regard, the apparatus 30 embodied by the target control node, such as a target MME, includes means, such as the processor 32 or the like, configured to determine whether the local identifier field for the UE 18 has a predefined flag value. In an instance in which the local identifier field has a predefined flag value, the apparatus embodied by the target control node, such as the target MME, includes means, such as the processor or the like, for determining that the user equipment has been redirected from a different control node. See block 42 of Figure 3. In an instance in which the local identifier field does not have the predefined value, the attachment process with the target control node proceeds in a conventional fashion. However, in an instance in which the UE is determined to have been redirected from a different control node, e.g., the source control node 14 of the source control network instance 10, the apparatus includes means, such as the processor, the communication interface 36 or the like, for causing a reallocation command to be transmitted to the UE 18. See, block 44 of Figure 3 as well as signal flow 56 of Figure 4.

[0042] The reallocation command is associated with and generally includes a second global identifier of the UE 18. The second global identifier of the user equipment includes the globally unique identifier of the target control node 16 of the target control network instance 12 and the

identifier field includes a first locally unique user equipment identifier within the target control node of the target core network instance. The globally unique identifier of the target control node is the same globally unique identifier of the target control node as provided by the source control node in the reject message. The first locally unique user equipment identifier is different than the predefined flag value that is utilized to indicate the redirection of the UE. In an example embodiment in which the target core network instance is an EPC overlay supporting enhancements for 5G or 5GCthat includes an MME serving as the mobility control node or an AMF, respectively, the first locally unique user equipment identifier that is provided by the second global identifier includes an MME temporary mobile subscriber identity (M-TMSI) or a 5G-TMSI, respectively, although the a first globally unique temporary identity in the form of an M-TMSI will be referenced below for purposes of illustration but not limitation. Thereafter, the UE may be served by the target core network instance 12 after having been successfully redirected from the source core network instance 10 and attaching to the target core network instance.

[0043] In an example embodiment, the apparatus 30 includes means, such as the proessor 32 or the like, configured to determine whether a third global identifier of the UE 18 is received during the attachment process. See block 46 of Figure 3. The third global identifier includes a globally unique identifier of the different control node from which the UE is redirected, that is, the source control node, and the local identifier field having a second locally unique user equipment identifier. For example, the third global identifier of the UE may have been provided in conjunction with the attach or TAU request to the source control node and may now also be provided to the mobility control node following redirection of the UE. In one example embodiment of the third global identifier, the globally unique identifier of the different control node from which the UE is redirected may be the GUMMEI of the source MME and the second locally unique user equipment identifier may be an M-TMSI value that temporarily identifies the UE to the source core network instance.

[0044] In a case in which the third global identifier is received, the apparatus 30 is configured to obtain and utilize context information relating to the context of the UE 18 and its service from the source core network instance 10, such as the source control node 14. In this example embodiment, the apparatus includes means, such as the processor 32 or the like, configured to determine whether the target control node 16 and the source control node 14 are

members of a common control node group. In this regard, the apparatus of an example embodiment includes means, such as the processor, the communication interface 36 or the like, configured to determine whether a third global identifier of the UE, such as a third GUTI, different than the second GUTI, is received during the attachment process. See block 48. By including not only the second global identifier, but also the third global identifier, that is, both the second and third GUTIs, of the UE, the apparatus 30 is capable of distinguishing multiple UEs being redirected to the mobility control node with a local identifier field having the same predefined flag value.

[0045] Based upon the first and second globally unique identifers of the mobility control node, the apparatus 30, such as the processor 32 or the like, is configured to determine whether the mobility control node and the different control node, that is, the target and source control nodes, respectively, are members of the common control node group. Although this analysis may be performed in various manners, the apparatus, such as the processor, of an example embodiment is configured to analyze the second and third GUTIs to determine if both the second and third GUTIs have the same MME group identifier (MMEGI). In an instance in which both the second and third GUTIs have the same MMEGI, the apparatus, such as the processor, is configured to determine that the source control node and target control node are in the same pool and, as a result, are members of a common control node group. In this instance, the apparatus includes means, such as the processor, the communication interface 36 or the like, configured to obtain context information for the UE from the source control node, such as unused authentication vectors and/or the packet data network (PDN) gateway (PGW) address. See signal flow 58 of Figure 4. However, in an instance in which the target control node and the source control node are determined to not be members of the common control node group, the target core network instance proceeds with servicing the UE, albeit without the benefit of context information from other core network instances.

[0046] In other embodiments, the apparatus 30 is unable to obtain and utilize context information relating to the context of the UE 18 and its service from the source core network instance 10, such as the source control node 14. In this case, the UE does not provide, during the attachment process, a third global identifier of the UE, such as the third GUTI that comprises a globally unique identifier of the different control node and the local identifier field with a second locally unique user equipment identifier. In this example embodiment, the apparatus includes

means, such as the processor 32 or the like, configured to, cause a detach request to be sent toward the UE. See block 49 of Figure 3 and signal flow 59 of Figure 4 (the alternative nature of signal flows 58 and 59 being indicted by the dashed lines in Figure 4). The detach request includes a detach type value which, in turn, is set to a re-attach value. By also having provided the reallocation command including the second global identifier to the UE, the UE avoids attempting to re-attach to the source control node, thereby increasing the efficiency of the re-attachment process.

[0047] In the foregoing examples in which the mobility control node 14 of the core network is an MME, the globally unique identifiers of the mobility control node and the different control node, that is, the source control node, are different globally unique MME identifiers (GUMMEIs) and the first and second locally unique user equipment identifiers comprise different MME temporary mobile subscriber identities (M-TMSIs). Alternatively, the mobility control node may be an access and mobility management function (AMF). In this example embodiment, the globally unique identifers of the mobility control node and the different control node are different globally unique AMF identifiers (GUAMIs) and the first and second locally unique user equipment identifiers comprise different fifth generation temporary mobile subscriber identities (5G-TMSIs).

[0048] In the foregoing example embodiment in which the UE 18 is redirected to a different control node, the UE may be redirected in a manner that is transparent to the radio access network (RAN) 20. In this regard, the UE may be redirected without provisioning any subscription information in the HSS or the 5G unified data management function (UDF) that is requied to be interpreted by the RAN to select the appropriate control node. Thus, the method, apparatus 30 and computer program product of an example may be readily adopted since the performance of the radio access network need not be modified. Moreover, the target control node 16 need not reserve a plurality of M-TMSI or 5G-TMSI values to be utilized during redirection of the UE as required by other redirection techniques and, instead, utilizes a local identifier field having a predefined flag value to signal the redirection and then a single M-TMSI or 5G-TMSI value that uniquely identifies the UE to the target control node.

[0049] The redirection of the UE 18 may be performed in other manners. As shown in the flow chart of Figure 5 and the signal flow diagram of Figure 6, for example, the UE may issue an attach or TAU request to a source core network instance 10, such as a source control node 14, as

shown in signal flow 70 of Figure 6. In an instance in which the source core network instance is not going to support the UE, such as for any of a variety of different reasons including those described above, the source core network instance, such as the source control node of this example embodiment, is configured to direct a reject message, such as a non-access stratum (NAS) reject message as shown in signal flow 72, e.g., an attach reject message or a TAU reject message, to the UE indicating that the UE is being redirected so as to be serviced by a different core network instance, such as the target core network instance 12. In order to redirect the UE to a different core network instance in accordance with this example embodiment, the reject message includes the target tracking area identifier (TAI). The UE therefore receives the NAS reject message, such as an attach reject message or a TAU reject message, that includes the target TAI and that indicates to the UE that the UE is being redirected. See block 60 of Figure 5. Utilizing the target TAI and as shown in signal flow 74 of Figure 6, the UE then creates a NAS request message, such as an attach request message or a TAU message, that includes the target TAI. See block 62. The UE then causes the NAS request message to be sent toward a mobility control node of a core network, such as the target control node 16 of the target core network instance 12, as identified by the target TAI in order to attach to the target control node and to be serviced thereby. See block 64. In at least some example embodiments, the NAS request message provides for cell re-selection to the target control node of the target core network instance that is within the same PLMN as the source core network instance and its soruce control node.

[0050] In the foregoing example embodiment in which the UE 18 is redirected to a different core network instance utilizing a target TAI, the UE is impacted, but the redirection is performed in a manner that is transparent to the radio access network 20. In this regard, the UE may be redirected without provisioning any subscription information in the HSS. Moreover, the use of the target TAI avoids the target control node 16 needing to reserve a plurality of M-TMSI values to be utilized during redirection of the UE as required by other redirection techniques.

[0051] As described above, Figure 3 is a flowchart of an apparatus 30, method, and computer program product according to example embodiments of the invention. It will be understood that each block of the flowcharts, and combinations of blocks in the flowcharts, may be implemented by various means, such as hardware, firmware, processor, circuitry, and/or other devices associated with execution of software including one or more computer program instructions. For

example, one or more of the procedures described above may be embodied by computer program instructions. In this regard, the computer program instructions which embody the procedures described above may be stored by a memory device 34 of an apparatus employing an embodiment of the present invention and executed by a processor 32 of the apparatus. As will be appreciated, any such computer program instructions may be loaded onto a computer or other programmable apparatus (e.g., hardware) to produce a machine, such that the resulting computer or other programmable apparatus implements the functions specified in the flowchart blocks. These computer program instructions may also be stored in a computer-readable memory that may direct a computer or other programmable apparatus to function in a particular manner, such that the instructions stored in the computer-readable memory produce an article of manufacture, the execution of which implements the function specified in the flowchart blocks. The computer program instructions may also be loaded onto a computer or other programmable apparatus to cause a series of operations to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the instructions which execute on the computer or other programmable apparatus provide operations for implementing the functions specified in the flowchart blocks.

[0052] A computer program product is therefore defined in those instances in which the computer program instructions, such as computer-readable program code portions, are stored by at least one non-transitory computer-readable storage medium with the computer program instructions, such as the computer-readable program code portions, being configured, upon execution, to perform the functions described above, such as in conjunction with the flowchart of Figure 3. In other embodiments, the computer program instructions, such as the computer-readable program code portions, need not be stored or otherwise embodied by a non-transitory computer-readable storage medium, but may, instead, be embodied by a transitory medium with the computer program instructions, such as the computer-readable program code portions, still being configured, upon execution, to perform the functions described above.

[0053] Accordingly, blocks of the flowcharts support combinations of means for performing the specified functions and combinations of operations for performing the specified functions. It will also be understood that one or more blocks of the flowcharts, and combinations of blocks in the flowcharts, may be implemented by special purpose hardware-based computer systems which

perform the specified functions, or combinations of special purpose hardware and computer instructions.

[0054] In some embodiments, certain ones of the operations above may be modified or further amplified. Furthermore, in some embodiments, additional optional operations may be included. Modifications, additions, or amplifications to the operations above may be performed in any order and in any combination.

[0055] Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, although the foregoing descriptions and the associated drawings describe example embodiments in the context of certain example combinations of elements and/or functions, it should be appreciated that different combinations of elements and/or functions may be provided by alternative embodiments without departing from the scope of the appended claims. In this regard, for example, different combinations of elements and/or functions than those explicitly described above are also contemplated as may be set forth in some of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

WHAT IS CLAIMED IS:

1. A method comprising:

receiving a first global identifier of a user equipment during an attachment process to a mobility control node of a core network, wherein the first global identifier includes a globally unique identifier of the mobility control node and a local identifier field for the user equipment within the mobility control node;

in a case in which the local identifier field has a predefined flag value, determining that the user equipment has been redirected from a different control node; and

in a case in which the user equipment has been redirected from the different control node, causing a reallocation command to be transmitted to the user equipment, the reallocation command comprising a second global identifier of the user equipment including the globally unique identifier of the mobility control node and the local identifier field having a first locally unique user equipment identifier, different than the predefined flag value.

2. A method according to Claim 1 wherein the predefined flag value of the local identifier field is a null value or a specifically reserved value.

3. A method according to any of Claim 1 or 2 further comprising:

receiving a third global identifier of the user equipment during the attachment process, wherein the third global identifier comprises a globally unique identifier of the different control node and the local identifier field having a second locally unique user equipment identifier;

based upon the first and second globally unique identifiers of the mobility control node, determining whether the mobility control node and the different control node are members of a common control node group; and

in a case in which the control node and the different control node are members of the common control node group, obtaining context information relating to the user equipment from the different control node.

4. A method according to Claim 3 wherein the second and third global identifiers of the user equipment comprise different globally unique temporary identities of the user equipment.

5. A method according to any of Claim 1 or 2 further comprising:

in a case in which the user equipment does not provide, during the attachment process, a third global identifier of the user equipment that comprises a globally unique identifier of the different control node and the local identifier field with a second locally unique user equipment identifier, causing a deteach request to be sent toward the user equipment, wherein the detach request comprises a detach type value, and wherein the detach type value is set to a re-attach value.

6. A method according to any of Claims 3 to 5 wherein the mobility control node of the core network comprises a mobility management entity (MME), wherein the globally unique identifiers of the mobility control node and the different control node are different globally unique MME identifiers (GUMMEIs), and wherein the first and second locally unique user equipment identifiers comprise different MME temporary mobile subscriber identities (M-TMSIs).

7. A method according to any of Claims 3 to 5 wherein the mobility control node of the core network comprises an access and mobility management function (AMF), wherein the globally unique identifiers of the mobility control node and the different control node are different globally unique AMF identifiers (GUAMIs), and wherein the first and second locally unique user equipment identifiers comprise different fifth generation temporary mobile subscriber identities (5G-TMSIs).

8. An apparatus comprising:

means for receiving a first global identifier of a user equipment during an attachment process to the apparatus, wherein the first global identifier includes a golobally unique identifier of the apparatus and a local identifier field for user equipment within the apparatus;

means for determining, in a case in which the local identifier field has a predefined flag value, that the user equipment has been redirected from a different control node; and

means for causing a reallocation command to be transmitted to the user equipment in a case in which the user equipment has been redirected from the different control node, the reallocation command comprising a second global identifier of the user equipment including the globally unique identifier of the apparatus and the local identifier field having a first locally unique user equipment identifier, different than the predefined flag value.

9. An apparatus according to Claim 8 wherein the predefined flag value of the local identifier field is a null value or a specifically reserved value.

10. An apparatus according to any of Claim 8 or 9 further comprising:

means for receiving a third global identifier of the user equipment during the attachment process, wherein the third global identifier comprises a globally unique identifier of the different control node and the local identifier field having a second locally unique user equipment identifier;

means for determining, based upon the first and second globally unique identifiers of the apparatus, whether the apparatus and the different control node are members of a common control node group; and

means for obtaining context information relating to the user equipment from the different control node in a case in which the apparatus and the different control node are members of the common control node group.

11. An apparatus according to Claim 10 wherein the second and third global identifiers of the user equipment comprise different globally unique temporary identities of the user equipment.

12. An apparatus according to any of Claim 8 or 9 further comprising:

means for causing a deteach request to be sent toward the user equipment in a case in which the user equipment does not provide, during the attachment process, a third global identifier of the user equipment that comprises a globally unique identifier of the different

control node and the local identifier field with a second locally unique user equipment identifier, wherein the detach request comprises a detach type value, and wherein the detach type value is set to a re-attach value.

13. An apparatus according to any of Claims 10 to 12 wherein the apparatus is embodied by a mobility management entity (MME), wherein the globally unique identifiers of the apparatus and the different control node are different globally unique MME identifiers (GUMMEIs), and wherein the first and second locally unique user equipment identifiers comprise different MME temporary mobile subscriber identities (M-TMSIs).

14. An apparatus according to any of Claims 10 to 12 wherein the apparatus comprises an access and mobility management function (AMF), wherein the globally unique identifiers of the apparatus and the different control node are different globally unique AMF identifiers (GUAMIs), and wherein the first and second locally unique user equipment identifiers comprise different fifth generation temporary mobile subscriber identities (5G-TMSIs).

15. A method comprising:

receiving, at a user equipment, a non-access stratum reject message, wherein the non-access stratum reject message comprises a target tracking area identifier, and wherein the non-access stratum reject message also comprises either an attach reject message or a tracking area update reject message;

creating a non-access stratum request message, wherein the non-access stratum request message includes the target tracking area identifier, and wherein the non-access stratum request message also comprises either an attach request message or a tracking area update message; and

causing the non-access stratum request message to be sent toward a mobility control node of a core network.

16. A method according to Claim 15 wherein the non-access stratum reject message indicates to the user equipment that the user equipment is being redirected.

17. A method according to any of Claim 15 or 16 wherein causing the non-access stratum request message to be sent toward the mobility control node of the core network comprises providing for cell re-selection within a same public land mobile network (PLMN) based on the target tracking area identifier.

18. An apparatus comprising:

means for receiving, at a user equipment, a non-access stratum reject message, wherein the non-access stratum reject message comprises a target tracking area identifier, and wherein the non-access stratum reject message also comprises either an attach reject message or a tracking area update reject message;

means for creating a non-access stratum request message, wherein the non-access stratum request message includes the target tracking area identifier, and wherein the non-access stratum request message also comprises either an attach request message or a tracking area update message; and

means for causing the non-access stratum request message to be sent toward a mobility control node of a core network.

19. An apparatus according to Claim 18 5 or 16 wherein the non-access stratum reject message indicates to the user equipment that the user equipment is being redirected.

20. An apparatus according to any of Claims 18 or 19 wherein the on-access stratum request message caused to be sent toward the mobility control node of the core network provides for cell re-selection within a same public land mobile network (PLMN) based on the target tracking area identifier.

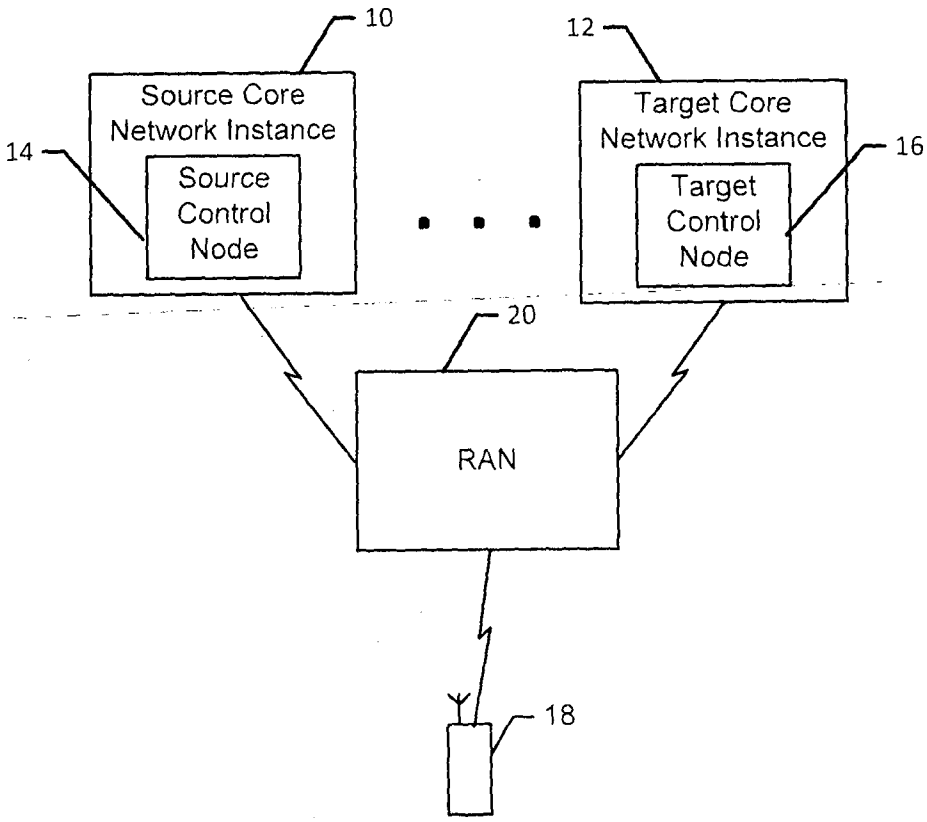
10
12
Source Core Network Instance
Source Control Node
14
Target Core Network Instance
Target Control Node
16
20
RAN
18

Figure 1

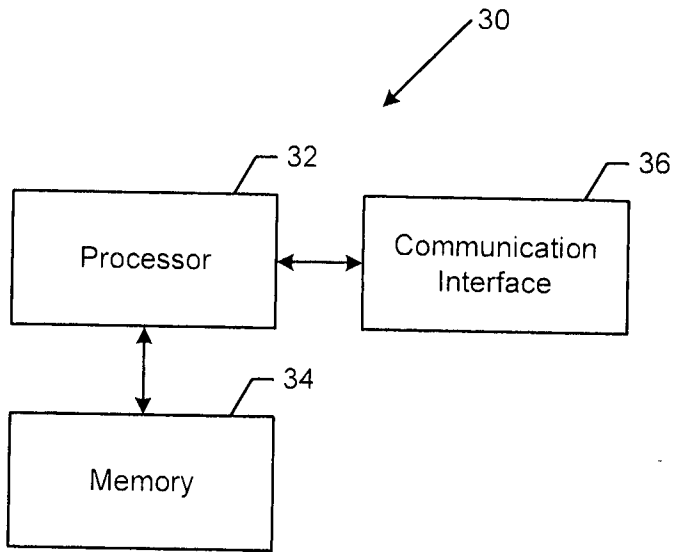

Figure 2

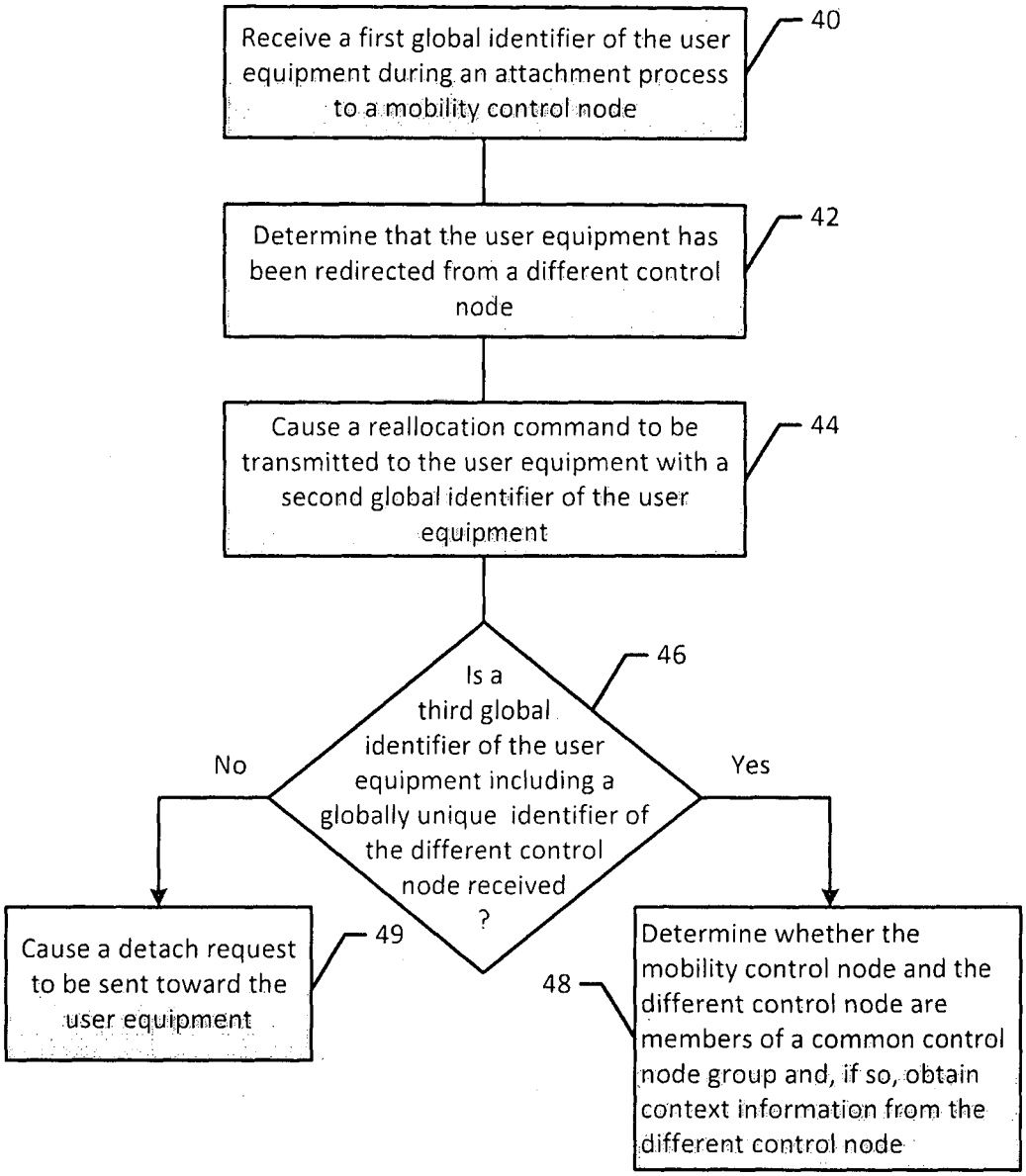
Receive a first global identifier of the user equipment during an attachment process to a mobility control node
40
Determine that the user equipment has been redirected from a different control node
42
Cause a reallocation command to be transmitted to the user equipment with a second global identifier of the user equipment
44
Is a third global identifier of the user equipment including a globally unique identifier of the different control node received ?
46
No
Yes
Cause a detach request to be sent toward the user equipment
49
Determine whether the mobility control node and the different control node are members of a common control node group and, if so, obtain context information from the different control node
48

Figure 3

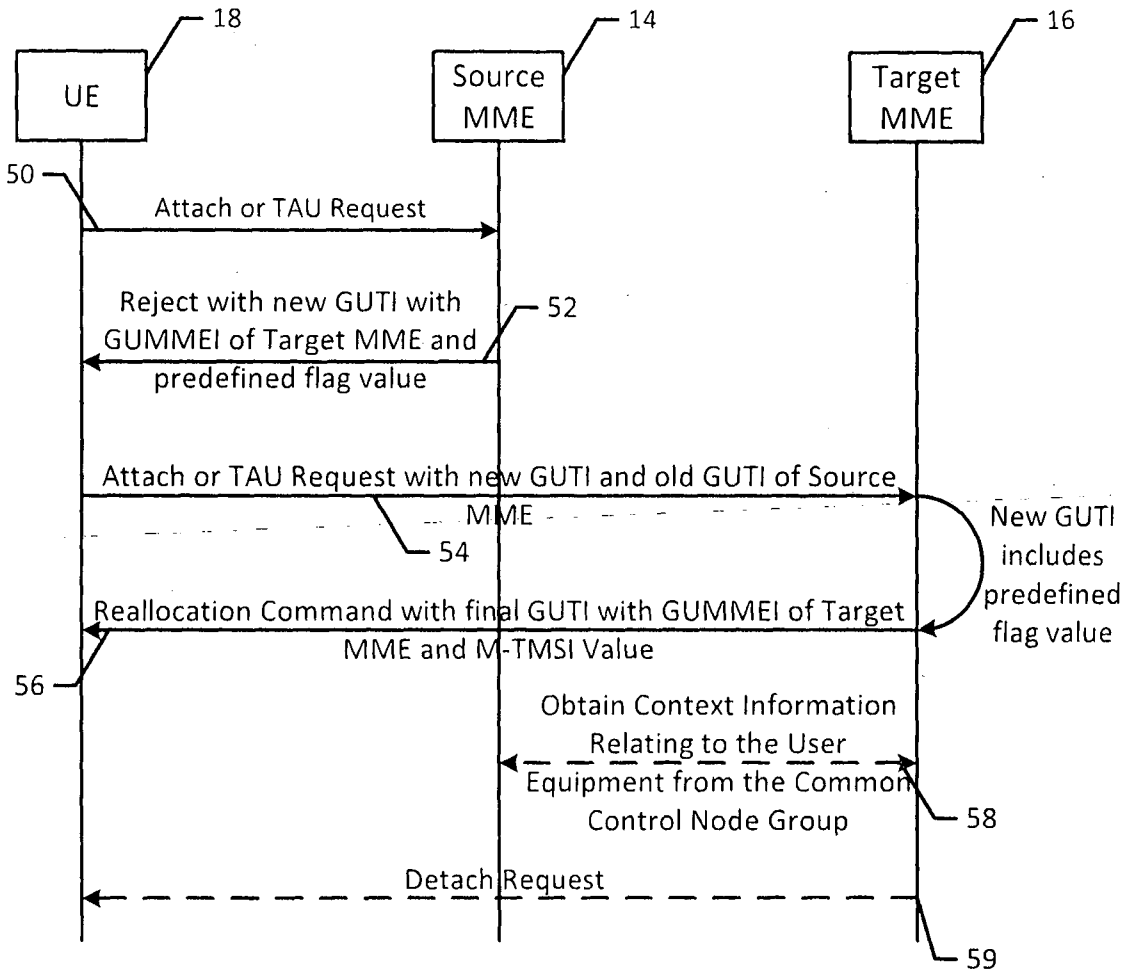
18
14
16
UE
Source MME
Target MME
50
Attach or TAU Request
Reject with new GUTI with GUMMEI of Target MME and predefined flag value
52
Attach or TAU Request with new GUTI and old GUTI of Source MME
54
New GUTI includes predefined flag value
Reallocation Command with final GUTI with GUMMEI of Target MME and M-TMSI Value
56
Obtain Context Information Relating to the User Equipment from the Common Control Node Group
58
Detach Request
59

Figure 4

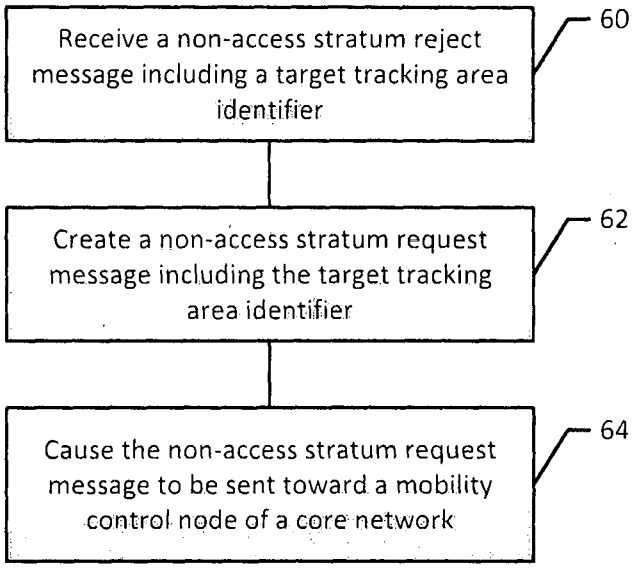
Receive a non-access stratum reject message including a target tracking area identifier
60
Create a non-access stratum request message including the target tracking area identifier
62
Cause the non-access stratum request message to be sent toward a mobility control node of a core network
64

Figure 5

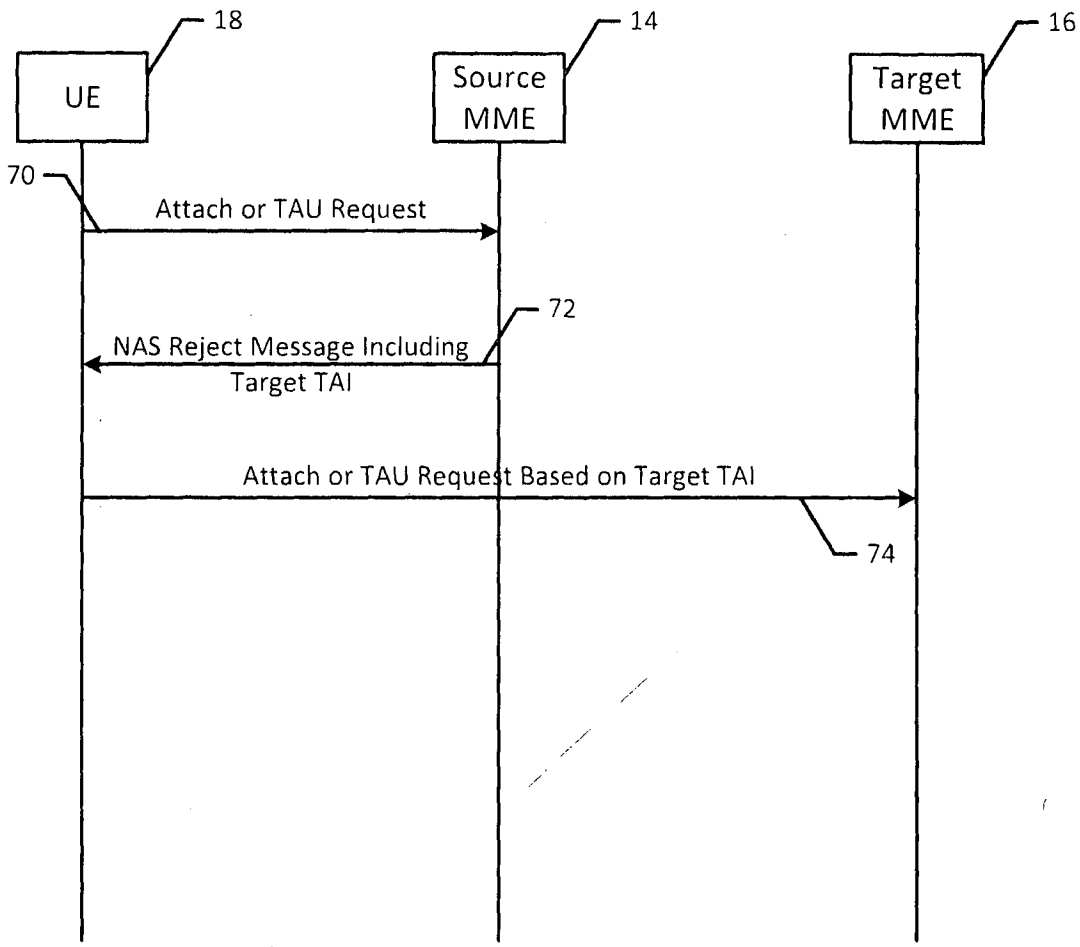
18
14
16
UE
Source MME
Target MME
70
Attach or TAU Request
72
NAS Reject Message Including Target TAI
Attach or TAU Request Based on Target TAI
74

Figure 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/GR2018/000018

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W36/00 H04W36/12
ADD.

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 data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2016/066219 A1 (POIKONEN HENRI MIKAEL [FI] ET AL) 3 March 2016 (2016-03-03) paragraphs [0027] - [0040] figures 1, 2	1,2,5-9, 12-14 3,4,10, 11
Y	US 2014/133464 A1 (LI QINGYU [CN] ET AL) 15 May 2014 (2014-05-15) paragraphs [0080] - [0121], [0232] - [0313] figures 8-11, 20-26	3,4,10, 11

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 September 2018	17/09/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Davidovic, Sasa

INTERNATIONAL SEARCH REPORT

International application No
PCT/GR2018/000018

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access (Release 15)", 3GPP STANDARD; TECHNICAL SPECIFICATION; 3GPP TS 23.401, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. SA WG2, no. V15.2.0, 22 December 2017 (2017-12-22), pages 1-404, XP051392097, [retrieved on 2017-12-22] Sections 5.3.2, 5.3.7 figures 5.3.2.1-1, 5.3.7-1 -----	1-14
X	US 2003/040313 A1 (HOGAN WILLIAM DAMIAN [IE] ET AL) 27 February 2003 (2003-02-27) paragraphs [0008] - [0038], [0044] - [0050] figures 1-5, 9-12 -----	15-20
A	US 2011/111771 A1 (BARBER PHILLIP [US]) 12 May 2011 (2011-05-12) paragraphs [0026] - [0035]; figures 1, 2 -----	15-20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GR2018/000018

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-14

   - a method comprising: receiving a first global UE identifier during attach procedure to a mobility control node of a core network, the first global identifier comprising a unique code of the mobility control node and a local identifier for the UE within the mobility control node; if the the local identifier has a predefined value determining that the UE has been redirected from another mobility control node and sending a reallocation command to the UE comprising a second global UE identifier having the unique code of the mobility control nide and a first local identifier different than the predefined value;
   - a corresponding apparatus.

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2. claims: 15-20

   - a method comprising: receiving at a UE a NAS reject message comprising a target TAI, wherein the NAS reject message can be an attach reject or TAU reject message; creating a NAS request message including the TAI, wherein the NAS request message may be an attach request or TAU request message; sending the NAS request message to a mobility control node of a core network;- a corresponding apparatus.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GR2018/000018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016066219 A1	03-03-2016	US 2016066219 A1	03-03-2016
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US 2014133464 A1	15-05-2014	AT 515131 T	15-07-2011
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US 2011111771 A1	12-05-2011	US 2011111771 A1	12-05-2011
		WO 2011054316 A1	12-05-2011