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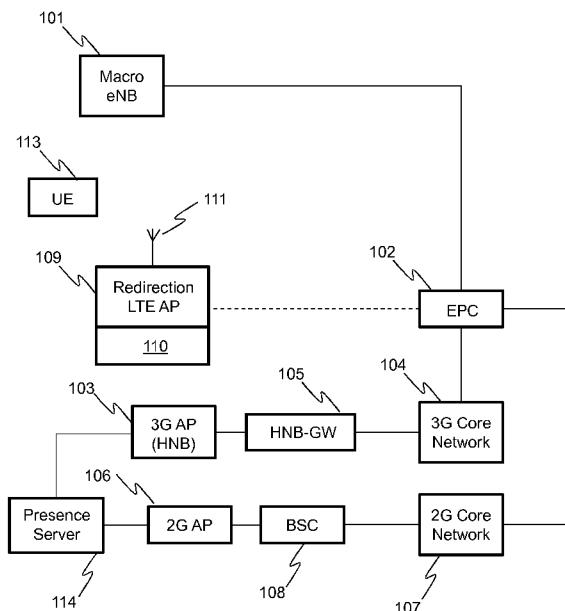
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(54) Title: NETWORK ELEMENTS, WIRELESS COMMUNICATION SYSTEM AND METHODS THEREFOR



(57) Abstract: A method and apparatus for redirecting a wireless communication unit (113) from a LTE cell to a neighbouring 3G or 2G cell for the purposes of performing a procedure which is available in the 2G or 3G cell but not available in the LTE cell includes the provision of an additional LTE access point (109) within the coverage area of an LTE macrocell. The additional LTE access point (109) is arranged to capture a wireless communication unit (113) which is camped onto the LTE macrocell and redirect it to a 3G/2G cell irrespective of whether or not a better service may be provided in the 2G/3G cell.. The invention has application to presence detection where collection of wireless communication units' and subscribers' IDs for such a purpose is possible in 3G and 2G cells but not in LTE cells.

FIG. 1



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NETWORK ELEMENTS, WIRELESS COMMUNICATION SYSTEM AND METHODS THEREFOR

5 **Field of the invention**

The field of this invention relates to network elements, a wireless communication system and methods for operating a cellular communication system and has particular applicability to providing a location presence service in such a system.

10 **Background of the Invention**

Wireless communication systems, such as the 3rd Generation (3G) of mobile telephone standards and technology, are well known. An example of such 3G standards and technology is the Universal Mobile Telecommunications System (UMTS™), developed by the 3rd Generation Partnership Project (3GPP™) (www.3gpp.org). The 3rd generation of wireless communications has generally been developed to support macro-cell mobile phone communications. Such macro cells utilise high power base stations (NodeBs in 3GPP parlance) to communicate with wireless communication units within a relatively large geographical coverage area. Typically, wireless communication units, or User Equipment (UEs) as they are often referred to in 3G parlance, communicate with a Core Network (CN) of the 3G wireless communication system via a Radio Network Subsystem (RNS). A wireless communication system typically comprises a plurality of radio network subsystems, each radio network subsystem comprising one or more cells to which UEs may attach, and thereby connect to the network. Each macro-cellular RNS further comprises a controller, in a form of a Radio Network Controller (RNC), operably coupled to the one or more Node Bs, via a so-called Iub interface.

25 The second generation wireless communication system (2G), also known as GSM, is a well-established cellular, wireless communications technology whereby "base transceiver stations" (equivalent to the Node B's of the 3G system) and "mobile stations" (user equipment) can transmit and receive voice and packet data. Several base transceiver stations are controlled by a Base Station Controller (BSC), equivalent to the RNC of 3G systems.

30 Communications systems and networks are developing towards a broadband and mobile system. The 3rd Generation Partnership Project has proposed a Long Term Evolution (LTE) solution, namely, an Evolved Universal Mobile Telecommunication System Territorial Radio Access Network, (E-UTRAN), for a mobile access network, and a System Architecture Evolution (SAE) solution, namely, an Evolved Packet Core (EPC), for a mobile core network. An evolved packet system (EPS) 35 network provides only packet switching (PS) domain data access so voice services are provided by Voice-over-LTE (VoLTE – a VoIP technique) or, via Circuit Switched Fallback (CSFB) by a 2G or 3G Radio Access Network (RAN) and circuit switched (CS) domain network. User Equipment(UE) can access a CS domain core network through a 2G/3GRAN such as the (Enhanced Data Rate for GSM Evolution, EDGE) Radio Access Network (GERAN) or a Universal Mobile Telecommunication System 40 Terrestrial Radio Access Network (UTRAN), and access the EPC through the E-UTRAN.

Some User Equipments have the capability to communicate with networks of differing radio access technologies. For example, a user equipment may be capable of operating within a UTRAN and within an E-UTRAN.

Lower power (and therefore smaller coverage area) cells are a recent development within the field of wireless cellular communication systems. Such small cells are effectively communication coverage areas supported by low power base stations. The terms "picocell" and "femtocell" are often used to mean a cell with a small coverage area, with the term femtocell being more commonly used with reference to residential small cells. Small cells are often deployed with minimum RF (radio frequency) planning and those operating in consumers' homes are often installed in an *ad hoc* fashion.

5 The low power base stations which support small cells are referred to as Access Points (APs) with the term Home Node B (HNB, specifically for 3G) or Evolved Home Node B (HeNB, specifically for LTE) defined by 3GPP to identify femtocell Access Points. Each small-cell is supported by a single Access Point. These small cells are intended to augment the wide area macro network and support communications to multiple User Equipment devices in specific environments, for example, indoor or

10 enterprise. Such small cells are intended to be able to be deployed "underneath" a macrocell (in a multi-layer structure, for example) in order to support communications to UEs in a restricted area such as a shopping mall, for example. An additional benefit of small cells is that they can offload traffic from the macro network, thereby freeing up valuable macro network resources). One or more Access Points are linked to a Core Network through an Access Controller. An Access Controller which links

15 one or more HNB's to the Core Network is known as a Home Node B Gateway (HNB-GW). An HNB provides a radio access network connectivity to a user equipment (UE) using the so-called Iuh interface to a HNB-GW.

Although there are no standard criteria for the functional components of an AP, an example of a typical AP for use within a 3GPP 3G system may comprise Node-B functionality and some aspects 25 of Radio Network Controller (RNC) functionality as specified in 3GPP TS 25.467.

A current industry model is to implement a GSMA one API on one of three places: viz. on the User Equipment (for handset applications) or on the small cell (for local applications) or on the application Gateway (for external third-party access). The GSMA one API is an application 30 programming interface which has been developed by the GSM (Global System for Mobile Communications) Association. It is intended to be a web service interface. An application developed with one API can obtain information across network operators that support it. It is intended for operation on servers and mobile devices and the first API's to be implemented will be for messaging and location functions. Specifically, version 1 requires "location presence" capability and the ability to 35 send and receive short message services (SMS) and multimedia messaging services (MMS) through the application Gateway using the GSMA one API.

"Presence" services in general permit an individual and equipment which he/she uses for communication to share information on the state of the individual and that equipment. Such information can include whether the individual and his communication equipment are currently able to communicate with others or are engaged on a video call, for example. "Presence" can also include 40 information relating to the location of a user's communication equipment. A "presence server" may be provided in such instances for, on detection that a particular UE has entered a particular location,

enabling applications that subscribe to a “presence” service to take some form of action. For example, location information can be very useful to retailers and advertisers who may wish to communicate with shoppers who are known to be in a certain location at a certain time, a shopping mall for example.

Some current Location Presence services are based on the use of a localised Identity
5 Request sent by an Access Point to a UE to obtain its IMSI International Mobile Subscriber Identifier). This was originally proposed to support a form of access control. If the Access Point is prepared to offer normal telecommunications services, then the UE is allowed to register on the small cell. Alternatively, the IMSI may be captured from the so-called “Common_ID” sent by the Core network. In each case an Access Point must have a different LAC/RAC from the surrounding coverage (ie. other
10 small cells or overlapping macrocell) in order to prompt a Registration attempt when camping on. A registration attempt may be used to prompt a location presence trigger. (See Applicant's co-pending Application GB 1209224.3). Collection of a UE's IMSI is possible in 3G and 2G networks but not in LTE networks. In LTE networks, by contrast with 2G and 3G networks, the signalling that carries the IMSI is ciphered between the UE and the core and so cannot be inspected in the RAN and used as a
15 basis of presence services.

Summary of the invention

20 According to one aspect of the invention, there is provided communications apparatus comprising a first access point for providing communications in a first cell using a radio access technology (RAT), wherein the first cell has a coverage area which overlaps at least a part of a coverage area of a second cell which uses a radio access technology which is the same as that of the first cell, and at least a part of a coverage area of a third cell which uses a radio access technology
25 which is different from that of the first and second cells, wherein the first cell has a tracking area code (TAC) which is different from a tracking area code assigned to the second cell, and wherein the first access point includes a memory for storing information relating to the third cell, and wherein the first access point is arranged to receive a request for connection from a wireless communication unit which is within the coverage area of the first cell and camped on to the second cell, and in response to
30 receiving said request for connection, redirect the wireless communication unit to the third cell by sending to the wireless communication unit, a Radio Resource Control Connection Release message including a Radio Resource Control redirection Information Element which includes the stored information relating to the third cell.

In one embodiment, the communications apparatus includes a second access point for
35 providing communications services in said third cell and arranged to receive a request for connection from a wireless communication unit which has been re-directed thereto by the first access point and further arranged to request from the wireless communication unit, a unique identifier relating to the wireless communication unit, to receive said unique identifier from the wireless communication unit, and to generate a presence notification message including said unique identifier and forward said
40 presence notification message to a remote entity.

The second access point may generate a message requesting the wireless communication unit to provide its unique identifier without any assistance from a core network

The second access point may be arranged to provide services to the re-directed wireless communication unit or to reject its request for connection or re-direct it to a neighbouring cell, once the unique identifier has been received.

The first and second access points may be co-located or situated at different geographical locations.

The first access point may be provided with a network listen device for gathering information on the third cell from broadcasts by the third cell, for storage in the memory.

10 The unique identifier may be the IMSI of the wireless communication unit.

The RAT used by the first and second cells may be LTE and the RAT used by the third cell may be 2G or 2G.

According to another aspect of the invention, there is provided a method for operating a cellular communication system, the method comprising; in a first access point which provides communications in a first cell using a radio access technology (RAT), wherein the first cell has a coverage area which overlaps at least a part of the coverage area of a second cell which uses a radio access technology which is the same as that of the first cell and at least a part of the coverage area of a third cell which uses a radio access technology which is different from that of the first and second cells, assigning a tracking area code to the first cell which is different from a tracking area code assigned to the second cell, storing information relating to the third cell, receiving a request for connection from a wireless communication unit which is within the coverage area of the first cell and camped on to the second cell, and in response to receiving said request for connection, redirecting the wireless communication unit to the third cell by sending to the wireless communication unit, a Radio Resource Control Connection Release message including a Radio Resource Control redirection Information Element which includes the stored information relating to the third cell.

Specific embodiments of the invention are set forth in the dependent claims.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

Functional elements of the access points may be implemented in one or more integrated circuit devices.

The invention provides a method and apparatus for redirecting a wireless communication unit from an LTE cell to a neighbouring 3G or 2G macrocell for the purposes of performing a procedure which is available in the 2G or 3G cell but not available in the LTE cell. The invention includes the provision of an additional LTE access point within the coverage area of an LTE macrocell. The additional LTE access point may be arranged to capture a wireless communication unit which is in idle mode and registered with the LTE macrocell and redirect it to a 3G/2G cell irrespective of whether or not a better service may be provided in the 2G/3G cell. The invention has application to presence detection where collection of wireless communication units' and/or subscribers' IDs for such a purpose is possible in 3G and 2G cells but not in LTE. There could be other examples where it is desired to override the normal macro policies to steer a UE towards a localised coverage area on an alternate

RAT. These examples require a localised solution that is capable of overriding normal macro LTE policy to steer an Idle UE from the LTE service layer to another RAT.

The invention may use a redirection procedure of an LTE cell to immediately redirect a captured UE to another RAT (e.g. 3G or 2G), thus overriding the normal layer behaviour. The 2G or 5 3G access point to which the UE has been directed, can subsequently perform a presence operation at its particular location without core network support. This would not be possible if the UE had remained attached to the LTE cell.

The invention may be used within a multimode cell (e.g. LTE + 3G) or may be realised as 10 separate components (e.g. a single LTE cell used as a Redirection Gateway to one or more 3G and/or 2G cells)

The invention can provide a localised method of steering a UE from an LTE cell to a cell on another RAT that can operate alongside existing macro-layer policies

In one embodiment, for the purposes of a redirection-only procedure, the LTE cell need not be connected to the EPC, thus reducing the signalling load on the Core Network.

15

Brief Description of the Drawings

Further details, aspects and embodiments of the invention will be described, by way of example only, with reference to the drawings. Elements in the figures are illustrated for simplicity and 20 clarity and have not necessarily been drawn to scale. Like reference numerals have been included in the respective drawings to ease understanding.

FIG. 1 is a simplified block diagram of a cellular communications system operating in accordance with an embodiment of the invention; and

FIG. 2 is a simplified flowchart chart of an example of a method for redirecting a wireless 25 communication unit between cells using different radio access technologies and performing a presence service, in accordance with an embodiment of the invention.

Detailed Description

30 The inventive concept finds particular applicability in a cellular communication system that supports a number of overlapping communication coverage areas, for example a communication system that comprises a combination of small cells and macro cells. Further, the inventive concept finds applicability in a cellular communication system comprising more than one Radio Access Technology.

35 Those skilled in the art will recognize and appreciate that the specifics of the examples described are merely illustrative of some embodiments and that the teachings set forth herein are applicable in a variety of alternative settings.

Referring now to FIG.1, a macro Evolved NodeB (ENodeB or eNodeB or ENB) 101 provides 40 cellular communications services over a respective coverage area and operates using the LTE radio access technology. The macro eNodeB is of conventional design. For example, the eNodeB may, typically, contain information about neighbouring cells such as the operating frequencies and/or

identities. The eNodeB is also provisioned with a Tracking Area Code (TAC) which is a number configured into the eNodeB to denote a particular tracking area (TA). The eNode B is connected to and communicates with an Evolved Packet Core (EPC) 102 in a conventional manner. The Evolved Packet Core 102 is also conventional and may comprise, for example, a Serving Gateway a Packet 5 Gateway and a Mobility Management Entity (not shown).

A 3G access point.(3G AP)103, which in this example is a Home Node B (HNB), provides cellular communications services over a respective coverage area and operates using the 3G radio access technology. In other examples, in place of the Home Node B the 3G access point could be a node B having a typically greater coverage area compared with the HNB. The 3G access point 103 in 10 some embodiments can communicate with a 3G core network 104 in a conventional manner via a Home Node B Gateway (HNB-GW) 105. In this example, the 3G core network 104 communicates with the Evolved Packet Core 102.

A 2G access point 106 provides cellular communications services over a respective coverage area and operates using the 2G radio access technology. The 2G access point 106 in some 15 embodiments can communicate with a 2G core network 107 in a conventional manner via a Base Station Controller (BSC) 108. The 2G access point 106 may comprise a base station transceiver. In this example, the 2G core network 107 communicates with the Evolved Packet Core 102.

In alternative embodiments, either one or both of the 2G and 3G access points 106, 103 could 20 be isolated cells, not actually connected to a core network but merely configured to determine an identity (for example the IMSI) of the user equipment (for the purpose of achieving a presence service for example) and then to redirect the UE back to another cell which is connected with the core network.

A “redirection” LTE access point (LTE AP) 109 provides cellular communication services over 25 a respective coverage area which overlaps at least part of the coverage areas of the macro eNodeB 101, the 3G access point 103 and the 2G access point 106. In one example, the LTE access point 109 is an evolved Home Node B serving a small coverage area and may be deployed in locations where a presence service is desired; such as a shopping mall for example. Hence in this example, the LTE access point's cell sits underneath the macrocells which are served by the macro eNodeB 101, the 3G HNB 103 and the 2G access point 106. In other embodiments, the LTE access point 109 may be a 30 Node B with a larger coverage area. The LTE access point 109 is provisioned with a TAC which is different from that of the macro eNodeB. The LTE access point 109 includes a memory 110 which stores information relating to neighbouring cells. In particular, such information relates to the 3G HNB 103, and the 2G access point 106 and may include, for example their operating frequencies and an identifier. The memory 110 may be provisioned with this information under the control of a 35 conventional access management system (not shown). In another embodiment, the LTE access point 109 is provided with a network listen device 111 which listens to broadcasts from neighbouring cells, collects information relating to the neighbouring cells from the broadcast information and stores it in the memory 110. Specifically, the network listen device 111 monitors broadcasts from the 3G and 2G access points 103 and 106 respectively.

40 In one embodiment, the LTE access point 109 is connected to and communicates with the EPC 102 in a conventional fashion over a link 112. In this case the LTE access point 109 is able to

provide the usual communication services to a user equipment which may enter its coverage area in addition to performing an immediate redirection operation on another UE. In another embodiment, the LTE access point 109 is not used to provide any communication services via the EPC 102 and so no connection is provided and in this configuration, the LTE access point 109 performs a redirection 5 operation only. The LTE access point 109 is arranged to receive messages from a user equipment 113, and generate redirection messages for sending to selected user equipments.

A remote presence server 114 is connected to the 3G access point 103 and to the 2G access point 106.

Examples of operation of the invention will now be described. An LTE access point 109 is 10 deployed in an area where it is desired to have a policy override such that a UE 113 which is 'camped on' to a LTE macrocell may be reselected on to the LTE Access Point with specific policy, and will in turn be redirected to a 3G or 2G cell, 103 or 106 whether or not the service provided by the 3G or 2G cell is superior to that provided by the LTE cell. The LTE access point is also deployed in an area where a presence detection of user equipments is required. The LTE access point has a different TAC 15 to the LTE macrocell. This will prompt a TAU (Tracking Area Update) procedure by the UE on reselection. In this example, the LTE access point 109 does not communicate with the EPC 102 and is used solely for redirection purposes.

Referring now to Fig. 2, at 200, a TAC, which is different from that of the LTE macrocell, is 20 assigned to the cell supported by the LTE access point 109. A UE 113 is "camped on" to the macrocell served by eNodeB 101. That is to say that the UE 113 is in idle mode and has registered with the LTE macrocell. The UE 113 moves into the coverage area of the (redirection) LTE access point 109. As is conventional, the UE takes measurements of neighbouring cells and according to the conventional policies, identifies the LTE access point 109 as a suitable candidate for 'reselection,' because, for example, the LTE access point's broadcast signal strength (or quality) is better than that 25 of the macro eNodeB 101. The UE, following conventional procedures, also detects that the LTE access point 109 has a different TAC to the macro eNodeB. So, in accordance with the macro policy, the UE reselects to the LTE access point 109 and initiates an RRC (Radio Resource Control) Connection Request with the intention of performing a TAU (Tracking Area Update).

Thus, at 201, the LTE AP 109 receives the RRC Connection Request.

30 The LTE AP 109 accepts the RRC Connection Request and at 202 responds by sending to the UE an RRC Connection Setup message.

In response, the UE sends an RRC Connection Setup Complete message which is received by the LTE AP at 203.

35 The LTE access point 109 does not pass any NAS (non-access stratum) messages towards the Core Network but instead, immediately initiates a redirection to the 3G cell 103 by releasing the RRC Connection (RRC Connection Release) at 204.

Alternatively, the LTE access point 109 may choose to redirect the UE to the 2G cell 106.

40 The RRC Connection Release message which is sent to the UE by the LTE access point 109 includes an RRC redirection IE (Information Element). In this way, the UE receives information about the 3G (or 2G) neighbouring cell, this information having been retrieved from the access point's memory 110. The RRC redirection IE includes redirectedCarrierInfo (and

idleModeMobilityControlInfo); and optionally cellInfoList-r9. “redirectedCarrierInfo” can specify the carrier of the target 2G/3G cell. “idleModeMobilityControlInfo” can be used to reinforce that the wanted target cell carrier is highest priority. “cellInfoList-r9” can save time when reselecting to the 3G cell by providing SysInfo for immediate use.

5 The UE then reselects the 3G cell (served by 3G AP 103) and UE sends an RRC Connection Request which is received by the 3G access point 103 at 205.

In response, at 206, the 3G access point 103 sends an RRC Connection Setup message to the UE 113.

10 In response, the UE sends an RRC Connection Setup Complete message which is received by the 3G access point 103 at 207.

This is followed by a RRC Initial Direct Transfer (Location Updating Request) which is received by the 3G access point 103 at 208.

Now that the UE has initiated communication with the 3G cell, the 3G radio access network can use established techniques to recover the identity of the UE 113 for presence service purposes.

15 So at 209, the 3G AP 103 requests the unique identity of the UE by sending an RRC Downlink Direct Transfer (Mobility Management Identity Request).

The UE responds with an RRC Uplink Direct Transfer (Mobility Management Identity Response) message which includes the IMSI. This is received by the 3G AP at 210.

At 211, the 3G AP 103 generates a presence notification message and forwards it to the presence server 114. The notification message includes the IMSI, which has been captured by the 3G AP 103, and also information which relates to the LTE AP 109 so that the presence server 114 can link the received IMSI with a geographical location. If the LTE AP 109 and the 3G AP 103 are co-located, then information relating to the 3G AP 103 could be sent instead. The 3G AP 103 or the presence server 114 may time-stamp the presence notification message.

25 At 212, in this example, the 3G AP 103 continues to operate as conventional by supplying normal communications services to the UE 113 by way of its links to the 3G core network 104 through the HNB Gateway 105.

In alternative embodiments the HNB Gateway 105 (or other entity), rather than the 3G AP 103, generates and sends the presence notification. For example, the 3G AP 103 sends the received 30 IMSI to the HNB Gateway 105 using standard messaging such as HNBAP (Home Node B Application Part) UE Register Request. An identifier relating to the location of the LTE AP 109 (or 3G AP 103 if the two are co-located) may be sent by the 3G AP 103 to the HNB Gateway 105 or the HNB Gateway may be pre-provisioned with such information. Then, the HNB Gateway 105 generates and sends a presence notification message to the presence server 114.

35 In other environments, the 3G access point 103 may reject the UE 113 after receiving the IMSI. This may be done in the 3G AP 103 by generating a Downlink Transfer (Location Updating Reject with cause) to the UE 113. In another embodiment, the 3G AP 103, after receiving the IMSI, may re-direct the UE to a neighbouring cell such as the LTE macrocell by generating an RRC Connection Release message with relevant information about the LTE macrocell.

The signal processing functionality of the embodiments of the invention, particularly those functions performed by the access points may be achieved using computing systems or architectures known to those who are skilled in the relevant art. Computing systems such as, a desktop, laptop or notebook computer, hand-held computing device (PDA, cell phone, palmtop, etc.), 5 mainframe, server, client, or any other type of special or general purpose computing device as may be desirable or appropriate for a given application or environment can be used. The computing system can include one or more processors which can be implemented using a general or special-purpose processing engine such as, for example, a microprocessor, microcontroller or other control module.

The computing system can also include a main memory, such as random access memory 10 (RAM) or other dynamic memory, for storing information and instructions to be executed by a processor. Such a main memory also may be used for storing temporary variables or other intermediate information during execution of instructions to be executed by the processor. The computing system may likewise include a read only memory (ROM) or other static storage device for storing static information and instructions for a processor.

15 The computing system may also include an information storage system which may include, for example, a media drive and a removable storage interface. The media drive may include a drive or other mechanism to support fixed or removable storage media, such as a hard disk drive, a floppy disk drive, a magnetic tape drive, an optical disk drive, a compact disc (CD) or digital video drive (DVD) read or write drive (R or RW), or other removable or fixed media drive. Storage media may include, 20 for example, a hard disk, floppy disk, magnetic tape, optical disk, CD or DVD, or other fixed or removable medium that is read by and written to by media drive. The storage media may include a computer-readable storage medium having particular computer software or data stored therein.

In alternative embodiments, an information storage system may include other similar 25 components for allowing computer programs or other instructions or data to be loaded into the computing system. Such components may include, for example, a removable storage unit and an interface, such as a program cartridge and cartridge interface, a removable memory (for example, a flash memory or other removable memory module) and memory slot, and other removable storage units and interfaces that allow software and data to be transferred from the removable storage unit to computing system.

30 The computing system can also include a communications interface. Such a communications interface can be used to allow software and data to be transferred between a computing system and external devices. Examples of communications interfaces can include a modem, a network interface (such as an Ethernet or other NIC card), a communications port (such as for example, a universal serial bus (USB) port), a PCMCIA slot and card, etc. Software and data transferred via a 35 communications interface are in the form of signals which can be electronic, electromagnetic, and optical or other signals capable of being received by a communications interface medium.

In this document, the terms 'computer program product', 'computer-readable medium' 'non-transitory computer-readable medium' and the like may be used generally to refer to tangible media 40 such as, for example, a memory, storage device, or storage unit. These and other forms of computer-readable media may store one or more instructions for use by the processor comprising the computer system to cause the processor to perform specified operations. Such instructions, generally referred

to as 'computer program code' (which may be grouped in the form of computer programs or other groupings), when executed, enable the computing system to perform functions of embodiments of the present invention. Note that the code may directly cause a processor to perform specified operations, be compiled to do so, and/or be combined with other software, hardware, and/or firmware elements 5 (e.g., libraries for performing standard functions) to do so.

In an embodiment where the elements are implemented using software, the software may be stored in a computer-readable medium and loaded into computing system using, for example, removable storage drive. A control module (in this example, software instructions or executable computer program code), when executed by the processor in the computer system, causes a 10 processor to perform the functions of the invention as described herein.

Furthermore, the inventive concept can be applied to any circuit for performing signal processing functionality within a network element. It is further envisaged that, for example, a semiconductor manufacturer may employ the inventive concept in a design of a stand-alone device, such as a microcontroller or a digital signal processor (DSP), or application-specific integrated circuit 15 (ASIC) and/or any other sub-system element.

It will be appreciated that, for clarity purposes, the above description has described 20 embodiments of the invention with reference to a single processing logic. However, the inventive concept may equally be implemented by way of a plurality of different functional units and processors to provide the signal processing functionality. Thus, references to specific functional units are only to 25 be seen as references to suitable means for providing the described functionality, rather than indicative of a strict logical or physical structure or organisation.

Aspects of the invention may be implemented in any suitable form including hardware, 25 software, firmware or any combination of these. The invention may optionally be implemented, at least partly, as computer software running on one or more data processors and/or digital signal processors or configurable module components such as FPGA devices. Thus, the elements and components of an embodiment of the invention may be physically, functionally and logically implemented in any suitable way. Indeed, the functionality may be implemented in a single unit, in a plurality of units or as part of other functional units.

Although the present invention has been described in connection with some embodiments, it 30 is not intended to be limited to the specific form set forth herein. Rather, the scope of the present invention is limited only by the accompanying claims. Additionally, although a feature may appear to be described in connection with particular embodiments, one skilled in the art would recognize that various features of the described embodiments may be combined in accordance with the invention. In the claims, the term 'comprising' does not exclude the presence of other elements or steps.

Furthermore, although individually listed, a plurality of means, elements or method steps may 35 be implemented by, for example, a single unit or processor. Additionally, although individual features may be included in different claims, these may possibly be advantageously combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. Also, the inclusion of a feature in one category of claims does not imply a limitation to 40 this category, but rather indicates that the feature is equally applicable to other claim categories, as appropriate.

Furthermore, the order of features in the claims does not imply any specific order in which the features must be performed and in particular the order of individual steps in a method claim does not imply that the steps must be performed in this order. Rather, the steps may be performed in any suitable order. In addition, singular references do not exclude a plurality. Thus, references to 'a', 'an', 5 'first', 'second', etc. do not preclude a plurality.

Claims

1. Communications apparatus comprising a first access point (109) for providing communications in a first cell using a radio access technology (RAT), wherein the first cell has a coverage area which overlaps at least a part of a coverage area of a second cell which uses a radio access technology which is the same as that of the first cell, and at least a part of a coverage area of a third cell which uses a radio access technology which is different from that of the first and second cells, wherein the first cell (109) has a tracking area code (TAC) which is different from a tracking area code assigned to the second cell, and wherein the first access point (109) includes a memory (110) for storing information relating to the third cell, and wherein the first access point (109) is arranged to receive a request for connection from a wireless communication unit (113) which is within the coverage area of the first cell and camped on to the second cell, and in response to receiving said request for connection, redirect the wireless communication unit (113) to the third cell by sending to the wireless communication unit, a Radio Resource Control Connection Release message including a Radio Resource Control redirection Information Element which includes the stored information relating to the third cell.
2. Communications apparatus according to claim 1 and including a second access point (103) for providing communications services in said third cell and arranged to receive a request for connection from a wireless communication unit (113) which has been redirected thereto by the first access point (109), and further arranged to request from the wireless communication unit (113), a unique identifier relating to the wireless communication unit, to receive said unique identifier from the wireless communication unit (113) and to generate a presence notification message including said unique identifier and forward said presence notification message to a remote entity (114).
3. Communications apparatus according to claim 2 wherein the second access point (103) is arranged to accept the request for connection from the wireless communication unit (113) and provide to communications services to the wireless communication unit (113) via a core network (102).
4. Communications apparatus according to claim 2 wherein the second access point (103) is arranged to reject the request for connection from the wireless communication unit (113) after receiving the unique identifier.
5. Communications apparatus according to claim 2 wherein the second access point (103) is arranged to re-direct the wireless communication unit (113) to a neighbouring cell after receiving the unique identifier.

6. Communications apparatus according to any preceding claim wherein the radio access technology used by the first and second cells is a Long Term Evolution radio access technology and the radio access technology used by the third cell is a 3G radio access technology.

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7. Communications apparatus according to any of claims 1 to 5 wherein the radio access technology used by the first and second cells is a Long Term Evolution radio access technologies and the radio access technology used by the third cell is a 2G radio access technology.

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8. Communication apparatus according to any preceding claim wherein the first access point (109) includes a network listen device (111) for receiving information relating to the third cell, broadcast by the third cell, for storage in the memory (110).

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9. Communications apparatus according to any of claims 2 to 8 wherein the unique identifier is an International Mobile Subscriber Identity (IMSI).

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10. A method for operating a cellular communication system, the method comprising; in a first access point which provides communications in a first cell using a radio access technology (RAT), wherein the first cell has a coverage area which overlaps at least a part of the coverage area of a second cell which uses a radio access technology which is the same as that of the first cell and at least a part of the coverage area of a third cell which uses a radio access technology which is different from that of the first and second cells, assigning (200) a tracking area code to the access point which is different from a tracking area code assigned to the second cell, storing information relating to the third cell, receiving (201) a request for connection from a wireless communication unit which is within the coverage area of the first cell and camped on to the second cell, and in response to receiving said request for connection, redirecting (204) the wireless communication unit to the third cell by sending to the wireless communication unit, a Radio Resource Control Connection Release message including a Radio Resource Control redirection Information Element which includes the sored information relating to the third cell.

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11. A method according to claim 10 including; at a second access point which is arranged to provide communications services in said third cell, receiving (205) a request for connection from a wireless communication unit which has been re-directed thereto by the first access point, requesting (209) from the wireless communication unit, a unique identifier relating to the wireless communication unit, receiving (210) said unique identifier from the wireless communication unit, generating (211) a presence notification message including said

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unique identifier and forwarding (212) said presence notification message to a remote entity.

12. A method according to claim 11 including; at the second access point, accepting the
5 request for connection from the wireless communication unit and providing communications services to the wireless communication unit via a core network.

13. A method according to claim 11 including; at the second access point, rejecting the request for connection from the wireless communication unit after receiving the unique identifier.

10 14. A method according to claim 11 including; at the second access point, re-directing the wireless communication unit to a neighbouring cell after receiving the unique identifier.

15 15. A non-transitory computer readable medium having computer readable instructions stored thereon for execution by a processor to perform the method of claim 10 or claim 11.

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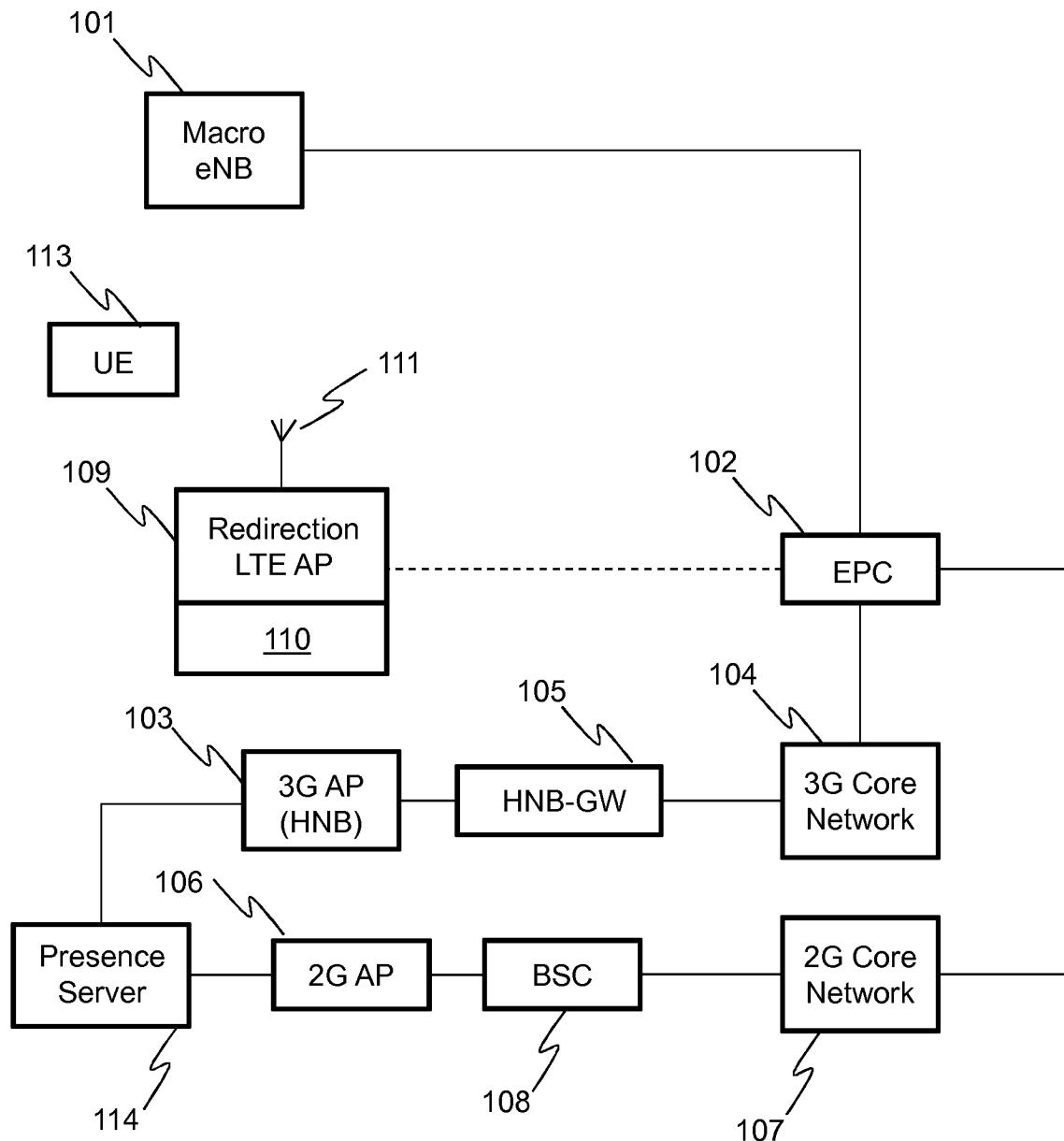


FIG. 1

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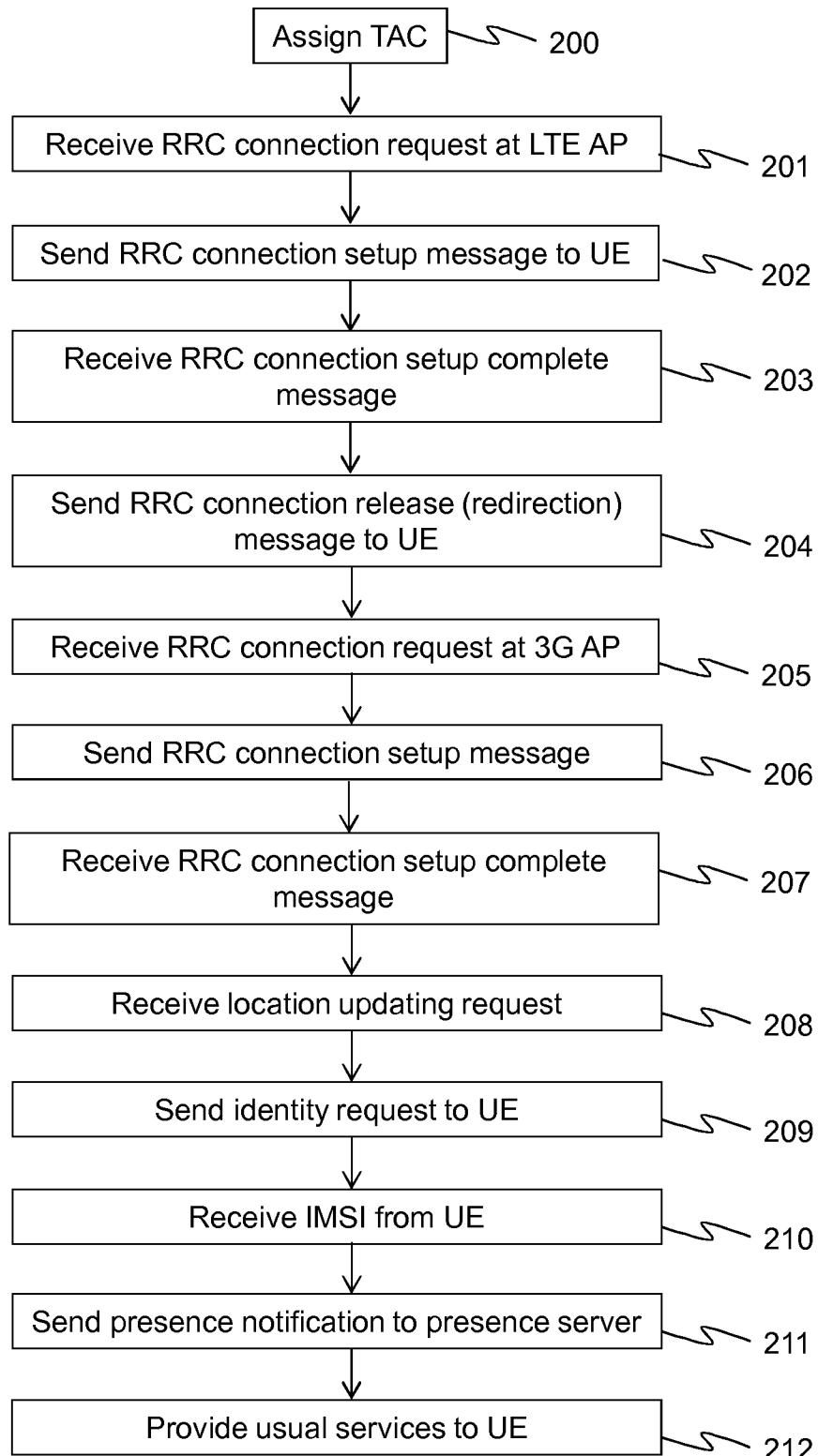


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/053473

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W48/12
ADD. H04W36/00

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, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/121877 A1 (RAGHURAM SHARADA [US] ET AL) 8 June 2006 (2006-06-08) abstract figures 1-5 paragraph [0011] - paragraph [0020] -----	1-15
A	US 2013/225160 A1 (FUJINO KOSUKE [JP] ET AL) 29 August 2013 (2013-08-29) abstract figures 1-4 paragraph [0060] - paragraph [0063] ----- -/-	1-15

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"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
16 June 2015	24/06/2015
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Volpato, Andrea

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/053473

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>"Performance of CS Fallback from LTE to UMTS", IEEE COMMUNICATIONS MAGAZINE, IEEE SERVICE CENTER, PISCATAWAY, US, vol. 51, no. 9, 1 September 2013 (2013-09-01), XP011525689, ISSN: 0163-6804, DOI: 10.1109/MCOM.2013.6588662 [retrieved on 2013-09-03] abstract SYSTEM ARCHITETURE AND CSFB PROCEDURES -----</p>	1-15
T	<p>"3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (Release 12)", 3GPP STANDARD; 3GPP TS 36.331, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. V12.0.0, 7 January 2014 (2014-01-07), pages 1-349, XP050729407, [retrieved on 2014-01-07] -----</p>	1-15
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Information on patent family members

International application No

PCT/EP2015/053473

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