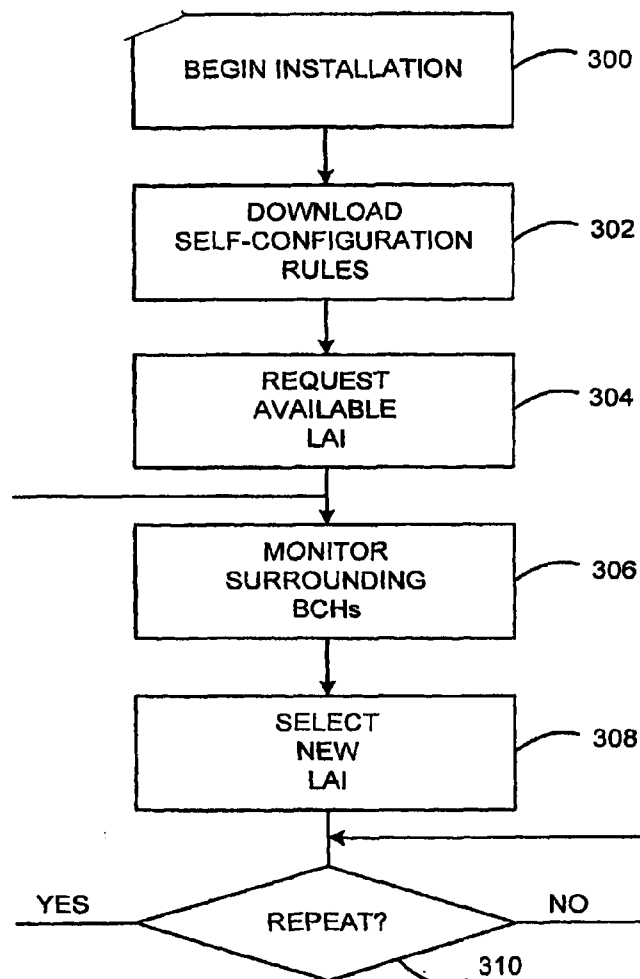




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Keevill et al.(10) **Pub. No.: US 2010/0190495 A1**(43) **Pub. Date: Jul. 29, 2010**(54) **AUTOMATIC BASE STATION
CONFIGURATION**(30) **Foreign Application Priority Data**(75) Inventors: **Peter Keevill**, Bath (GB); **William
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(GB)(21) Appl. No.: **12/752,900**(22) Filed: **Apr. 1, 2010****Related U.S. Application Data**(62) Division of application No. 11/664,360, filed on Mar.
29, 2007, filed as application No. PCT/GB06/02824
on Jul. 28, 2006.(57) **ABSTRACT**

A basestation in a cellular communications network is configured such that it has a different Location Area Identification from other local basestations in the cellular network. This has the effect that a Location Area Update procedure is performed when a mobile device wishes to camp onto that basestation. The basestation is able to configure itself automatically, to ensure that its Location Area Identification differs from other local basestations.



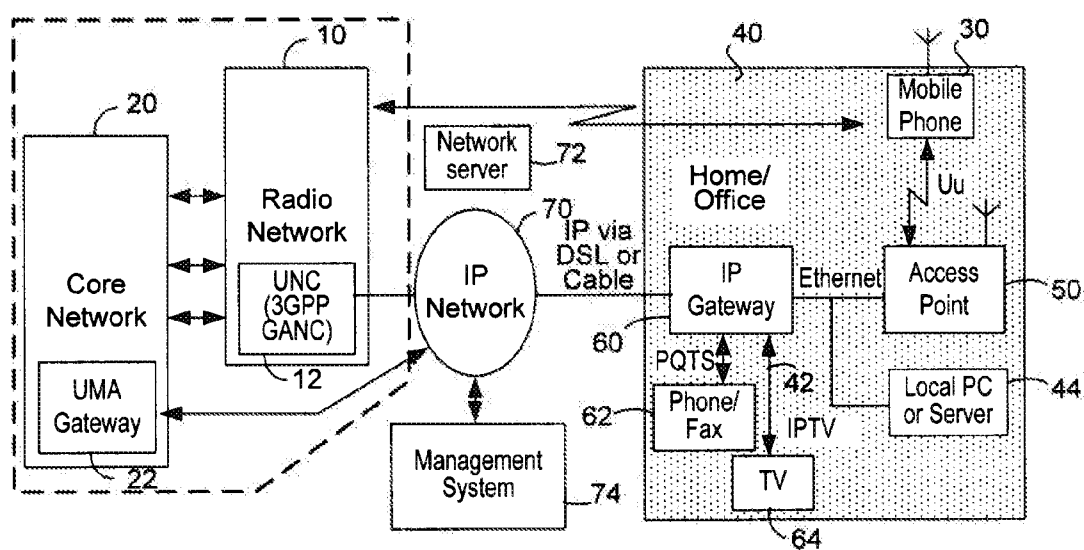


Figure 1

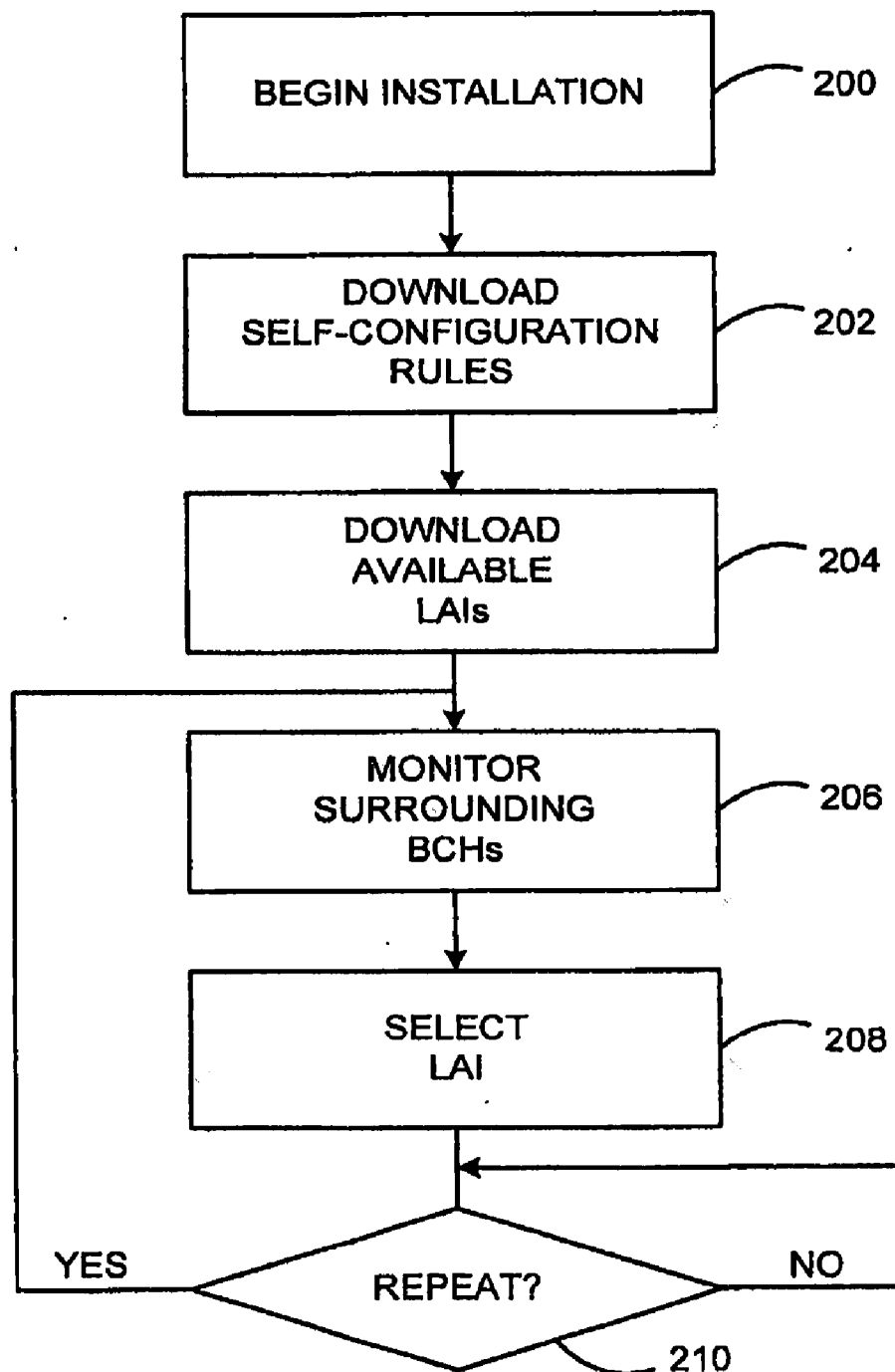


Figure 2

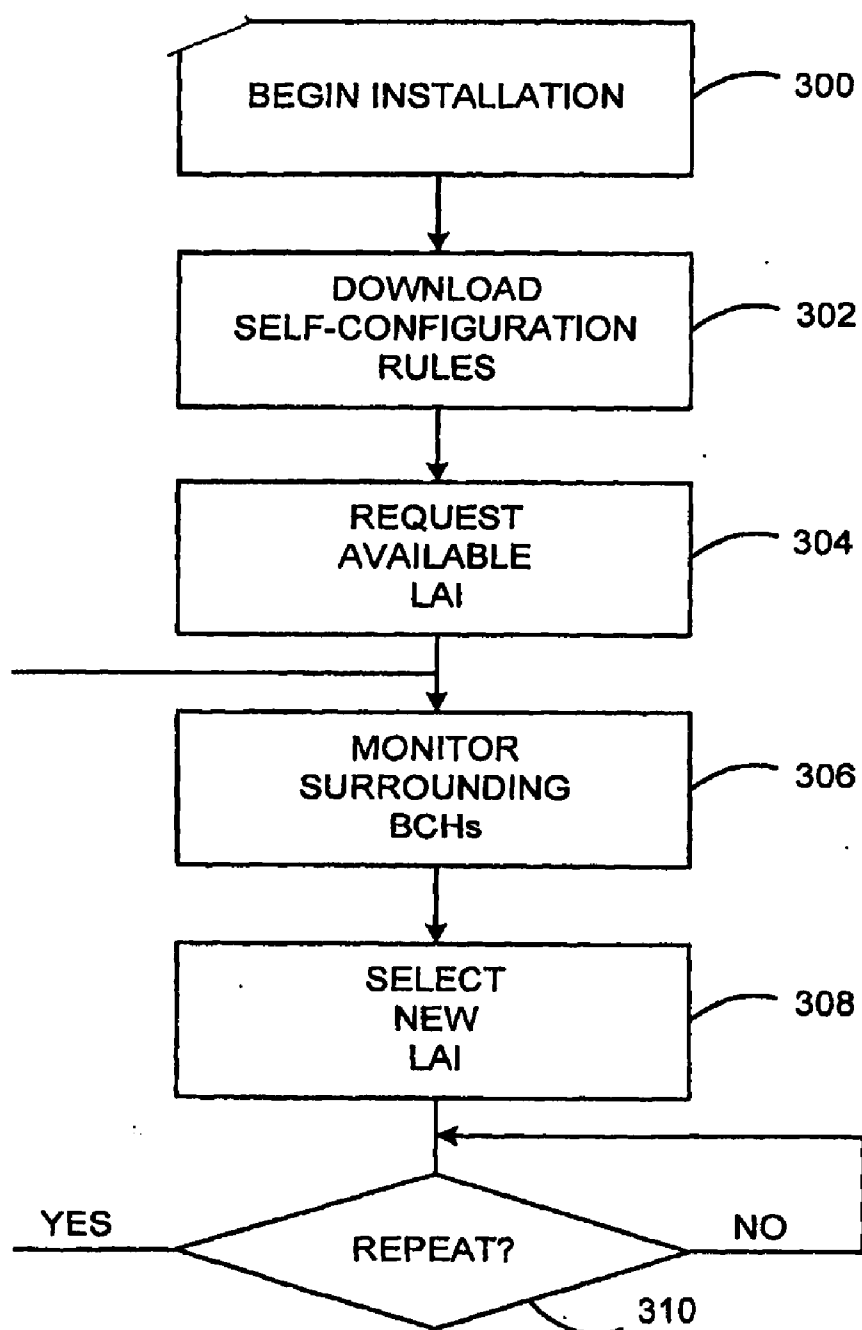


Figure 3

AUTOMATIC BASE STATION CONFIGURATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of U.S. application Ser. No. 11/664,360, filed Mar. 29, 2007, which is a National Phase U.S. filing under 35 U.S.C. §371 of International Application No. PCT/GB06/02824, filed Jul. 28, 2006, which claims priority from GB Application No. 0515888.6, filed Aug. 1, 2005, and GB Application No. 0610650.4, filed May 30, 2006, each of which is incorporated herein by reference in their entirety for all purposes. The present application claims priority to and benefit of each of these applications.

BACKGROUND

[0002] This invention relates to a cellular basestation for a wireless communications network, and in particular to a basestation for a cellular communications network, that can conveniently be used to provide a cellular service, for example within a home or office. More specifically, the invention relates to a basestation that is able to configure itself for operation within the cellular wireless communications network.

[0003] Conventional cellular wireless communications networks, for example, based on the GSM or UMTS standards, make use of a number of identifiers in the radio network, and these identifiers allow the network to be subdivided into a number of sections, normally based around geography. The purpose of the identifiers is to ease the management of the network and improve efficiency in some aspects, such as organization of paging.

[0004] For example, the document ETSI TS 123 003-V3.4.0, section 4, "Identification of location areas and base stations" describes the use of three identifiers, namely the Location Area Identification (LAI), the Routing Area Identification (RAI), and the Service Area Identification (SAI).

[0005] Typically, many tens or hundreds of basestations share a common controller, either a Base Station Controller (BSC) in the case of GSM, or a Radio Network Controller (RNC) in the case of UMTS. These basestations would usually be included in a single Location Area and would therefore have the same LAI.

[0006] Routing Area and Service Area Identifications can each be used to subdivide a Location Area into smaller units, in order to break very large paging groups down into smaller, more manageable units.

[0007] In addition, basestations are uniquely identified by a Cell Identity (CI).

[0008] All of these parameters are specified from a centralized network control function as part of the commissioning process for the cellular radio network, and are typically static, or at least are changed very infrequently.

[0009] The present invention relates primarily to a small basestation that is located on a customer's premises, and can be put into service by the customer as he wishes. In such a situation, it is potentially very time-consuming for the network operator to have to configure the Identifications for each such basestation.

[0010] According to a first aspect of the present invention, there is provided a method of allocating a Location Area

Identification to a basestation in a cellular wireless Communications network, the method comprising:

[0011] in the basestation itself, configuring the basestation such that it has a different Location Area Identification from other local basestations of said network.

[0012] According to a second aspect of the present invention, there is provided a basestation, for use in a cellular wireless communications network, wherein the basestation is adapted to configure itself such that it has a different Location Area Identification from other local basestations of said network.

[0013] According to a third aspect of the present invention, there is provided a management node for a basestation in a cellular wireless communications network, the management node being adapted to receive a request for a list of available Location Area Identifications from a management node of the network, and to provide a list of available Location Area Identifications in response thereto.

[0014] According to a fourth aspect of the present invention, there is provided a method of identifying a Location Area in a cellular communications network, the method comprising, in a basestation of said network:

[0015] including a first Location Area Identification in radio transmissions from said basestation, said first Location Area Identification being selected from a first set of Location Area Identifications;

[0016] including a second Location Area Identification in messages sent to a core network of said cellular communications network, said second Location Area Identification being selected from a second set of Location Area Identifications.

[0017] According to a fifth aspect of the present invention, there is provided a method of restricting access to a basestation in a cellular wireless communications network, the method comprising:

[0018] maintaining in said basestation a list of authorized devices; and

[0019] when an unauthorized device camps onto the basestation, sending a "Location Area Not Allowed" message to said unauthorized device.

[0020] For a better understanding of the present invention, and to show how it may be put into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

[0021] FIG. 1 is a block schematic diagram of a system incorporating a basestation in accordance with the present invention.

[0022] FIG. 2 is a flow chart, illustrating a first procedure in accordance with the invention.

[0023] FIG. 3 is a flow chart, illustrating a second procedure in accordance with the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0024] FIG. 1 is a block schematic diagram, illustrating a system architecture. A mobile network operator (MNO) owns and operates a wireless communications network, including a radio access network 10, including a network of cellular basestations (not shown), and a core network 20, having a connection into the fixed telephone network. These are generally conventional, except as described below.

[0025] A mobile phone 30, when roaming in the territory covered by the wireless communications network, is able to establish a wireless connection with one of the cellular basestations, in order to communicate with other telephones in

the fixed telephone network, or with other mobile phones, which have established their own wireless connections with a cellular basestation, and hence with the fixed telephone network.

[0026] In accordance with the present invention, there is provided, for example within a home or office **40** or in another location where additional wireless coverage is required, a further basestation, or access point, **50**. This access point **50** is provided for use by the owner of the premises where it is located, but is integrated into the wireless communications network. That is, the access point shares the part of the radio frequency spectrum allocated to that wireless communications network, by having allocated to it, either permanently or temporarily, some of the group of channels. This group of channels is thus shared with other basestations, which may serve macrocells, microcells, picocells, or even “femtocells”, in the public, wide area network. As a result, the mobile phone **30** can roam from the access point **50** to another basestation when leaving the immediate vicinity of the access point **50**, or can roam to the access point **50** from another basestation when returning to the immediate vicinity of the access point **50**.

[0027] The access point **50** therefore acts as a basestation within the relevant wireless communications network. For example, it can allow an entirely conventional and unmodified mobile phone **30** or other user device to establish a connection for voice and/or data services using GSM/GPRS and/or UMTS air interfaces. Of course, the access point **50** can be enabled to establish connections with the mobile phone **30** using the standard air interface of any suitable cellular wireless communications system.

[0028] The access point **50** has a connection for an Ethernet Local Area Network (LAN) **42**, within the home or office **40**. As shown in FIG. 1, the access point **50** can connect over the Ethernet LAN **42** to one or more local PCs or servers **44**.

[0029] The access point **50** can connect over the Ethernet LAN **42** to an IP gateway device **60**. The IP gateway device **60** provides an IP connection over an IP network **70**, for example the internet, to the MNO network either via a Digital Subscriber Line (DSL) or via other IP transport methods such as a digital multimedia Cable network. Thus, the existing IP connection from the home or office can be used to provide backhaul from the access point **50**. Flexible interfacing to the operator's network **20** can be provided via connections to either the MNO Core Network or Radio Access Network, using the SIP Gateway or UMA UNC respectively. This approach enables low-cost transport of data and voice using Voice-over-Internet Protocol (VoIP) techniques.

[0030] The connection from the IP gateway **60** over the IP network **70** into the MNO Radio Access Network **10** is provided by a UMA Unlicensed Network Controller (UNC) **12**, which has been standardised by 3GPP as a Generic Access Network Controller (GANC). Other non-standardised solutions to interface to the Radio Access Network **10** could also be employed as an alternative approach. Direct connection to the operator's Core Network can be achieved through use of a SIP Interface between the access point and a suitable gateway such as a SIP Gateway or an IP Multimedia Subsystem.

[0031] In this illustrated embodiment, the DSL or cable IP gateway device **60** includes provision for connection of a POTS telephone or fax device **62**, and audio/video connections for providing IPTV services to a TV **64**. The access point **50** includes a services environment which allows these

facilities to be integrated into the MNO network, enabling sophisticated new services for users.

[0032] In an alternative implementation of the invention, the access point **50** can be integrated as a component within the IP gateway device **60**; an internal IP connection then links the embedded access point component to the router functions within the IP gateway device. This configuration can potentially provide a lower overall cost and is convenient for operators looking to provide gateway units which unify data, fixed voice, multimedia and mobile services.

[0033] Thus, while the mobile phone **30** is within the home or office **40**, or otherwise within the coverage area of the access point **50**, it can connect into the MNO network in the same way as via any other basestation in the cellular wireless communications network.

[0034] FIG. 1 also shows a network server **72** connected to the IP network **70**. As will be appreciated, where the IP network **70** is the internet, a very large number of servers and other devices are connected to the network. As will be described in more detail below, the user of the mobile phone **30** can access such devices by means of the access point **50**.

[0035] FIG. 1 also shows a management system **74**, connected to the IP network **70**. The management system **74** is provided by the mobile network operator for managing the operation of the access point **50**, including controlling the available services.

[0036] For example, as mentioned above, and as described in more detail below, a user of the mobile phone **30** can establish a connection through the access point **50** over the Ethernet LAN **42** to one or more local PCs or servers **44**, or through the IP gateway device **60** to another device connected thereto, or through the IP gateway device **60** to a network server **72** connected to the IP network **70**. These connections can be established without passing traffic over the core network **20** of the wireless communications network. The management system **74** is able to define the devices, or the IP addresses, with which such connections can be established. Then, these connections can be established with only a restricted number of devices or IP addresses, if desired by the mobile network operator.

[0037] Also, the management system **74** is able to specify a set of channels (which may be defined by frequencies, time slots, and/or spreading codes, depending on the particular cellular wireless communications system) allocated for the access point **50** to use. These channels may be allocated semi-permanently, or may be changed regularly, depending on the requirements of the network as a whole. The access point will select an optimal channel configuration for use, from the set specified by the management system.

[0038] In normal macrocell operation, a UE, such as the mobile phone **30**, registers onto a cell by means of a Location Registration (LR) if the selected or reselected cell has a different Location Area or PLMN (Public Land Mobile Network) identity. In the case of cells with a common Location Area Identifier, the UE can simply camp on to any cell with the common LAI without giving any indication to the network that it has done so.

[0039] The network configuration for the access point **50** is somewhat different from a conventional radio network. For example, the access point **50** includes BSC/RNC functionality, and may be independent of any other radio network control function. As a result, the typical use of Location Area Identifications (LAIs) and Routing Area Identifications (RAIs) does not apply.

[0040] Furthermore the access point 50 requires the mobile phone 30 to identify itself as it roams in from the macrocell network. Identifying the access point 50 with a LAI which is different from the overlying macro layer (and from any other local access point) triggers a Location Update Procedure in the mobile phone 30, which automatically informs the mobile phone 30 and the network that it has moved to coverage by the access point 50.

[0041] Therefore, the access point 50 will configure itself to have a different Location Area (and therefore Routing Area) to the macro-network, so that a Location Registration procedure will always be necessary. An IMSI Attach may also be performed during the Location Registration procedure.

[0042] It is envisaged that the network may include a relatively large number of access points such as the access point 50, and moreover that the distribution of active access points may change relatively frequently. Thus, configuring the access point LAIs from a central control scheme would be time-consuming.

[0043] The access point 50 therefore uses an automatic self-configuration scheme. FIG. 2 is a flow chart, illustrating this automatic self-configuration scheme.

[0044] At step 200, the access point 50 starts its installation procedure, for example when first powered up. In one embodiment, the rules for the self-configuration are specified centrally in the management system 74, and are downloaded to the access point 50 at step 202 during installation.

[0045] In one embodiment, the Mobile Network Operator reserves a group of LAIs for use by access points such as the access point 50. The Location Area Code (LAC) of the Location Area Identification (LAI), as defined in the document ETSI TS 123 003-V3.4.0, section 4.1, has 16 bits, and thus there are about 65,000, 216, possible identifiers. A typical conventional network might use less than 1000 of these. Thus, in accordance with this embodiment of the invention, the Mobile Network Operator reserves a list of LAIs for use by access points such as the access point 50. This list may for example include 100-10,000 LAIs.

[0046] At step 204, this list of available LAIs is downloaded to the access point 50.

[0047] As part of the general installation procedure, the access point 50 performs an RF scan process. During this process, at step 206 of the procedure shown in FIG. 2, the access point 50 monitors the Broadcast Channel (BCH) of transmissions from surrounding Node-B's and access points in accordance with the present invention. The LAI and RAI information is included in the BCH transmission, and so the installing access point 50 will be able to deduce which of LAIs from the list of available LAIs have been taken by surrounding access points.

[0048] Then, in step 208, the access point 50 selects its own LAI using a random choice of the remaining available LAIs.

[0049] The key issue is that the LAIs for all of the access points observed from any single mobile are unique. Depending on the transmit power of the access points, amongst other things, this may mean all of the access points in a radius of less than 200 m. It is acceptable for more distant access points to repeat LAIs.

[0050] The access point 50 can then enter service, using the selected LAI.

[0051] At step 210, it is determined whether to repeat the selection procedure. The procedure may be repeated at each installation and at each power-up, but, in a typical case, the automatically configured LAI will be retained unless there is

a significant change in the surrounding cell environment such as a relocation of the access point itself.

[0052] FIG. 3 is a flow chart, illustrating an alternative automatic self-configuration scheme in accordance with an embodiment of the invention.

[0053] At step 300, the access point 50 starts its installation procedure, for example when first powered up. In one embodiment, the rules for the self-configuration are specified centrally in the management system 74, and are downloaded to the access point 50 at step 302 during installation.

[0054] In this embodiment, the Mobile Network Operator reserves a group of LAIs for use by access points such as the access point 50. The Location Area Code (LAC) of the Location Area Identification (LAI), as defined in the document ETSI TS 123 003-V3.4.0, section 4.1, has 16 bits, and thus there are about 65,000, 216, possible identifiers. A typical conventional network might use less than 1000 of these. Thus, in accordance with this embodiment of the invention, the Mobile Network Operator reserves a list of LAIs for use by access points such as the access point 50. This list may for example include about 10,000 LAIs.

[0055] At step 304, the access point 50 sends a message to the management system 74, requesting a LAI from the list of available LAIs. The management system 74 responds with an LAI that is available for use by the access point 50.

[0056] In order to assist with this, it may be required that each new access point customer should record their address details, and these could be recorded in the management system 74. By using these address details, for example using post code information in the UK, the management system 74 can make an initial allocation of an LAI identifier to each new customer that is highly probable to be unique within that particular locality.

[0057] The access point may confirm, by observation of information transmitted by surrounding access points on their respective broadcast channels, that the received LAI is not in use in any observable local access points. If the received LAI is not found to be in use in any observable local access points, that LAI can be configured; if the access point detects another local access point with the same LAI, it can request the management system for another LAI.

[0058] The access point 50 can then enter service, using the selected LAI. Since the list of available LAIs contains so many LAIs, there is only a low probability that two local access points will select the same LAI. In that event, the collision may be corrected by later observation.

[0059] Thus, when the access point 50 performs an RF scan process, at step 306 of the procedure shown in FIG. 3, the access point 50 monitors the Broadcast Channel (BCH) of transmissions from surrounding Node-B's and access points in accordance with the present invention. The LAI and RAI information is included in the BCH transmission, and so the installing access point 50 will be able to deduce whether its own LAI is shared with the any of the surrounding access points.

[0060] If so, in step 308, the access point 50 selects a new LAI, for example by requesting a new LAI from the management system 74, as described above.

[0061] Thus, it is possible to ensure that, for almost all mobiles and for almost all of the time, the LAIs for all of the access points observed from any single mobile are unique. In any event, it will be noted that the access point 50 can be connected directly to the core network using a network interfacing scheme, such as via SIP or IMS, in which the LAI

identifiers are not required for locating users and routing paging messages. Rather, IP address information is recorded and used instead. Thus, it would be permissible in these scenarios for the access point **50** to reselect its LAI at power-up or during the next scheduled RF scan, if it detected a common LAI used by another local access point.

[0062] At step **310**, it is determined whether to repeat the selection procedure. The procedure may be repeated at each installation and at each power-up but, as noted above with reference to step **210**, it is most likely to remain static until a major change in the surrounding cellular environment is observed.

[0063] Thus, there are described methods for selecting a new LAI in the access point **50**. It will be noted that the LAI simply has to be different from that of the surrounding cells in order to force the Location Update. It is not necessary for the LAI to remain static. Moreover, when a LAI is allocated to the access point, a new RAI is also allocated.

[0064] The use of distinct LAI identifiers has benefits in scenarios where the access to the access point **50** is to be restricted to specific users. That is, the access point **50** can be configured such that only certain specified devices (UEs) are allowed to connect to the network through that access point. Typically, an access point on the premises of a particular customer will be configured such that only the specified devices (UEs) owned by that customer are allowed to connect to the network through that access point. That is, only those UEs whose IMSIs are defined within the management system and subsequently downloaded to the access point, are allowed to camp on that access point.

[0065] The access point **50** may carry the PLMN identifier of the MNO macro network (which will typically be specified as the Home PLMN in the SIM card of the UE(s) of the relevant customer), or it may be identified by a PLMN which is different to the macro network but is defined as an "Equivalent PLMN" within the macro network. In the case where the access point **50** has the same PLMN as the macro network or an Equivalent PLMN to the macro network, any macro network UE will camp onto the access point if it determines it to be the strongest signal. In the case of an access point **50** configured such that only certain specified devices (UEs) are allowed to connect to the network through that access point, the access point will respond to a non-specified device camping on by issuing a standard GSM/UMTS rejection message to cause the offending UE to reselect another cell, typically the macro cell it has just roamed out of.

[0066] If the offending UE camps back onto the access point cell within a few minutes of this rejection, the access point can use an alternative rejection message "Location Area Not Allowed" which causes the LAI identifier of the specific access point to be added to a list of banned cells maintained by the UE. Once the LAI is included in the banned list, the UE will not attempt to camp on again. The banned list is maintained until the UE is turned off or reset.

[0067] In this situation, it is advantageous if the LAI of the access point is not used in any other access point.

[0068] On the other hand, if the number of LAIs allocated to access points such as the access point **50** is very much smaller than the number of access points, there exists a risk that the LAI in the banned list of the offending UE might also be the LAI of a different access point cell that the user may legitimately access. In this scenario, the access point **50** may, before using the "Location Area Not Allowed" rejection message, request the management system to cross check that the

offending IMSI is not associated with an access point, or, if it is, that the LAI from which the user is about to be banned is not the same as the LAI(s) associated with the access point(s) that the user is allowed to access.

[0069] As mentioned above, a typical conventional network may use only a relatively small number (for example less than 100, or even less than 100) of the available LAIs, even when the network is large. In that case, it may present some complications for the MNO if a large set of LAI/RAI identifiers is available for use by access points such as the access point **50**.

[0070] If so, this set of LAI/RAI identifiers can be collapsed into a smaller set. This may be done in a centralised location or through a translation mapping operation within the access point itself. The access point includes a sophisticated protocol stack which includes Non-Access Stratum functions typically found in the circuit and packet core of a mobile network. The access point can use these functions to terminate mobility management (MM) and GPRS mobility management (GMM) signalling from the UE. Optionally, the access point can intercept these messages and modify them before passing them on to the MNO network.

[0071] Thus, the LAI/RAI identifiers included in the messages received from the UE (and derived from the LAI/RAI identifier transmitted by the access point over the GSM/UMTS air interface) can be replaced in messages passed onto the MNO network by an alternative LAI/RAI identifier to suit the convenience of the operator.

[0072] For example, even though several thousand LAIs may be used by all of those access points such as the access point **50** in the network, there could be a much smaller number (for example only three) of LAIs which are carried in signalling exchanges from the UEs to the core network. As an example, one LAI could be used for access point users within their own premises, one could be used for nominated guests of access point users, and one could be used for other users who have roamed onto access points which have capacity available for non-authorised users. The three LAIs in this example might be used to convey tariff information to the MNO network billing system.

[0073] There is thus described a system in which a base-station is configured such that it has a different Location Area Identification from other local base-stations in the cellular network.

What is claimed is:

1. A method of identifying a Location Area in a cellular communications network, the method comprising, in a base-station of said network:

including a first Location Area Identification in radio transmissions from said base-station, said first Location Area Identification being selected from a first set of Location Area Identifications;

including a second Location Area Identification in messages sent to a core network of said cellular communications network, said second Location Area Identification being selected from a second set of Location Area Identifications.

2. A method as claimed in claim 1, comprising including said first Location Area Identification in all radio transmissions from said base-station.

3. A method as claimed in claim 1, wherein the second Location Area Identification included in a message sent to a core network of said cellular communications network is

selected from said second set of Location Area Identifications based on an identity of a mobile device communicating with said basestation.

4. A method as claimed in claim 1, wherein the first set of Location Area Identifications and the second set of Location Area Identifications are mutually exclusive.

5. A method as claimed in claim 1, wherein the first set of Location Area Identifications comprises more than 100 Location Area Identifications.

6. A method as claimed in claim 1, wherein the second set of Location Area Identifications comprises less than 10 Location Area Identifications.

7. A basestation for a cellular communications network, wherein the basestation identifies itself in radio transmissions therefrom by means of a first Location Area Identification, and

wherein the basestation includes a second Location Area Identification in messages sent to a core network of said cellular communications network, said second Location Area Identification being selected based on an identity of a mobile device communicating with said basestation.

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