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Other: **WPI, EPODOC, XP3GPP, INSPEC**

(54) Title of the Invention: **Apparatus and method for use in a communication system**
Abstract Title: **Small cell access in a wireless communications system**

(57) A macrocell base station or eNodeB 106 controls one or more local area base stations 110, 118, 120, 122 and allocates resources of a common random access channel between the local area base stations, the resources comprising preambles. The macrocell base station informs the local area base stations and user equipment 110 within a given area about the allocation. The resources allocated to a local area cell comprise a subset of the preambles of the random access channel (RACH). In one embodiment the macrocell eNodeB divides the RACH occasions in time for different local area eNBs. A t any one time instant preambles may be divided between local area eNBs. A predetermined amount of contention-free and contention based preamble indexes may be allocated.

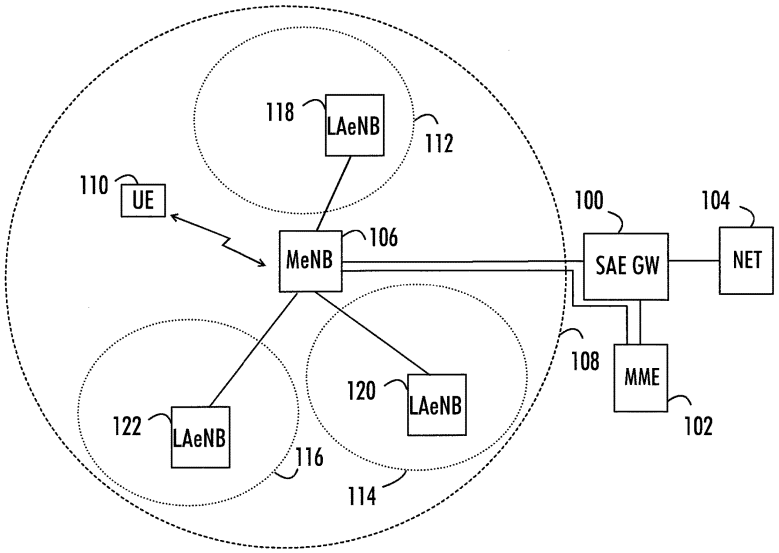

FIG. 1

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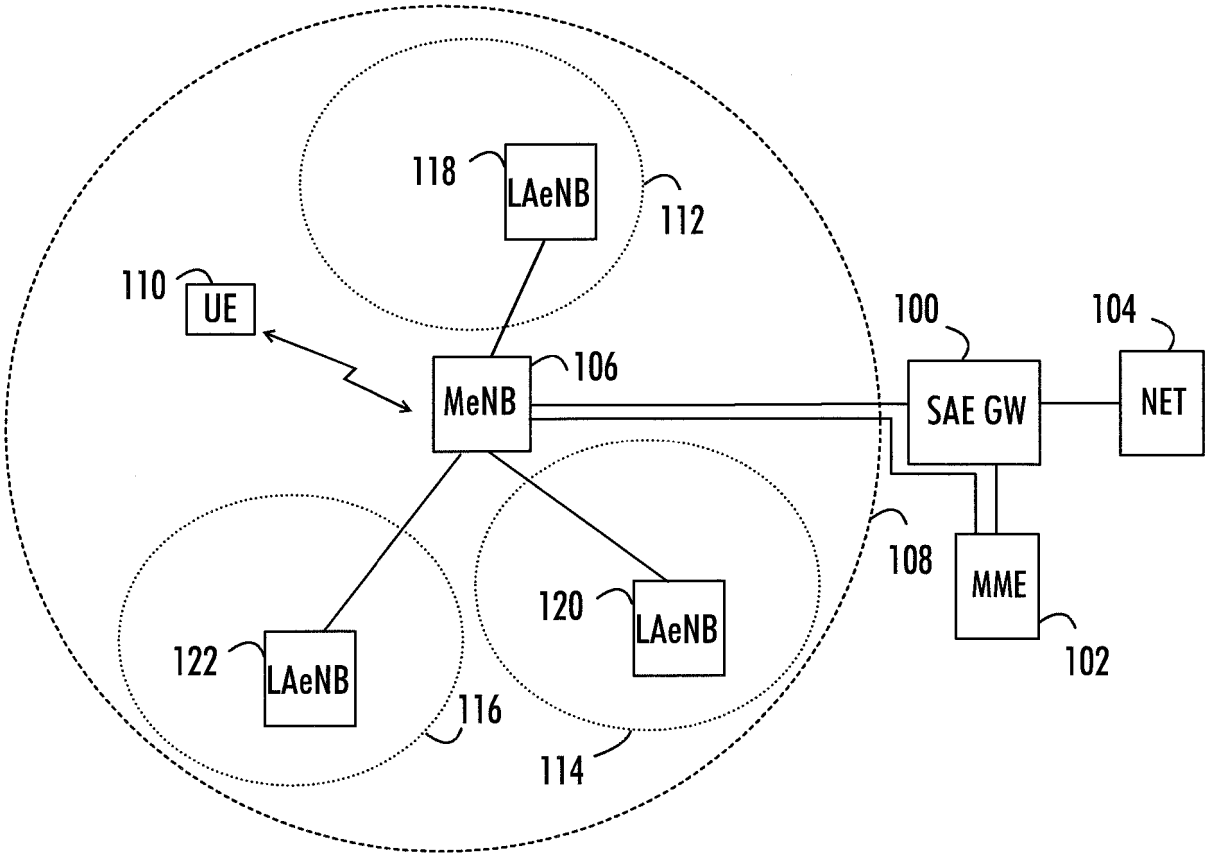
118
LAeNB
112
110
UE
100
104
106
MeNB
SAE GW
NET
108
MME
120
LAeNB
122
LAeNB
102
116
114

FIG. 1

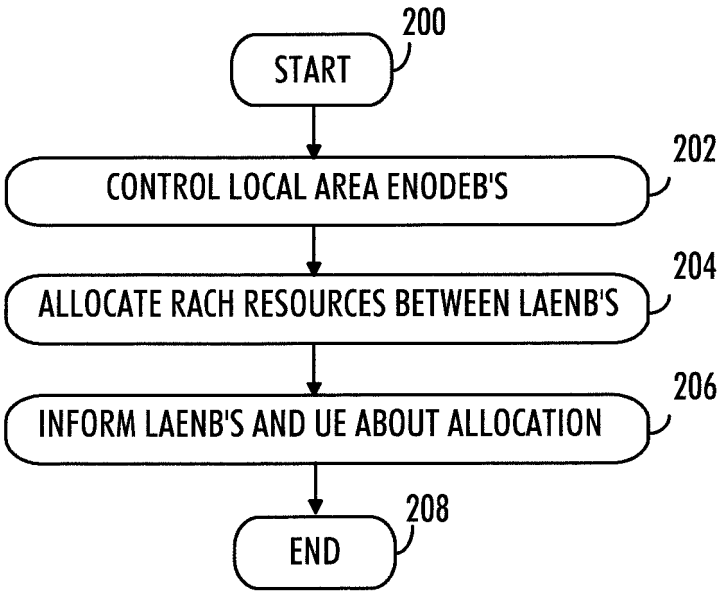
200
START
202
CONTROL LOCAL AREA ENODEB'S
204
ALLOCATE RACH RESOURCES BETWEEN LAENB'S
206
INFORM LAENB'S AND UE ABOUT ALLOCATION
208
END

FIG. 2A

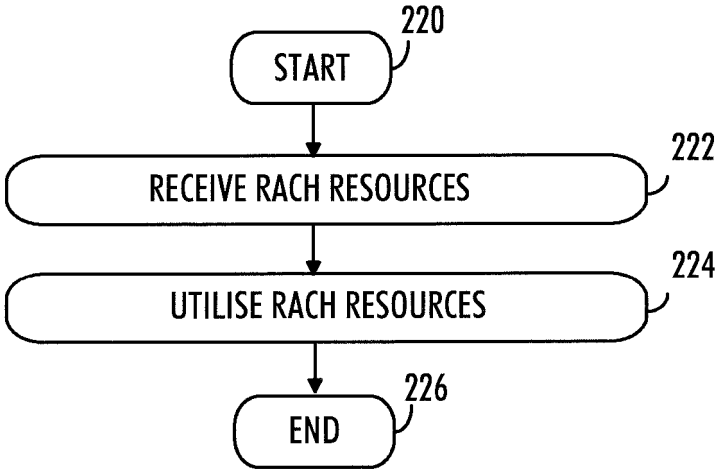
220
START
222
RECEIVE RACH RESOURCES
224
UTILISE RACH RESOURCES
226
END

FIG. 2B

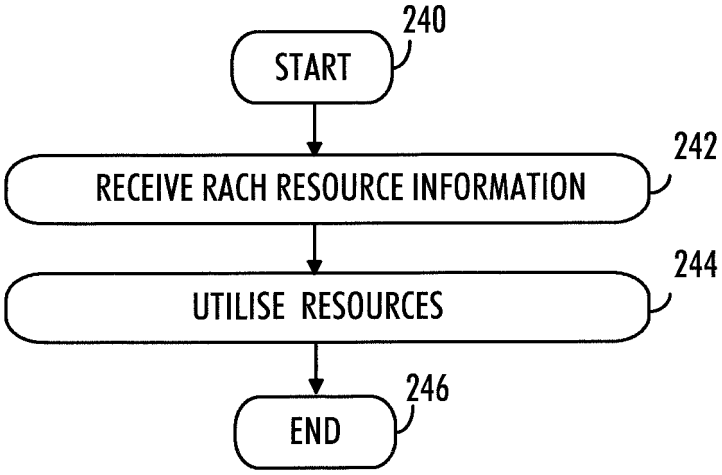
240
START
242
RECEIVE RACH RESOURCE INFORMATION
244
UTILISE RESOURCES
246
END

FIG. 2C

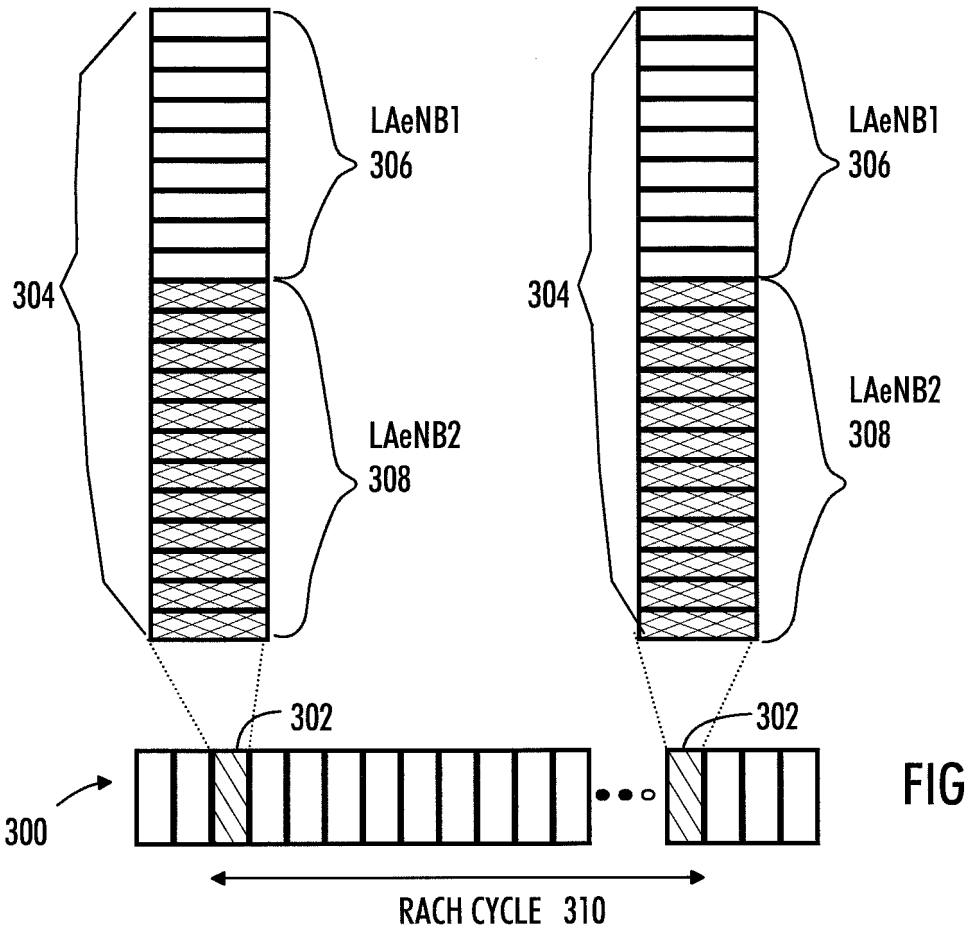
LAeNB1
306
304
LAeNB2
308
302
300
RACH CYCLE 310

FIG. 3

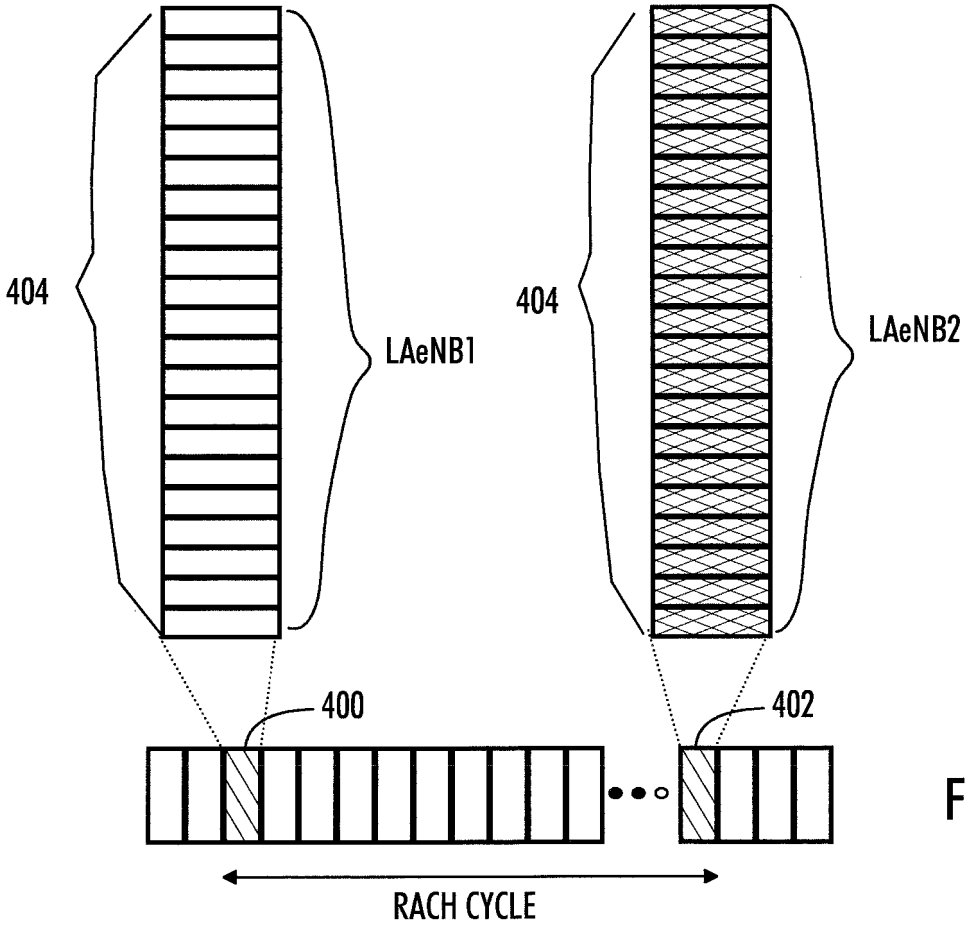
404
LAeNB1
400
LAeNB2
402
RACH CYCLE

FIG. 4

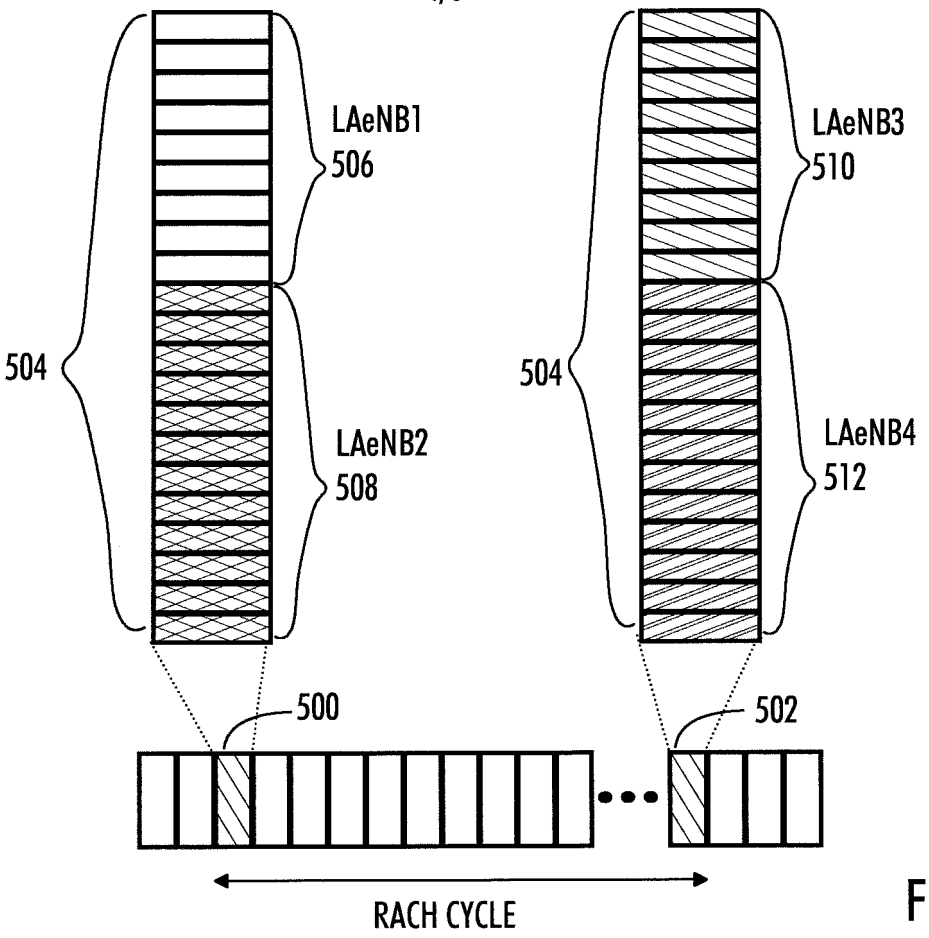
LAeNB1
506
LAeNB2
508
504
LAeNB3
510
LAeNB4
512
504
500
502
RACH CYCLE

FIG. 5

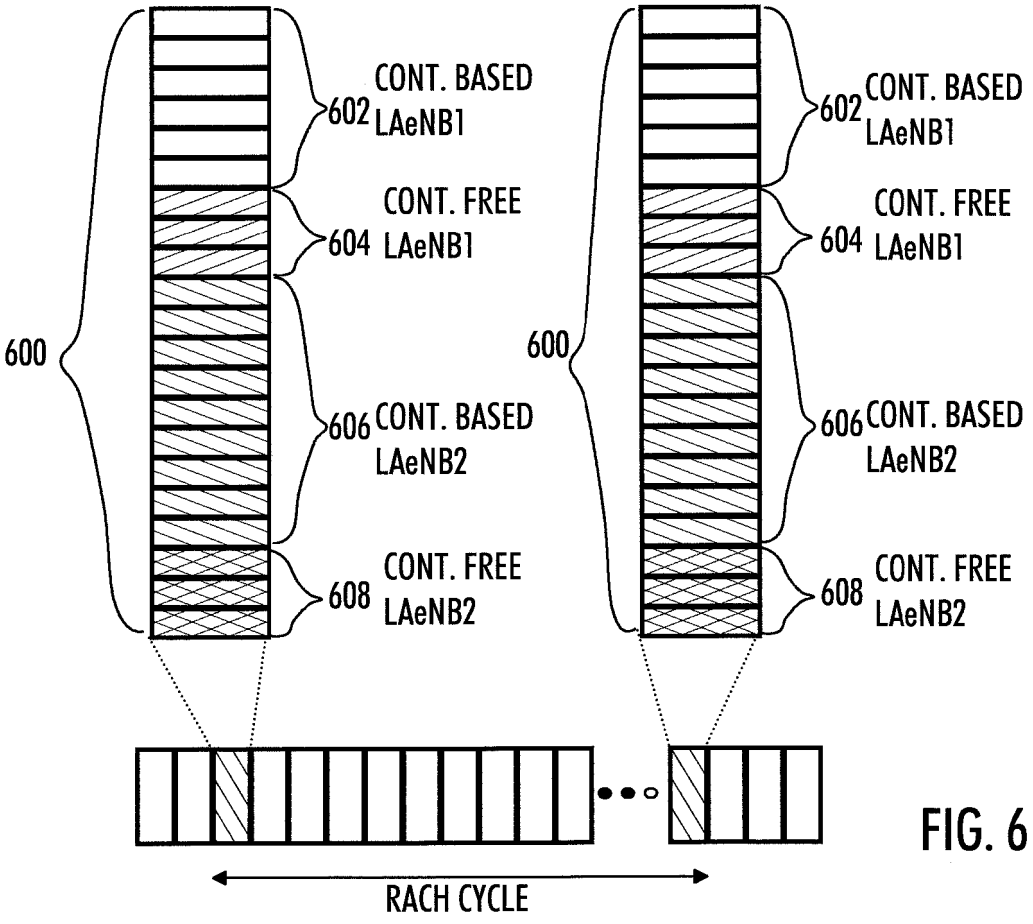
CONT. BASED
602 LAeNB1
CONT. FREE
604 LAeNB1
600
606 CONT. BASED
LAeNB2
CONT. FREE
608 LAeNB2
RACH CYCLE

FIG. 6

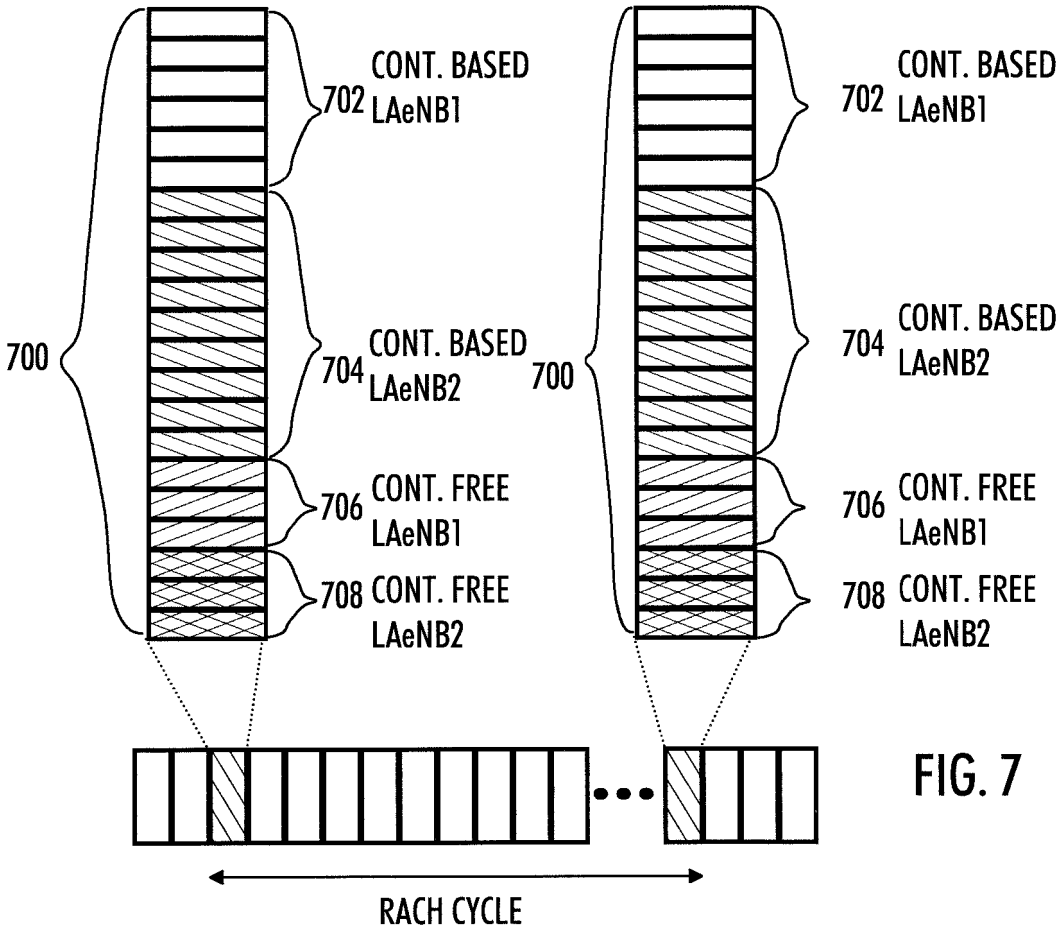
700
702 CONT. BASED LAeNB1
704 CONT. BASED LAeNB2
706 CONT. FREE LAeNB1
708 CONT. FREE LAeNB2
700
702 CONT. BASED LAeNB1
704 CONT. BASED LAeNB2
706 CONT. FREE LAeNB1
708 CONT. FREE LAeNB2
RACH CYCLE

FIG. 7

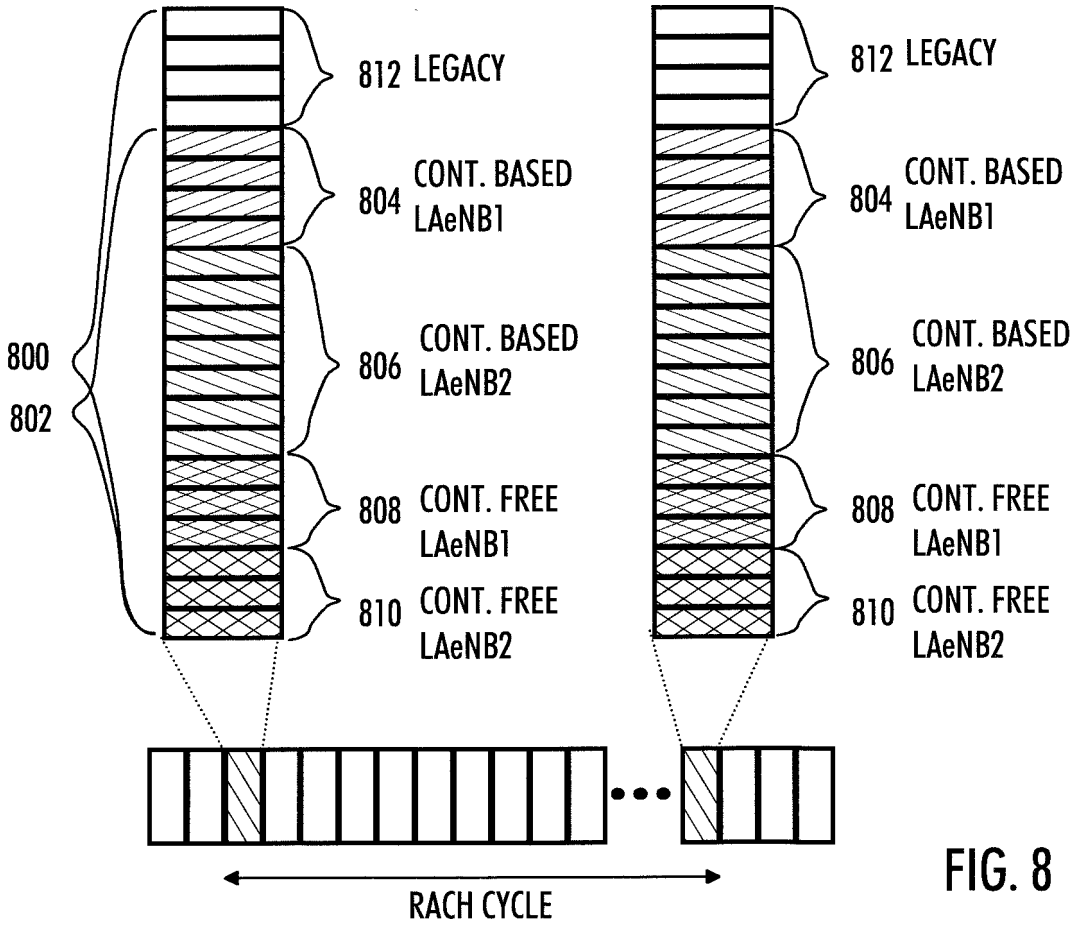
800
802
812 LEGACY
804 CONT. BASED LAeNB1
806 CONT. BASED LAeNB2
808 CONT. FREE LAeNB1
810 CONT. FREE LAeNB2
812 LEGACY
804 CONT. BASED LAeNB1
806 CONT. BASED LAeNB2
808 CONT. FREE LAeNB1
810 CONT. FREE LAeNB2
RACH CYCLE

FIG. 8

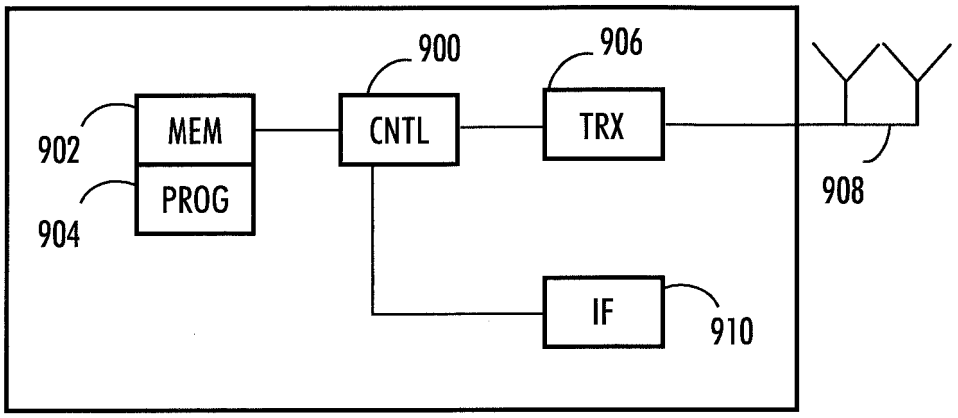
900
906
902
MEM
CNTL
TRX
904
PROG
908
IF
910

FIG. 9

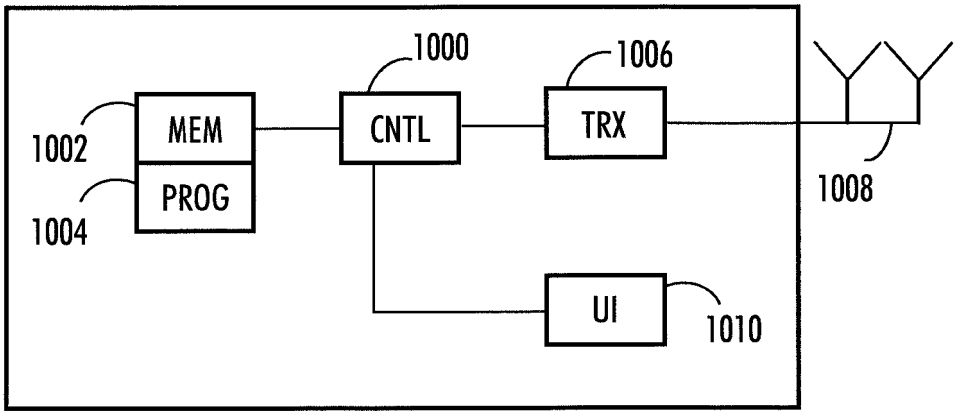
1000
1006
1002
MEM
CNTL
TRX
1004
PROG
1008
UI
1010

FIG. 10

Apparatus and Method for use in a Communication System

Technical Field

The present invention relates to an apparatus and method for use in a Communication System, in particular, but not exclusively, a wireless communication system. Embodiments of the invention relate especially to cell access in communication networks.

Background

Wireless communication systems are constantly under development. Developing systems provide a cost-effective support of high data rates and efficient resource utilization. One communication system under development is the 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE). An improved version of the Long Term Evolution radio access system is called LTE-Advanced (LTE-A). The LTE is designed to support various services, such as high-speed data, multimedia unicast and multimedia broadcast services.

One aspect under development is the concept of small cells. It has been proposed that under a macro cell serving a large area there would be a number of smaller cells with local area coverage. The small cells could reduce the power consumption at both base stations and user equipment side, offload traffic from the macro cell, and also potentially enable some new service types in the future.

It has been proposed that the small cells may be similar to Remote Radio Heads (RRH) which operate as individual cells but some of the processing, such as the baseband processing, may be done in a central entity. On the other hand, the small cell nodes may be more independent of the macro node. Thus, all the processing may be done in the small cell nodes but a specified interface may be deployed between a macro node and a small cell node.

Summary

The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the invention. It is not intended to identify key/critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some concepts of the invention in a simplified form as a prelude to a more detailed description that is presented later.

According to an aspect of the present invention, there is provided an apparatus for use in a communication system, the apparatus comprising a processing system configured to: control one or more local area base stations; and allocate resources of a common random access channel between the local area base stations, the resources comprising preambles.

According to an aspect of the present invention, there is provided an apparatus for use in a communication system, the apparatus comprising a processing system configured to: receive information on resources of a common random access channel allocated to the apparatus, the resources comprising a subset of the preambles of the common random access channel, the preambles being divided between other respective apparatuses, and utilise the allocated resources.

According to an aspect of the present invention, there is provided an apparatus for use in user equipment, the apparatus comprising a processing system configured to: control the reception of information on resources of a common random access channel allocated to one or more local area base stations, the resources allocated to each local area base station comprising a subset of preambles of the common random access channel, and utilise the resources when controlling the transmission of a random access preamble.

According to another aspect of the present invention, there is provided a method in a communication system, the method comprising: controlling one or more local area base stations; allocating resources of a common random access channel between the local area base stations, the resources comprising preambles.

According to another aspect of the present invention, there is provided a method in a communication system, the method comprising: receiving information on resources of a common random access channel allocated to the apparatus, the resources comprising a subset of the preambles of the common random access channel, the preambles being divided between other respective apparatuses, and utilising the allocated resources.

According to another aspect of the present invention, there is provided a method in a communication system, the method comprising: controlling the reception of information on resources of a common random access channel allocated to one or more local area base stations, the resources allocated to each local area base station comprising a subset of preambles of the common random access channel, and utilising the resources when controlling the transmission of a random access preamble.

Further features and advantages of the invention will become apparent from the following description of preferred embodiments of the invention, given by way of example only, which is made with reference to the accompanying drawings.

Brief Description of the Drawings

Figure 1 shows an example of a communication environment;

Figures 2A, 2B and 2C are flowcharts illustrating some example embodiments of the invention;

Figures 3, 4, 5, 6, 7 and 8 show examples of random access channel preamble allocations and configurations; and

Figures 9 and 10 show some examples of apparatuses applying some embodiments of the invention.

Detailed Description

Some embodiments of the present invention are applicable to user equipment (UE), a base station, eNodeB, a corresponding component, and/or to any communication system or any combination of different communication systems that support the required functionality.

The protocols used, the specifications of communication systems, servers and user terminals, especially in wireless communication, develop rapidly. Such development may require extra changes to an embodiment. Therefore, all words and expressions should be interpreted broadly and they are intended to illustrate, not to restrict, embodiments.

Many different radio protocols for use in communications systems exist. Some examples of different communication systems are the universal mobile telecommunications system (UMTS) radio access network (UTRAN), HSPA (High Speed Packet Access), long term evolution (LTE)®, known also as evolved UMTS Terrestrial Radio Access Network E-UTRAN), long term evolution advanced (LTE-A), Wireless Local Area Network (WLAN) based on IEEE 802.11standard, worldwide interoperability for microwave access (WiMAX®), Bluetooth®, personal communications services (PCS) and systems using ultra-wideband (UWB) technology. IEEE refers to the Institute of Electrical and Electronics Engineers. For example, LTE® and LTE-A are developed by the Third Generation Partnership Project 3GPP.

Figure 1 illustrates a simplified view of a communication environment only showing some elements and functional entities, all being logical units whose implementation may differ from what is shown. The connections shown in Figure 1 are logical connections; the actual physical connections may be different. It is apparent to a person skilled in the art that the systems also comprise other functions and structures. It should be appreciated that the functions, structures, elements and the protocols used in or for communication are irrelevant to the actual invention. Therefore, they need not to be discussed in more detail here.

In the example of Figure 1, a radio system based on LTE/SAE (Long Term Evolution/System Architecture Evolution) network elements is shown. However, the embodiments described in these examples are not limited to the LTE/SAE radio systems but can also be implemented in other radio systems.

The simplified example of a network of Figure 1 comprises a SAE Gateway (GW) 100 and an MME 102. The SAE Gateway 100 provides a connection to Internet

(NET) 104. Figure 1 shows a base station or an eNodeB 106 serving a cell 108. In this example, the eNodeB 106 is connected to the SAE Gateway 100 and the MME 102.

In this example, the cell 108 is a macro cell and the eNodeB 106 is a macro cell node. The macro node 106 may be denoted as Macro eNodeB (MeNB).

In general, the eNodeBs (Enhanced node Bs) of a communication system may host the functions for Radio Resource Management: Radio Bearer Control, Radio Admission Control, Connection Mobility Control, Dynamic Resource Allocation (scheduling). The MME 102 (Mobility Management Entity) is responsible for the overall UE control in mobility, session/call and state management with assistance of the eNodeBs through which the UEs connect to the network. The SAE GW 100 is an entity configured to act as a gateway between the network and other parts of communication network such as the Internet for example. The SAE GW may be a combination of two gateways, a serving gateway (S-GW) and a packet data network gateway (P-GW).

The eNodeB 106 may provide radio coverage to a cell 108. The cell 108 may be of any size or form, depending on the antenna system utilized. The eNodeB 106 may control a cellular radio communication link established between the eNodeB 106 and terminal devices or user equipment (UE) 110 located within the cell 108. The terminal device may be a user equipment of a cellular communication system, e.g. a personal computer (PC), a laptop, a hand held computer, a tablet, a mobile phone, or any other user terminal or user equipment capable of communicating with the cellular communication network.

In the example of Figure 1, there are three small cells 112, 114, 116 installed within the macro cell. Each small cell is served by a node, 118, 120 and 122. The nodes 118, 120, 122 serving small cells may be denoted as local area base stations or eNodeBs (LAeNB).

In an embodiment, the small cells operate on a separate frequency layer which is dedicated for small cell deployment. The operation in small cell frequency layer may be controlled by the overlaying macro cell that provides the coverage in another frequency layer over coverage area of the small cells. The control relationship

between macro and small cell layer may vary depending on the selected architecture. In an embodiment, the macro layer may provide common control information for the UEs operating in small cell layer.

In an embodiment, the small cells 112, 114,116 are intended to be deployed in an energy efficient manner, especially during time instants when there are no UEs connected to them. Thus, the amount of traffic the small cells transmit when they are in this "idle" mode should be minimized. The traffic may comprise discovery/beacon signal transmissions and listening to the UEs' attach requests, for example.

In an embodiment, the macro node may distribute information about the small cell discovery signals and attach parameters, for example. When the amount of small cells within the area of a macro cell increases also the amount of signaling overhead from the macro node may increase. In an embodiment, a common random access (RA) mechanism for small cells operating under given macro node may be utilized to reduce amount of parameters to be signaled from the macro node when configuration is distributed to the UE devices. The Random Access Channel (RACH) is an uplink transmission used by the UE to initiate synchronization with the eNodeB. Current LTE random access channel RACH includes 64 preambles to separate UEs camping on the cell simultaneously. For a small cell scenario the lower amount of preambles at one time occasion may be sufficient as the amount of UEs per a small cell is low.

Figure 2A is a flowchart illustrating an example embodiment of the invention. The apparatus employing the embodiment may be a base station or an eNodeB of a communication system serving a macro cell or a part of such an eNodeB, for example.

The process starts at step 200.

In step 202, the apparatus is configured to control one or more local area base stations. The control may be realized as the MeNB being responsible for providing common control information regarding the LAeNBs for the UEs operating in the small cell layer.

In step 204, the apparatus is configured to allocate resources of a random access channel between the local area base stations, the resources comprising preambles.

In an embodiment, the MeNB configures a common RACH for the LAeNBs under its control by selecting common parameters for RACH like time/frequency resource, periodicity, root sequence, and maximum amount of preamble transmissions. Examples of allocation and configurations are presented below in connection with figures 3 to 8.

In an embodiment, the apparatus is configured to inform the LAeNBs and the UEs within its area about the allocation in step 206. Thus each UE receives one random access channel configuration from MeNB that covers multiple LAeNBs.

The process ends in step 208.

Figure 2B is a flowchart illustrating an example embodiment of the invention. The apparatus employing the embodiment may be a local area base station or an eNodeB of a communication system serving a small cell or a part of such an eNodeB, for example. The process starts at step 220.

In step 222, the apparatus is configured to receive information on resources of a random access channel allocated to the apparatus. The resources may comprise a subset of the preambles of a random access channel, the preambles being divided between other corresponding apparatuses. Thus, each corresponding apparatus, such as a LAeNB, has been allocated different preambles of a single RACH, for example. In an embodiment, the information may be received via an interface between MeNB and LAeNB(e.g. X2 interface).

In step 224, the apparatus is configured to utilise the allocated resources. The apparatus may be configured to listen to the allocated resources for UE transmissions. For example, when the apparatus detects UE transmission on the RACH with a preamble which has been allocated to it, it is aware that the transmitting UE desires to connect to it and not to other apparatuses possibly serving nearby.

The process ends in step 226.

Figure 2C is a flowchart illustrating an example embodiment of the invention. The apparatus employing the embodiment may be user equipment of a communication system located in a small cell or a part of user equipment, for example. The process starts at step 240.

In step 242, the apparatus is configured to control the reception of information on resources of a random access channel allocated to one or more local area base stations, the resources allocated to each local area base station comprising a subset of preambles of the random access channel.

In an embodiment, the information is received as a part of dedicated signalling. In an embodiment, the apparatus is configured control the reception of one or more broadcast messages comprising the information. In yet another embodiment, the information is received in System Information Block transmissions.

In step 244, the apparatus is configured to utilise the resources when controlling the transmission of random access preambles. On the basis of the received information, the UE is aware of preambles allocated to each local area node. If the UE needs to contact a local area node it uses the preambles allocated to the node.
The process ends in step 246.

In current LTE specifications, the opportunity for UEs to transmit on RACH is periodical. The RACH cycle or time interval may be selected by the network. Factors affecting the cycle may be the expected RACH load and the size of the cell.
In an embodiment, a dedicated preamble group within one RACH is allocated by a MeNB for each LAeNB under its control. The preamble group size may be different for each LAeNB. For example, preamble indexes 0 to 15 of a given RACH may be allocated to LAeNB1 (e.g. LAeNB 118) and preamble indexes 16 to 47 of the same RACH to LAeNB2(e.g. LAeNB 120). Thus, UE wishing to camp on LAeNB1 would use preamble indexes 0 to 15 in transmission on the given RACH.

Figure 3 illustrates the above example. Figure 3 shows LTE subframe 300 comprising RACH 302. The RACH comprises a set of preambles 304 for the UEs to use. In this example, a given number of preambles 306 are allocated to LAeNB1 and another given number 308 to LAeNB2. The same RACH with the same allocations occurs again after a predetermined RACH cycle or time interval 310.

In an embodiment, the MeNB is configured to divide random access channel occasions in time for different LAeNBs.

Figure 4 illustrates this example. Assume here that the RACH occurs at time instants t1, t2, t3, t4,.... Figure 4 shows time instants t1 400 and t2 402 . At time instant t1 RACH preambles 404 are allocated to LAeNB1. At time instant t2 the same RACH preambles 404 are allocated to LAeNB2.

In an embodiment, the MeNB is configured to divide random access channel occasions in time for different LAeNB groups, each group comprising one or more LAeNBs.

Figure 5 illustrates this example. Assume here that RACH occurs at time instants t1, t2, t3, t4,.... The MeNB has divided the LAeNBs into two groups, LAeNB#1 and LAeNB#2. In this example, LAeNB#1 comprises LAeNBs LAeNB1 and LAeNB2. LAeNB#2 comprises LAeNBs LAeNB3 and LAeNB4., where each group comprises one or more LAeNBs. The MeNB may be configured to allocate RACHs of time instants t1, t3,... to LAeNB#1 and RACHs of time instants t2, t4,... to LAeNB#2.

Figure 5 shows time instants t1 500 and t2 502. At time instant t1 RACH preambles 504 are divided between LAeNBs of group LAeNB#1. The preambles 506 are allocated to LAeNB1 and preambles 508 are allocated to LAeNB2. At time instant t2 RACH preambles 504 are divided between LAeNBs of group LAeNB#2. The preambles 510 are allocated to LAeNB3 and preambles 512 are allocated to LAeNB4.

In an embodiment, the MeNB is configured to allocate a predetermined amount of contention free RA preambles for each LAeNB for handover purposes etc. The MeNB may indicate the amount of contention free RA preambles with one parameter value, for example.

For example, the contention free RA preamble indexes for a given LAeNB may be allocated after the contention based RA preamble indexes of the given LAeNB. Figure 6 illustrates this example. The RACH comprises preambles 600. The preambles 600 are allocated in this example such that first are contention based preambles 602 of LAeNB1, then contention free preambles 604 of LAeNB1, contention based preambles 606 of LAeNB2, and finally contention free preambles 608 of LAeNB2. The same order naturally repeats after the RACH cycle.

In an embodiment, the MeNB is configured to allocate the contention free RA preamble indexes for a given LAeNB after the all contention based RA preamble indexes. They may be allocated in the same order as the corresponding contention based RA preamble indexes for the LAeNBs. Figure 7 illustrates this example. The RACH comprises preambles 700. The preambles 700 of the RACH are allocated in this example such that first are contention based preambles 702 of LAeNB1, then contention based preambles 704 of LAeNB2, contention free preambles 706 of LAeNB1, and finally contention free preambles 708 of LAeNB2. The same order naturally repeats after the RACH cycle.

In an embodiment, random access preamble allocations are done in the contention free preamble space of the legacy RACH configuration to ensure backwards compatibility. Here the term legacy denotes a configuration where the solutions described in this application have not been applied.

Figure 8 illustrates this example. The RACH comprises preambles 800. Preambles 802 are legacy contention free and the random access preamble allocations are done in these preambles. In this example the allocations comprise contention based preambles 804 of LAeNB1, then contention based preambles 806 of LAeNB2, contention free preambles 808 of LAeNB1, and finally contention free preambles 810 of LAeNB2. The Legacy preamble group 812 is located outside the legacy contention free preambles. The same order repeats after each RACH cycle.

In an embodiment, the MeNB controlling LAeNBs is configured to send a Random Access Response (RAR) that corresponds to RACH defined for multiple LAeNBs. The RAR is a response to the UEs utilizing the resources allocated to the LAeNBs. The UEs are configured to determine Random Access Radio Network Temporary Identifier RA-RNTI corresponding to the RACH and wait for the RAR transmission with the correct RA-RNTI on the MeNB control channel. In another embodiment, each LAeNB sends its own RAR as a response to UE RACH transmissions. In an embodiment, the LAeNB may be configured to cause the sending of a Random Access Response that corresponds to the allocated resources of the random access channel.

Figure 9 illustrates a simplified example of an apparatus in which some embodiments of the invention may be applied. In some embodiments, the apparatus may be a base station or an eNodeB of a communication system or network. The apparatus may be a part or a section of a base station or an eNodeB.

Figure 10 illustrates a simplified example of an apparatus in which some embodiments of the invention may be applied. In some embodiments, the apparatus may be user equipment UE or a respective apparatus communicating with a base station or an eNodeB of a communications system. The apparatus may be a part or a section of user equipment (e.g. modem).

It should be understood that the apparatuses are depicted herein as examples illustrating some embodiments. It is apparent to a person skilled in the art that the apparatuses may also comprise other functions and/or structures and not all described functions and structures are required. Although the apparatuses have been depicted as single entities, different modules and memory may be implemented in one or more physical or logical entities. In addition, each apparatus may be a part of another apparatus.

Referring to Figure 9, the apparatus of the example includes one or more control circuitries or processing circuits (CNTL) 900 configured to control at least part of the operation of the apparatus.

The apparatus may comprise one or more memories (MEM) 902 for storing data. Furthermore the memory may store software (PROG) 904 executable by the control circuitry 900. The memory may be integrated in the control circuitry.
The apparatus may comprise a transceiver (TRX) 906. The transceiver is operationally connected to the control circuitry 900. It may be connected to an antenna arrangement 908 comprising one or more antennas or antenna elements. The apparatus may also comprise a connection to a transceiver instead of a transceiver.

The apparatus may comprise an interface (IF) 910. The interface is operationally connected to the control circuitry 900. The apparatus may be connected to network elements of the communication system or network via the interface.

The software 904 may comprise a computer program comprising program code means adapted to cause the control circuitry 900 of the apparatus to control a transceiver 906.

If the apparatus is a MeNB or a part of a MeNB, the software 904 may comprise a computer program comprising program code means adapted to cause the control circuitry 900 of the apparatus to control one or more local area base stations and allocate resources of a random access channel between the local area base stations, the resources comprising preambles.

If the apparatus is a LAeNB or a part of a LAeNB, the software 904 may comprise a computer program comprising program code means adapted to cause the control circuitry 900 of the apparatus to receive information on resources of a random access channel allocated to the apparatus, the resources comprising a subset of the preambles of a random access channel, the preambles being divided between other respective apparatuses, and utilise the allocated resources.

Figure 10 illustrates a simplified example of user equipment UE or a respective apparatus. The apparatus of the example includes one or more control circuitries or processing circuits (CNTL) 1000 configured to control at least part of the operation of the apparatus.

The apparatus may comprise one or more memories (MEM) 1002 for storing data. Furthermore the memory may store software (PROG) 1004 executable by the control circuitry 1000. The memory may be integrated in the control circuitry. The apparatus may comprise a transceiver (TRX) 1006. The transceiver is operationally connected to the control circuitry 1000. It may be connected to an antenna arrangement 1008 comprising one or more antennas or antenna elements. The device may also comprise a connection to a transceiver instead of a transceiver.

The software 1004 may comprise a computer program comprising program code means adapted to cause the control circuitry 1000 of the apparatus to control a transceiver 1006.

The software 1004 may comprise a computer program comprising program code means adapted to cause the control circuitry 1000 of the apparatus to control the

reception of information on resources of a random access channel allocated to one or more local area base stations, the resources allocated to each local area base station comprising a subset of preambles of the random access channel, and utilise the resources when controlling the transmission of a random access preamble.

The apparatus may further comprise user interface (UI) 1010 operationally connected to the control circuitry 1000. The user interface may comprise a display which may be touch sensitive, a keyboard or keypad, a microphone and a speaker, for example.

The steps and related functions described in the above and attached figures are in no absolute chronological order, and some of the steps may be performed simultaneously or in an order differing from the given one. Other functions can also be executed between the steps or within the steps. Some of the steps can also be left out or replaced with a corresponding step.

The apparatuses or controllers able to perform the above-described steps may be implemented as an electronic digital computer, processing system or a circuitry which may comprise a working memory (RAM), a central processing unit (CPU), and a system clock. The CPU may comprise a set of registers, an arithmetic logic unit, and a controller. The processing system, controller or the circuitry is controlled by a sequence of program instructions transferred to the CPU from the RAM. The controller may contain a number of microinstructions for basic operations. The implementation of microinstructions may vary depending on the CPU design. The program instructions may be coded by a programming language, which may be a high-level programming language, such as C, Java, etc., or a low-level programming language, such as a machine language, or an assembler. The electronic digital computer may also have an operating system, which may provide system services to a computer program written with the program instructions.

As used in this application, the term 'circuitry' refers to all of the following: (a) hardware-only circuit implementations, such as implementations in only analog and/or digital circuitry, and (b) combinations of circuits and software (and/or firmware), such as (as applicable): (i) a combination of processor(s) or (ii) portions of

processor(s)/software including digital signal processor(s), software, and memory(ies) that work together to cause an apparatus to perform various functions, and (c) circuits, such as 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 in this application. As a further example, as used in this application, the term 'circuitry' would also cover an implementation of merely a processor (or multiple processors) or a portion of a processor and its (or their) accompanying software and/or firmware. The term 'circuitry' would also cover, for example and if applicable to the particular element, 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, or another network device.

An embodiment provides a computer program embodied on a distribution medium, comprising program instructions which, when loaded into an electronic apparatus, are configured to control the apparatus to execute the embodiments described above.

The computer program may be in source code form, object code form, or in some intermediate form, and it may be stored in some sort of carrier, which may be any entity or device capable of carrying the program. Such carriers include a record medium, computer memory, read-only memory, and a software distribution package, for example. Depending on the processing power needed, the computer program may be executed in a single electronic digital computer or it may be distributed amongst a number of computers.

The apparatus may also be implemented as one or more integrated circuits, such as application-specific integrated circuits ASIC. Other hardware embodiments are also feasible, such as a circuit built of separate logic components. A hybrid of these different implementations is also feasible. When selecting the method of implementation, a person skilled in the art will consider the requirements set for the size and power consumption of the apparatus, the necessary processing capacity, production costs, and production volumes, for example.

It will be obvious to a person skilled in the art that, as technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

The above embodiments are to be understood as illustrative examples of the invention. Further embodiments of the invention are envisaged. It is to be understood that any feature described in relation to any one embodiment may be used alone, or in combination with other features described, and may also be used in combination with one or more features of any other of the embodiments, or any combination of any other of the embodiments. Furthermore, equivalents and modifications not described above may also be employed without departing from the scope of the invention, which is defined in the accompanying claims.

Claims

1. An apparatus for use in a communication system, the apparatus comprising a processing system configured to:

control one or more local area base stations; and

allocate resources of a common random access channel between the local area base stations, the resources comprising preambles.

2. The apparatus of claim 1, the processing system being further configured to allocate a dedicated preamble group within the random access channel for each local area base station.

3. The apparatus of claim 1 or 2, the processing system being further configured to divide random access channel occasions in time for different local area base station groups, each group comprising one or more local area base stations.

4. The apparatus of any preceding claim, the processing system being further configured to allocate a predetermined amount of contention free random access preambles for each of the one or more local area base stations.

5. The apparatus of claim 4, wherein indexes of the contention free random access preambles for a given local area base station are located after the contention based random access preamble indexes of the given local area base station.

6. The apparatus of claim 4, wherein indexes of the contention free random access preambles are located after the contention based random access preambles of all local area base stations and they are allocated in the same order as the corresponding contention based random access preambles.

7. The apparatus of any preceding claim, the processing system being further configured to inform user equipment about the allocation using dedicated signalling.

8. The apparatus of any preceding claim, the processing system being further configured to inform user equipment about the allocation using one or more broadcast messages.

9. The apparatus of any preceding claim, the processing system being further configured to inform user equipment about the allocation using System Information Block transmissions.

10. The apparatus of any of claims 4 to 6, the processing system being further configured to inform user equipment about the amount of contention free random access preambles with one parameter value.

11. The apparatus of any of claims 4 to 6, wherein the contention free random access preambles are located in the contention free preamble space of legacy user equipment.

12. The apparatus of any preceding claim, the processing system being further configured to cause the sending of a Random Access Response that corresponds to the random access channel defined for multiple local area base stations.

13. The apparatus of any preceding claim, the processing system being further configured to cause one random access channel configuration that covers more than one local area base station to be sent to user equipment.

14. The apparatus of any preceding claim, wherein the apparatus is a base station.

15. The apparatus of any preceding claim, wherein the apparatus is a base station of a Long Term Evolution or Long Term Evolution Advanced based communication system.

16. An apparatus for use in a communication system, the apparatus comprising a processing system configured to:

receive information on resources of a common random access channel allocated to the apparatus, the resources comprising a subset of the preambles of the common random access channel, the preambles being divided between other respective apparatuses, and

utilise the allocated resources.

17. The apparatus of claim 16, the processing system being further configured to control the apparatus to be a part of a group comprising one or more apparatuses and utilise the allocated resources of the random access channel only on time instants allocated to the group.

18. The apparatus of claim 16 or 17, the processing system being further configured to receive an allocation of a predetermined amount of contention free random access preambles.

19. The apparatus of claim 18, wherein indexes of the contention free random access preambles are located after contention based random access preamble indexes of the apparatus.

20. The apparatus of claim 18, wherein the contention free random access preambles are located after the contention based random access preambles of all other

respective apparatuses and they are allocated in the same order as the corresponding contention based random access preambles.

21. The apparatus of any of claims 16 to 20, the processing system being further configured to receive random access messages from user equipment utilising the allocated resources.

22. The apparatus of any of claims 16 to 21, the processing system being further configured to cause the sending of a Random Access Response that corresponds to the allocated resources of the random access channel.

23. The apparatus of any of claims 16 to 22, the processing system being further configured to receive one random access channel configuration that covers more than one local area base station.

24. The apparatus of any of claims 16 to 23, wherein the apparatus is a local area base station.

25. The apparatus of any of claims 16 to 24, wherein the apparatus is a local area base station of a Long Term Evolution or Long Term Evolution Advanced based communication system.

26. An apparatus for use in user equipment, the apparatus comprising a processing system configured to:

control the reception of information on resources of a common random access channel allocated to one or more local area base stations, the resources allocated to each local area base station comprising a subset of preambles of the common random access channel, and

utilise the resources when controlling the transmission of a random access preamble.

27. The apparatus of claim 26, the processing system being further configured to control the reception of dedicated signalling comprising the information.

28. The apparatus of claim 26, the processing system being further configured to control the reception of one or more broadcast messages comprising the information.

29. The apparatus of claim 26, the processing system being further configured to control the reception of System Information Block transmissions comprising the information.

30. The apparatus of any of claims 26 to 28, wherein the resources comprise contention free random access preambles, the processing system being further configured to control the reception of a parameter value indicating the amount of contention free random access preambles.

31. The apparatus of any of claims 26 to 30, the processing system being further configured to cause the sending of a random access preamble to a base station on the common random access channel.

32. The apparatus of claim 31, the processing system being further configured to control the reception of a Random Access Response from the base station, the response corresponding to the sent preamble.

33. The apparatus of any of claims 26 to 32, the processing system being further configured to receive one random access channel configuration that covers more than one local area base station.

34. The apparatus of any of claims 26 to 33, wherein the apparatus is user equipment.

35. The apparatus of claim 34, wherein the user equipment is a mobile device.

36. The apparatus of any of claims 26 to 33, wherein the apparatus is user equipment of a Long Term Evolution based communication system.

37. An apparatus for use in a communication system, the apparatus comprising:

means for controlling one or more local area base stations; and

means for allocating resources of a common random access channel between the local area base stations, the resources comprising preambles.

38. An apparatus for use in a communication system, the apparatus comprising:

means for receiving information on resources of a common random access channel allocated to the apparatus, the resources comprising a subset of the preambles of the common random access channel, the preambles being divided between other respective apparatuses, and

means for utilising the allocated resources.

39. An apparatus for use in a communication system, the apparatus comprising:

means for controlling the reception of information on resources of a common random access channel allocated to one or more local area base stations, the resources allocated to each local area base station comprising a subset of preambles of the common random access channel, and

means for utilising the resources when controlling the transmission of a random access preamble.

40. A method in a communication system, the method comprising:

controlling one or more local area base stations;

allocating resources of a common random access channel between the local area base stations, the resources comprising preambles.

41. The method of claim 40, further comprising:

allocating a dedicated preamble group within the random access channel for each local area base station.

42. The method of claim 40 or 41, further comprising:

dividing random access channel occasions in time for different local area base station groups, each group comprising one or more local area base stations.

43. The method of claim 40, 41 or 42, further comprising:

allocating a predetermined amount of contention free random access preambles for each of the one or more local area base stations.

44. The method of claim 43, wherein indexes of the contention free random access preambles for a given local area base station are located after the contention based random access preamble indexes of the given local area base station.

45. The method of claim 43, wherein indexes of the contention free random access preambles are located after the contention based random access preambles of all local area base stations and they are allocated in the same order as the corresponding contention based random access preambles.

46. The method of any of claims 40 to 45, further comprising:

informing user equipment about the allocation using dedicated signalling.

47. The method of any of claims 40 to 46, further comprising:

informing user equipment about the allocation using one or more broadcast messages.

48. The method of any of claims 40 to 47, further comprising:

informing user equipment about the allocation using System Information Block transmissions.

49. The method of any of claims 43 to 45, further comprising:

informing user equipment about the amount of contention free random access preambles with one parameter value.

50. The method of any of claims 43 to 45, wherein the contention free random access preambles are located in the contention free preamble space of legacy user equipment.

51. The method of any of claims 40 to 50, further comprising:

causing the sending of a Random Access Response that corresponds to the random access channel defined for multiple local area base stations.

52. The method of any of claims 40 to 51, further comprising:

causing one random access channel configuration that covers more than one local area base station to be sent to user equipment.

53. A method in a communication system, the method comprising:

receiving information on resources of a common random access channel allocated to an apparatus, the resources comprising a subset of the preambles of the

common random access channel, the preambles being divided between other respective apparatuses, and

utilising the allocated resources.

54. The method of claim 53, further comprising: controlling the apparatus be a part of a group comprising one or more apparatuses and utilise the allocated resources of the random access channel only on time instants allocated to the group.

55. The method of claim 53 or 54, further comprising: receiving an allocation of a predetermined amount of contention free random access preambles.

56. The method of claim 55, wherein indexes of the contention free random access preambles are located after contention based random access preamble indexes of the apparatus.

57. The method of claim 55, wherein the contention free random access preambles are located after the contention based random access preambles of all other respective apparatuses and they are allocated in the same order as the corresponding contention based random access preambles.

58. The method of any of claims 53 to 58, further comprising: receiving random access messages from user equipment utilising the allocated resources.

59. The method of any of claims 53 to 58, further comprising: causing the sending of a Random Access Response that corresponds to the allocated resources of the random access channel.

60. The method of any of claims 53 to 59, further comprising: receiving one random access channel configuration that covers more than one local area base station.

61. A method in a communication system, the method comprising:

controlling the reception of information on resources of a common random access channel allocated to one or more local area base stations, the resources allocated to each local area base station comprising a subset of preambles of the common random access channel, and

utilising the resources when controlling the transmission of a random access preamble.

62. The method of claim 61, further comprising:

controlling the reception of dedicated signalling comprising the information.

63. The method of claim 61, further comprising:

controlling the reception of one or more broadcast messages comprising the information.

64. The method of claim 61, further comprising:

controlling the reception of System Information Block transmissions comprising the information.

65. The method of any of claims 61 to 64, wherein the resources comprise contention free random access preambles, the method further comprising controling the reception of a parameter value indicating the amount of contention free random access preambles.

66. The method of any of claims 61 to 65, further comprising:

causing the sending of a random access preamble to a base station on the common random access channel.

67. The method of claim 66, further comprising: controlling the reception of a Random Access Response from the base station, the response corresponding to the sent preamble.

68. The method of any of claims 61 to 67, further comprising:

receiving one random access channel configuration that covers more than one local area base station.

69. A computer readable medium comprising a set of instructions, which, when executed on a processing system cause the processing system to perform the steps of any of claims 40 to 68.

INTELLECTUAL PROPERTY OFFICE

Application No: GB1218202.8 **Examiner:** Gareth Griffiths

Claims searched: 1-69 **Date of search:** 8 February 2013

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	26, 28, 29, 31, 32, 34-36, 39, 61, 63, 64, 66, 67, 69	EP2309817 A1 (KOREA ELECTRONICS TELECOMM) whole document

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

H04W

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, XP3GPP, INSPEC

International Classification:

Subclass	Subgroup	Valid From
H04W	0072/04	01/01/2009
H04W	0074/08	01/01/2009