



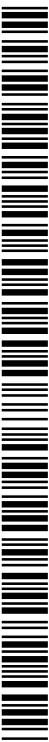
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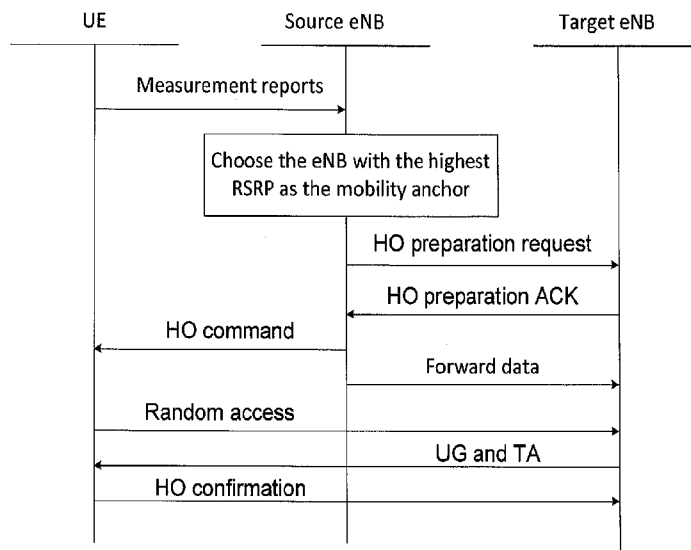
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(54) **Title:** MOBILITY MANAGEMENT FOR SMALL CELL DEPLOYMENT IN LONG TERM EVOLUTION SYSTEM



(57) **Abstract:** A communications system includes a plurality of cells having one or more macro cells and one or more small cells, a user equipment (UE), and a network through which the cells and the UE communicate with each other. A cell of the plurality of cells comprises a memory and a controller, the cell being a source cell that serves as a mobility anchor of the UE to handle all control signaling for the UE and receiving a measurement report from the UE. The controller of the source cell is operable to: choose, based on the measurement report, a target cell from the plurality of cells as a new mobility anchor of the UE; send a handover preparation request to the target cell; receive a handover preparation request acknowledgement from the target cell; and send a handover preparation command to the UE and start data forwarding to the target cell.

MOBILITY MANAGEMENT FOR SMALL CELL DEPLOYMENT IN LONG TERM EVOLUTION SYSTEM

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to wireless systems and, more particularly, to mobility management for small cell deployment in long term evolution (LTE) systems.

[0002] In a typical LTE/LTE-Advanced heterogeneous network, macro cells are deployed to provide the coverage and mobility management, while small cells are deployed to further enhance the user throughput. In a conventional handover procedure, a macro cell makes the handover decision based on the measurements of the signal strength from its neighboring macro cells only. This handover mechanism does not take the signal strength of small cells into account and thus may not be able to take fully advantage of small cell deployment. Typically, a macro cell has a coverage range of up to 35 kilometers, while a small cell has a coverage range of 10 meters to 2 kilometers, which is about 1-3 orders of magnitude smaller than that of a macro cell.

[0003] Consider a LTE/LTE-Advanced Heterogeneous Network, where a large number of small cells are deployed for throughput enhancement in the coverage area of a macro cell. In such a dense deployment, mobility management is usually performed in the macro layer only, i.e., handovers only occurs between two macro eNodeB (eNB) to avoid frequent handover. FIG. 1 shows a conventional handover procedure between two macro eNBs in a LTE network. The following steps are expected:

- [0004]** 1. A UE (user equipment or user) sends measurement reports including the Reference Signal Received Power (RSRP) from its serving macro eNB and neighboring macro eNBs.
- [0005]** 2. The serving macro eNB (also called source eNB) decides to handover the UE to another macro eNB (called target eNB) based on the measurement reports. For example, the RSRP of the target eNB is greater than that of the source eNB. It sends a Handover (HO) preparation request to the target eNB.
- [0006]** 3. The target macro eNB replies with a HO preparation request Acknowledgement (ACK).
- [0007]** 4. The source macro eNB sends a HO command to the UE and starts data forwarding to the target macro eNB.
- [0008]** 5. The UE performs cell acquisition by sending a random access request to the target macro eNB.
- [0009]** 6. The target macro eNB confirms the establishment of the connection by sending Uplink Grant (UG) and Timing Advance (TA).
- [0010]** 7. The UE sends the HO confirmation to the target macro eNB to complete the whole handover process.
- [0011]** In LTE Rel-12 (Release 12), dual connectivity is introduced which allows a UE to connect to two eNBs simultaneously. A typical employment of dual connectivity is shown in FIG. 2, where a UE is connected to a macro eNB on frequency band F1 and a small cell eNB on frequency band F2 at the same time. The macro eNB handles the mobility management and all control signaling (e.g., RRC (Radio Resource Control) signaling) for the UE, and acts as a mobility anchor. As a mobility anchor, packets are

routed through this point for intra E-UTRAN mobility and mobility with other 3GPP technologies. While the control signaling only comes from the macro eNB, the data can come from both the macro eNB and small cell eNB to improve the UE throughput. Both the macro eNB and small cell eNB are considered as serving eNBs for the UE.

BRIEF SUMMARY OF THE INVENTION

[0012] Exemplary embodiments of the invention provide two handover mechanisms for small cell deployment. The first handover mechanism can improve the system throughput by triggering the handover based on the signal strength measurements from both macro cells and small cells. The second handover mechanism can improve the control signaling reliability by allowing a small cell to be a temporary mobility anchor for a UE, which is used to handle all control signaling for the UE. This invention can be used to in a LTE-A heterogeneous network to improve the throughput performance and reliability of control signaling, especially for dense small cell deployment.

[0013] An aspect of the present invention is directed to a cell in a communications system which includes a plurality of cells having one or more macro cells and one or more small cells, a user equipment (UE), and a network through which the cells and the UE communicate with each other. The cell comprises a memory and a controller. The cell is a source cell that serves as a mobility anchor of the UE to handle all control signaling for the UE and receiving a measurement report from the UE. The controller of the source cell is operable to: choose, based on the measurement report, a target cell from the plurality of cells as a new mobility anchor of the UE; send

a handover preparation request to the target cell; receive a handover preparation request acknowledgement from the target cell; and send a handover preparation command to the UE and start data forwarding to the target cell.

[0014] In some embodiments, the controller is operable to choose, based on the measurement report, the target cell having a highest Reference Signal Received Power (RSRP) to the UE among the plurality of cells. At least one of the source cell and the target cell is a small cell. Both the source cell and the target cell may be small cells.

[0015] In accordance with another aspect of the invention, a communications system comprises: a plurality of cells including one or more macro cells and one or more small cells; a user equipment (UE); and a network through which the plurality of cells and the UE communicate with each other. One of the plurality of cells is a source cell that serves as a mobility anchor of the UE to handle all control signaling for the UE and receives a measurement report from the UE, the source cell including a memory and a controller, the controller of the source cell being operable to: choose, based on the measurement report, a target cell from the plurality of cells as a new mobility anchor of the UE; send a handover preparation request to the target cell; receive a handover preparation request acknowledgement from the target cell; and send a handover preparation command to the UE and start data forwarding to the target cell.

[0016] In specific embodiments, the UE has a UE memory and a UE controller which is operable to perform cell acquisition by sending a random access request to the target cell. The target cell has a memory and a

controller which is operable to confirm establishment of a connection with the UE by sending an Uplink Grant (UG) and a Timing Advance (TA). The UE controller is operable to send a handover confirmation to the target cell. The controller of the source cell is operable to choose, based on the measurement report, the target cell having a highest Reference Signal Received Power (RSRP) to the UE among the plurality of cells.

[0017] Another aspect of this invention is directed to a computer program for mobility management in a communications system which has a plurality of cells including one or more macro cells and one or more small cells, a user equipment (UE), and a network through which the plurality of cells and the UE communicate with each other, wherein one of the plurality of cells is a source cell that serves as a mobility anchor of the UE to handle all control signaling for the UE and receives a measurement report from the UE. The source cell includes a memory and a controller. The computer program comprises: code for choosing by the source cell, based on the measurement report, a target cell from the plurality of cells as a new mobility anchor of the UE; code for sending by the source cell a handover preparation request to the target cell; code for receiving by the source cell a handover preparation request acknowledgement from the target cell; and code for sending by the source cell a handover preparation command to the UE and start data forwarding to the target cell.

[0018] In some embodiments, the computer program further comprises code for performing cell acquisition by sending a random access request from the UE to the target cell. The computer program further comprises code for confirming by the target cell establishment of a connection with the UE by

sending an Uplink Grant (UG) and a Timing Advance (TA). The computer program according to claim 13, further comprises code for sending by the UE a handover confirmation to the target cell. The code for choosing the target cell comprises code for choosing by the source cell, based on the measurement report, the target cell having a highest Reference Signal Received Power (RSRP) to the UE among the plurality of cells.

[0019] Another aspect of this invention is directed to a non-transient computer readable storage medium storing a plurality of instructions for controlling a data processor to provide mobility management in a communications system which has a plurality of cells including one or more macro cells and one or more small cells, a user equipment (UE), and a network through which the plurality of cells and the UE communicate with each other, wherein one of the plurality of cells is a source cell that serves as a mobility anchor of the UE to handle all control signaling for the UE and receives a measurement report from the UE. The source cell includes a memory and the data processor. The plurality of instructions comprise: instructions that cause the data processor to choose, based on the measurement report, a target cell from the plurality of cells as a new mobility anchor of the UE; instructions that cause the data processor to send a handover preparation request to the target cell; instructions that cause the data processor to receive a handover preparation request acknowledgement from the target cell; and instructions that cause the data processor to send a handover preparation command to the UE and start data forwarding to the target cell.

[0020] These and other features and advantages of the present invention will become apparent to those of ordinary skill in the art in view of the following detailed description of the specific embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIG. 1 shows a conventional handover procedure between two macro eNBs in a LTE network.

[0022] FIG. 2 shows a typical employment of dual connectivity in a LTE network.

[0023] FIG. 3 is a block diagram showing an example of the primary eNB modules involved in the proposed solutions.

[0024] FIG. 4 shows an example of the mobility management module illustrating the internal processing thereof.

[0025] FIG. 5 shows an example of a small cell dense deployment scenario.

[0026] FIG. 6 is a diagram illustrating an example of the handover procedure for throughput improvement.

[0027] FIG. 7 shows another example of a small cell dense deployment scenario involving Coordinated Multi-Point (CoMP) transmission.

[0028] FIG. 8 is a diagram illustrating an example of the handover procedure for throughput improvement involving CoMP transmission.

[0029] FIG. 9 is a diagram illustrating an example of the handover procedure to improve control signaling reliability.

[0030] FIG. 10 shows an example of small cell dense deployment illustrating the proposed handover procedure to improve control signaling reliability.

DETAILED DESCRIPTION OF THE INVENTION

[0031] In the following detailed description of the invention, reference is made to the accompanying drawings which form a part of the disclosure, and in which are shown by way of illustration, and not of limitation, exemplary embodiments by which the invention may be practiced. In the drawings, like numerals describe substantially similar components throughout the several views. Further, it should be noted that while the detailed description provides various exemplary embodiments, as described below and as illustrated in the drawings, the present invention is not limited to the embodiments described and illustrated herein, but can extend to other embodiments, as would be known or as would become known to those skilled in the art. Reference in the specification to "one embodiment," "this embodiment," or "these embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention, and the appearances of these phrases in various places in the specification are not necessarily all referring to the same embodiment. Additionally, in the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one of ordinary skill in the art that these specific details may not all be needed to practice the present invention. In other circumstances, well-known structures, materials, circuits,

processes and interfaces have not been described in detail, and/or may be illustrated in block diagram form, so as to not unnecessarily obscure the present invention.

[0032] Furthermore, some portions of the detailed description that follow are presented in terms of algorithms and symbolic representations of operations within a computer. These algorithmic descriptions and symbolic representations are the means used by those skilled in the data processing arts to most effectively convey the essence of their innovations to others skilled in the art. An algorithm is a series of defined steps leading to a desired end state or result. In the present invention, the steps carried out require physical manipulations of tangible quantities for achieving a tangible result. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals or instructions capable of being stored, transferred, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, instructions, or the like. It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise, as apparent from the following discussion, it is appreciated that throughout the description, discussions utilizing terms such as "processing," "computing," "calculating," "determining," "displaying," or the like, can include the actions and processes of a computer system or other information processing device that manipulates and transforms data represented as physical (electronic) quantities within the computer system's

registers and memories into other data similarly represented as physical quantities within the computer system's memories or registers or other information storage, transmission or display devices.

[0033] The present invention also relates to an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, or it may include one or more general-purpose computers selectively activated or reconfigured by one or more computer programs. Such computer programs may be stored in a computer-readable storage medium, such as, but not limited to optical disks, magnetic disks, read-only memories, random access memories, solid state devices and drives, or any other types of media suitable for storing electronic information. The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general-purpose systems may be used with programs and modules in accordance with the teachings herein, or it may prove convenient to construct a more specialized apparatus to perform desired method steps. In addition, the present invention is not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the invention as described herein. The instructions of the programming language(s) may be executed by one or more processing devices, e.g., central processing units (CPUs), processors, or controllers.

[0034] Exemplary embodiments of the invention, as will be described in greater detail below, provide apparatuses, methods and computer programs for mobility management for small cell deployment in LTE systems.

[0035] In a conventional LTE/LTE-Advanced heterogeneous network, the mobility management is performed in the macro layer, i.e., the handovers only occur between two macro eNBs. More particularly, a macro cell makes the handover decision based on the measurements of the signal strength from its neighboring macro cells only. This handover mechanism does not take the signal strength of small cells into account and thus may not be able to take fully advantage of small cell deployment. The proposed solutions are intended to address the above issues.

[0036] FIG. 3 is a block diagram showing an example of the primary eNB modules involved in the proposed solutions. FIG. 3 shows the small cell/macro eNB modules and high-level inter-eNB interactions. The eNBs (eNB 1 and eNB 2) each have a mobility management module, a signal processor, and a memory. The inventive step features the mobility management module that is integrated into each eNB (macro and small cell). Each eNB has a controller which operates the signal processor and mobility management module. The information to be processed is stored in and retrieved from the memory. At the initiation, a process initialization message originates from one of the eNBs, followed by subsequent information exchange and conclusion of mobility management reconfiguration. The inter-eNB messaging is done via X2/Xn interfaces over backhaul links.

[0037] For additional clarity, the internal processing of the mobility management module is depicted in FIG. 4. For example, they include receiving UE measurements, performing comparisons to determine optimal mobility anchor, initiating communication with neighbor eNB(s), mobility anchor transfer, and data transmission point transfer (if needed). The details

of the various steps are provided in FIG. 6, FIG. 8, and FIG. 9 for several specific network scenarios and applications.

[0038] Proposed Solution for Throughput Enhancement

[0039] FIG. 5 shows an example of a small cell dense deployment scenario, where a large number of small cells are deployed in the coverage of macro cells. Assume that a UE has the capability of dual connectivity defined as follows: 1) the UE can connect to a macro eNB and a small cell eNB simultaneously, 2) the macro eNB handles the mobility management and all control signaling aspects while the small cell eNB is only used for data transmission, and 3) the downlink data from the core network first reaches the macro eNB and then are forwarded to the small cell eNB via the backhaul link. FIG. 6 is a diagram illustrating an example of the handover procedure for throughput improvement as follows.

[0040] 1. A UE sends measurement reports including the Reference Signal Received Power (RSRP) from its serving eNBs and neighboring eNBs. Note that the UE could have two serving eNBs, one macro eNB and one small cell eNBs. The neighboring eNBs include all macro eNBs and small cell eNBs in the neighborhood.

[0041] 2. The serving macro eNB makes handover decision based on the measurement reports from the UE as follows. If the RSRP of a small cell eNB is larger than the RSRP of the serving small cell eNB, the serving macro eNB consider the small cell eNB with the larger RSRP as the new serving small cell eNB and hands over the UE to the target macro eNB (associated with the new serving small cell eNB), which is supposed to

forward the data to the new serving small cell eNB. The serving macro eNB sends a HO preparation request to the target macro eNB.

[0042] 3. The target macro eNB replies with a HO preparation request Acknowledgement (ACK).

[0043] 4. The source macro eNB sends a HO command to the UE and starts data forwarding to the target macro eNB.

[0044] 5. The UE performs cell acquisition by sending a random access request to the target macro eNB.

[0045] 6. The target macro eNB confirms the establishment of the connection by sending Uplink Grant (UG) and Timing Advance (TA).

[0046] 7. The UE sends the HO confirmation to the target macro eNB.

[0047] 8. The UE sends the measurement reports including the Reference Signal Received Power (RSRP) from its serving eNBs and neighboring eNBs.

[0048] 9. The target macro eNB informs the UE of the new serving small cell via RRC signaling based on the received measurement reports, such that the UE can establish the connection to the small cell.

[0049] The proposed handover procedure can ensure that a dual-connectivity UE can always connect to a small cell which has the highest RSRP. Thus, the overall system throughput can be improved.

[0050] In the example as shown in FIG. 5, the UE is initially connected to macro eNB1 and small eNB1. If macro eNB1 figures out that the RSRP of small eNB2 is higher than that of small eNB1 based on the received measurement report, it will hand over the UE to macro eNB2, which is

configured to forward downlink data from core network to small eNB2. After the UE is handed over to macro eNB2, macro eNB2 will instruct the UE to establish connection to small eNB2 via RRC signaling.

[0051] A second example of a potential network scenario involving Coordinated Multi-Point (CoMP) transmission is shown in FIG. 7. It is assumed that the UE is capable of receiving data jointly from two serving cells, and that neighboring small cells have direct links to the core network to obtain UE downlink data from. Joint transmission is chosen as a non-limiting example, with other forms of CoMP transmission such as Dynamic Point Selection also being applicable. FIG. 8 is a diagram illustrating an example of the handover procedure for throughput improvement involving CoMP transmission as follows.

[0052] 1. A UE sends measurement reports including the Reference Signal Received Power (RSRP) from its serving eNBs and neighboring eNBs, and multiple CSI (Channel State Information) processes may be configured to enable CoMP-specific measurement reports. The neighboring eNBs include all macro eNBs and small cell eNBs in the neighborhood.

[0053] 2. The serving macro eNB makes handover decision based on the measurement reports from the UE as follows. If the data rate achievable with joint transmission from neighboring small cell eNBs exceeds the current throughput of the serving small cell eNB by at least a pre-determined threshold α , the serving macro eNB designates one of the neighbor small cell eNBs of the potential CoMP set as new serving small cell eNB and hands over the UE to the target macro eNB (associated with the new

serving small cell eNBs), which acts as the new mobility anchor. The serving macro eNB sends a HO preparation request to the target macro eNB.

[0054] 3. The target macro eNB replies with a HO preparation request Acknowledgement (ACK).

[0055] 4. The source macro eNB sends a HO command to the UE and starts data forwarding to the target macro eNB.

[0056] 5. The UE performs cell acquisition by sending a random access request to the target macro eNB.

[0057] 6. The target macro eNB confirms the establishment of the connection by sending Uplink Grant (UG) and Timing Advance (TA).

[0058] 7. The UE sends the HO confirmation to the target macro eNB.

[0059] 8. The UE sends the measurement reports including the Reference Signal Received Power (RSRP) from its serving eNBs and neighboring eNBs.

[0060] 9. The target macro eNB informs the UE of the new serving small cell via RRC signaling based on the received measurement reports, such that the UE can establish the connection to the small cells.

[0061] The proposed handover procedure can ensure that a dual-connectivity UE can always transition to a transmission mode which has the highest throughput.

[0062] Proposed Solution to Improve Control Signaling Reliability

[0063] Consider the same small cell dense deployment scenario as shown in FIG. 5. FIG. 9 is a diagram illustrating an example of the handover procedure to improve control signaling reliability as follows. The basic idea of

the proposed solution is to always choose the eNB with the highest RSRP as the mobility anchor, regardless of whether it is a macro eNB or small cell eNB.

[0064] 1. A UE sends measurement reports to its serving eNB that serves as the mobility anchor.

[0065] 2. The serving eNB (the source eNB) chooses the mobility anchor based on the received measurement report. For example, it chooses the target eNB with the highest RSRP as the mobility anchor. It sends a Handover (HO) preparation request to the target eNB.

[0066] 3. The target eNB replies with a HO preparation request Acknowledgement (ACK).

[0067] 4. The source eNB sends a HO command to the UE and starts data forwarding to the target eNB.

[0068] 5. The UE performs cell acquisition by sending a random access request to the target eNB.

[0069] 6. The target eNB confirms the establishment of the connection by sending Uplink Grant (UG) and Timing Advance (TA).

[0070] 7. The UE sends the HO confirmation to the target eNB to complete the whole handover process.

[0071] FIG. 10 shows an example of small cell dense deployment illustrating the proposed handover procedure to improve control signaling reliability. In this example, a UE is moving from macro eNB1 towards macro eNB2. Macro eNB1, small eNB2, and macro eNB2 will be chosen as the mobility anchor in steps 1-3, respectively, based on the instantaneous RSRP values of those three cells, as the UE moves from macro eNB1 towards small eNB2 and then towards macro eNB2.

[0072] Of course, the communications system shown in FIGS. 5 and 7 and the functional block diagram illustrated in FIG. 3 are purely exemplary of systems in which the present invention may be implemented, and the invention is not limited to a particular hardware or software configuration. The computers and storage systems implementing the invention can also have known I/O devices (e.g., CD and DVD drives, floppy disk drives, hard drives, etc.) which can store and read the modules, programs and data structures used to implement the above-described invention. These modules, programs and data structures can be encoded on such computer-readable media. For example, the data structures of the invention can be stored on computer-readable media independently of one or more computer-readable media on which reside the programs used in the invention. The components of the system can be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include local area networks, wide area networks, e.g., the Internet, wireless networks, storage area networks, and the like.

[0073] In the description, numerous details are set forth for purposes of explanation in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that not all of these specific details are required in order to practice the present invention. It is also noted that the invention may be described as a process, which is usually depicted as a flowchart, a flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged.

[0074] As is known in the art, the operations described above can be performed by hardware, software, or some combination of software and hardware. Various aspects of embodiments of the invention may be implemented using circuits and logic devices (hardware), while other aspects may be implemented using instructions stored on a machine-readable medium (software), which if executed by a processor, would cause the processor to perform a method to carry out embodiments of the invention. Furthermore, some embodiments of the invention may be performed solely in hardware, whereas other embodiments may be performed solely in software. Moreover, the various functions described can be performed in a single unit, or can be spread across a number of components in any number of ways. When performed by software, the methods may be executed by a processor, such as a general purpose computer, based on instructions stored on a computer-readable medium. If desired, the instructions can be stored on the medium in a compressed and/or encrypted format.

[0075] From the foregoing, it will be apparent that the invention provides methods, apparatuses and programs stored on computer readable media for mobility management for small cell deployment in LTE systems. Additionally, while specific embodiments have been illustrated and described in this specification, those of ordinary skill in the art appreciate that any arrangement that is calculated to achieve the same purpose may be substituted for the specific embodiments disclosed. This disclosure is intended to cover any and all adaptations or variations of the present invention, and it is to be understood that the terms used in the following claims should not be construed to limit the invention to the specific

embodiments disclosed in the specification. Rather, the scope of the invention is to be determined entirely by the following claims, which are to be construed in accordance with the established doctrines of claim interpretation, along with the full range of equivalents to which such claims are entitled.

WHAT IS CLAIMED IS:

1. A cell in a communications system which includes a plurality of cells having one or more macro cells and one or more small cells, a user equipment (UE), and a network through which the cells and the UE communicate with each other, the cell comprising a memory and a controller, the cell being a source cell that serves as a mobility anchor of the UE to handle all control signaling for the UE and receiving a measurement report from the UE, the controller of the source cell being operable to:
 - choose, based on the measurement report, a target cell from the plurality of cells as a new mobility anchor of the UE;
 - send a handover preparation request to the target cell;
 - receive a handover preparation request acknowledgement from the target cell; and
 - send a handover preparation command to the UE and start data forwarding to the target cell.
2. The cell according to claim 1,
 - wherein the controller is operable to choose, based on the measurement report, the target cell having a highest Reference Signal Received Power (RSRP) to the UE among the plurality of cells.
3. The cell according to claim 1,
 - wherein at least one of the source cell and the target cell is a small cell.

4. The cell according to claim 3,
wherein both the source cell and the target cell are small cells.

5. A communications system comprising:
a plurality of cells including one or more macro cells and one or more small cells;
a user equipment (UE); and
a network through which the plurality of cells and the UE communicate with each other;
wherein one of the plurality of cells is a source cell that serves as a mobility anchor of the UE to handle all control signaling for the UE and receives a measurement report from the UE, the source cell including a memory and a controller, the controller of the source cell being operable to:
choose, based on the measurement report, a target cell from the plurality of cells as a new mobility anchor of the UE;
send a handover preparation request to the target cell;
receive a handover preparation request acknowledgement from the target cell; and
send a handover preparation command to the UE and start data forwarding to the target cell.

6. The communications system according to claim 5,
wherein the UE has a UE memory and a UE controller which is operable to perform cell acquisition by sending a random access request to the target cell.

7. The communications system according to claim 6,
wherein the target cell has a memory and a controller which is operable to confirm establishment of a connection with the UE by sending an Uplink Grant (UG) and a Timing Advance (TA).

8. The communications system according to claim 7,
wherein the UE controller is operable to send a handover confirmation to the target cell.

9. The communications system according to claim 5,
wherein the controller of the source cell is operable to choose, based on the measurement report, the target cell having a highest Reference Signal Received Power (RSRP) to the UE among the plurality of cells.

10. The communications system according to claim 5,
wherein at least one of the source cell and the target cell is a small cell.

11. A computer program for mobility management in a communications system which has a plurality of cells including one or more macro cells and one or more small cells, a user equipment (UE), and a network through which the plurality of cells and the UE communicate with each other, wherein one of the plurality of cells is a source cell that serves as a mobility anchor of the UE to handle all control signaling for the UE and receives a measurement report

from the UE, the source cell including a memory and a controller, the computer program comprising:

code for choosing by the source cell, based on the measurement report, a target cell from the plurality of cells as a new mobility anchor of the UE;

code for sending by the source cell a handover preparation request to the target cell;

code for receiving by the source cell a handover preparation request acknowledgement from the target cell; and

code for sending by the source cell a handover preparation command to the UE and start data forwarding to the target cell.

12. The computer program according to claim 11, further comprising:
code for performing cell acquisition by sending a random access request from the UE to the target cell.

13. The computer program according to claim 12, further comprising:
code for confirming by the target cell establishment of a connection with the UE by sending an Uplink Grant (UG) and a Timing Advance (TA).

14. The computer program according to claim 13, further comprising:
code for sending by the UE a handover confirmation to the target cell.

15. The computer program according to claim 11, wherein the code for choosing the target cell comprises:

code for choosing by the source cell, based on the measurement report, the target cell having a highest Reference Signal Received Power (RSRP) to the UE among the plurality of cells.

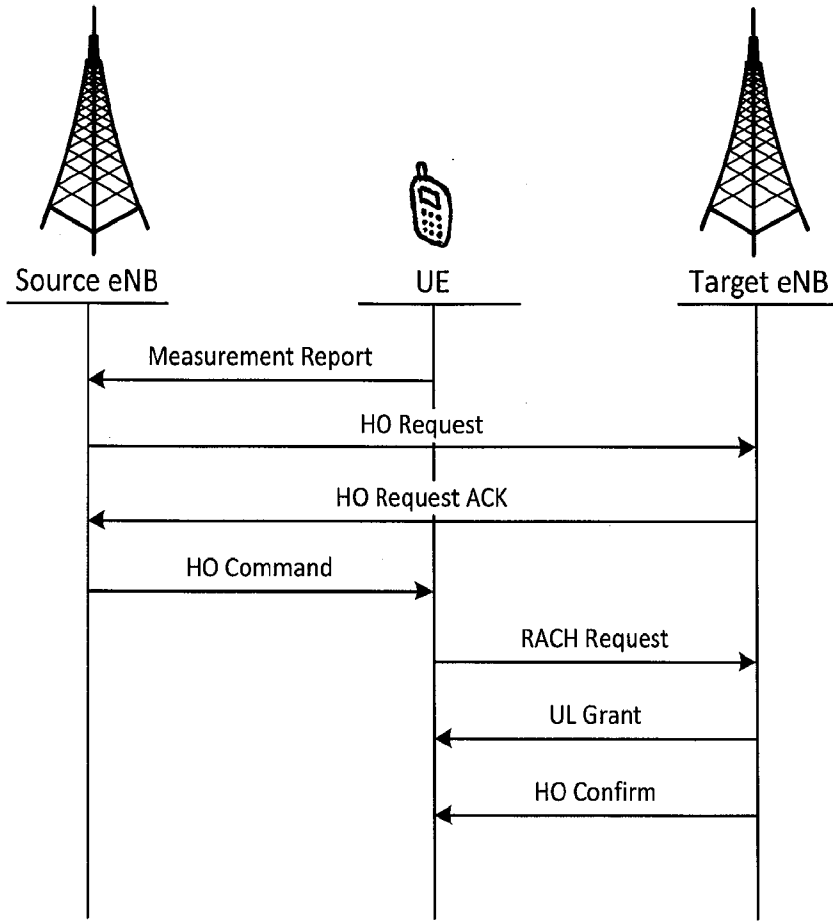


FIG. 1 (PRIOR ART)

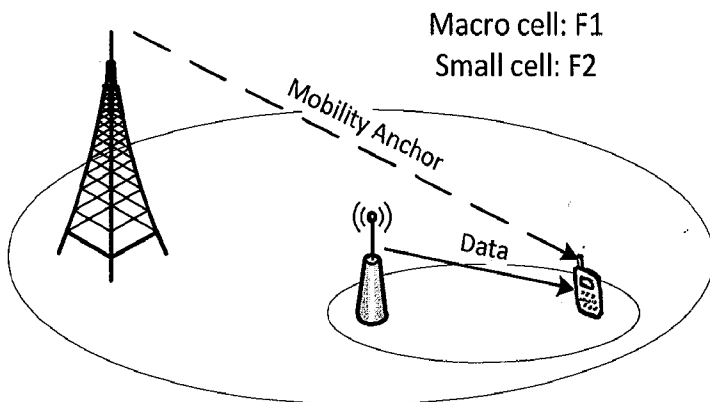


FIG. 2 (PRIOR ART)

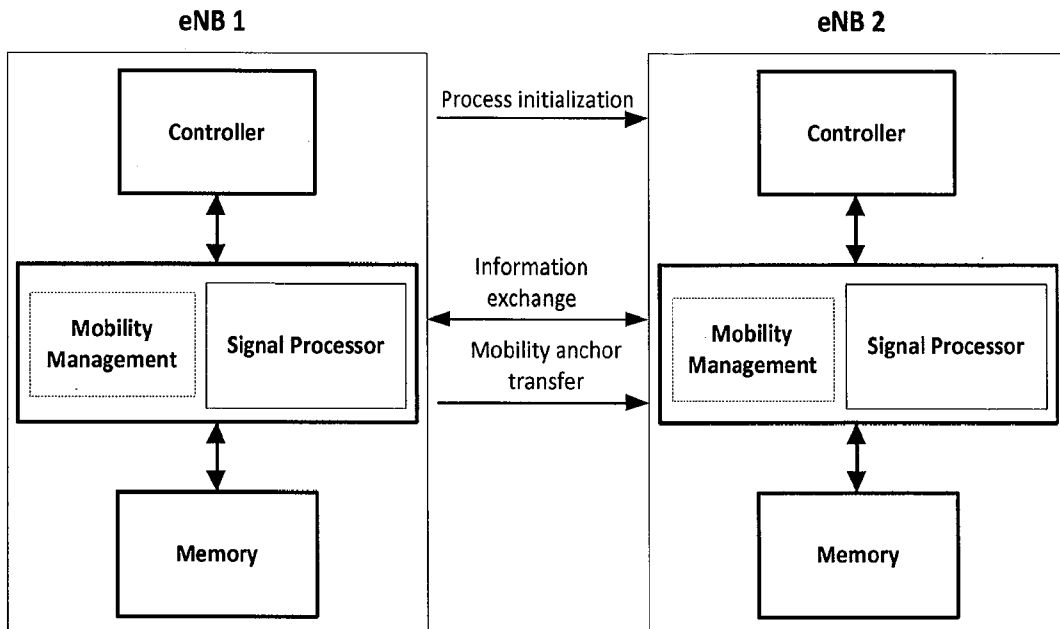


FIG. 3

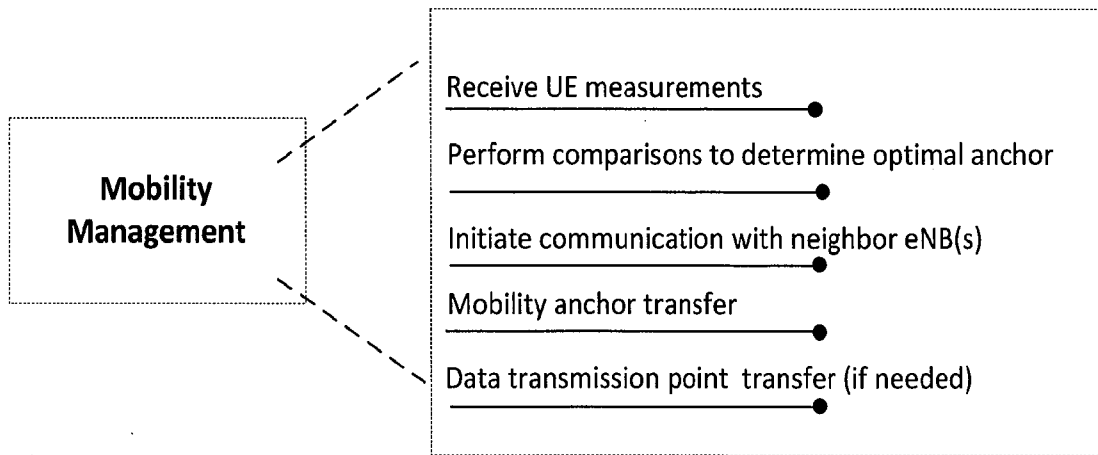


FIG. 4

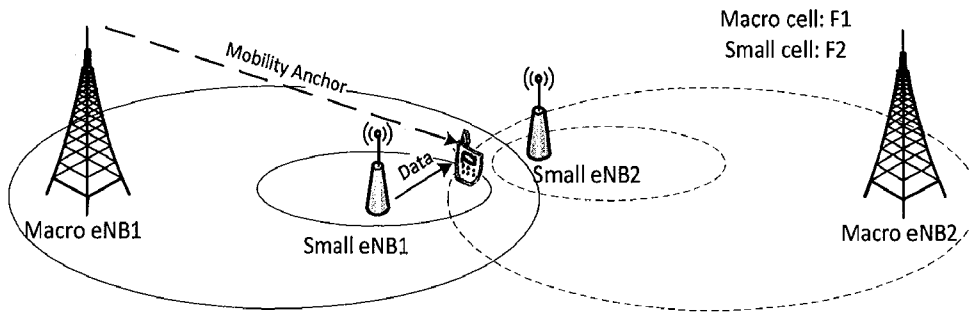


FIG. 5

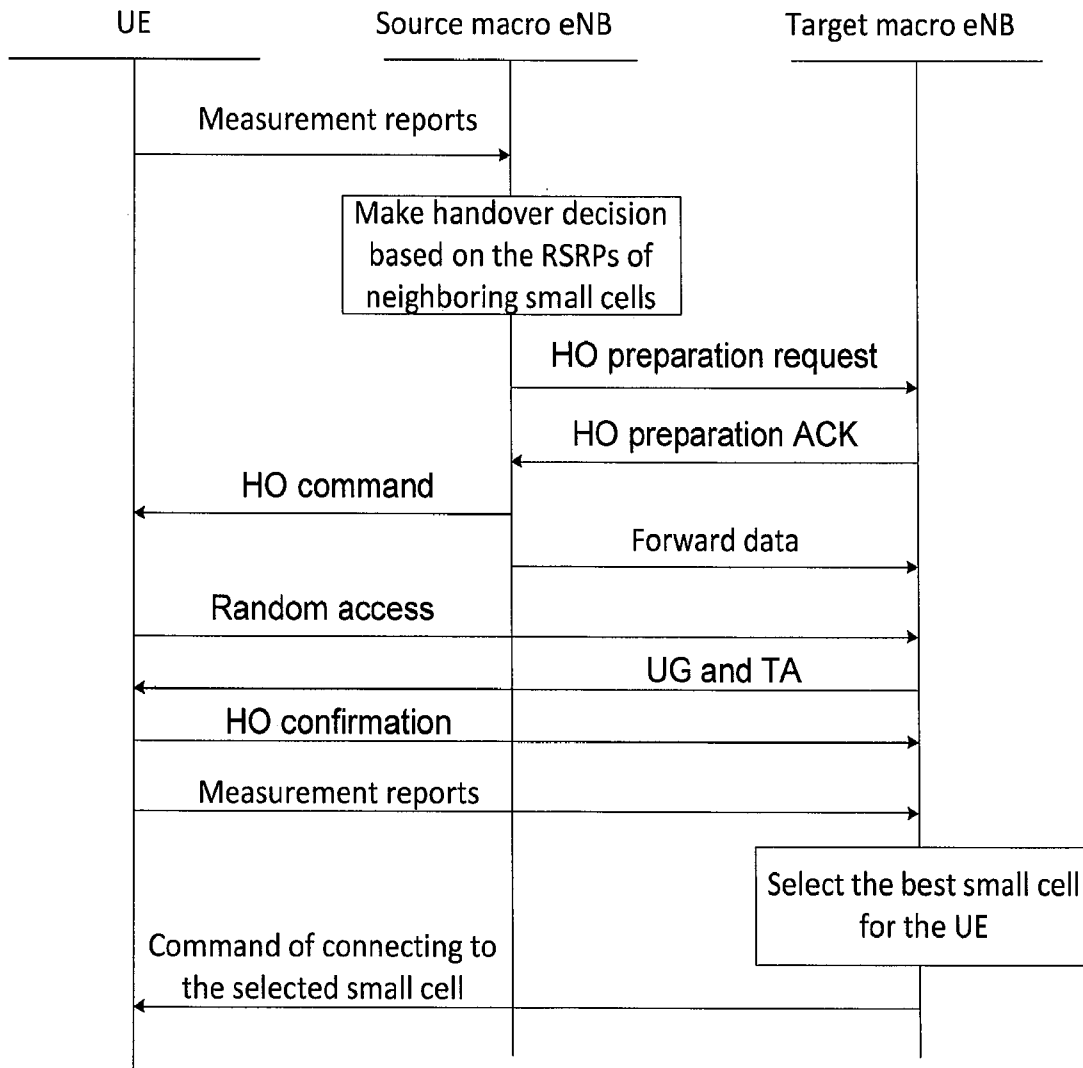


FIG. 6

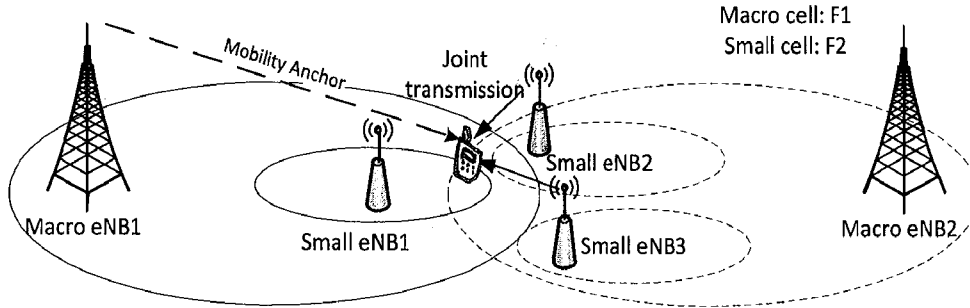


FIG. 7

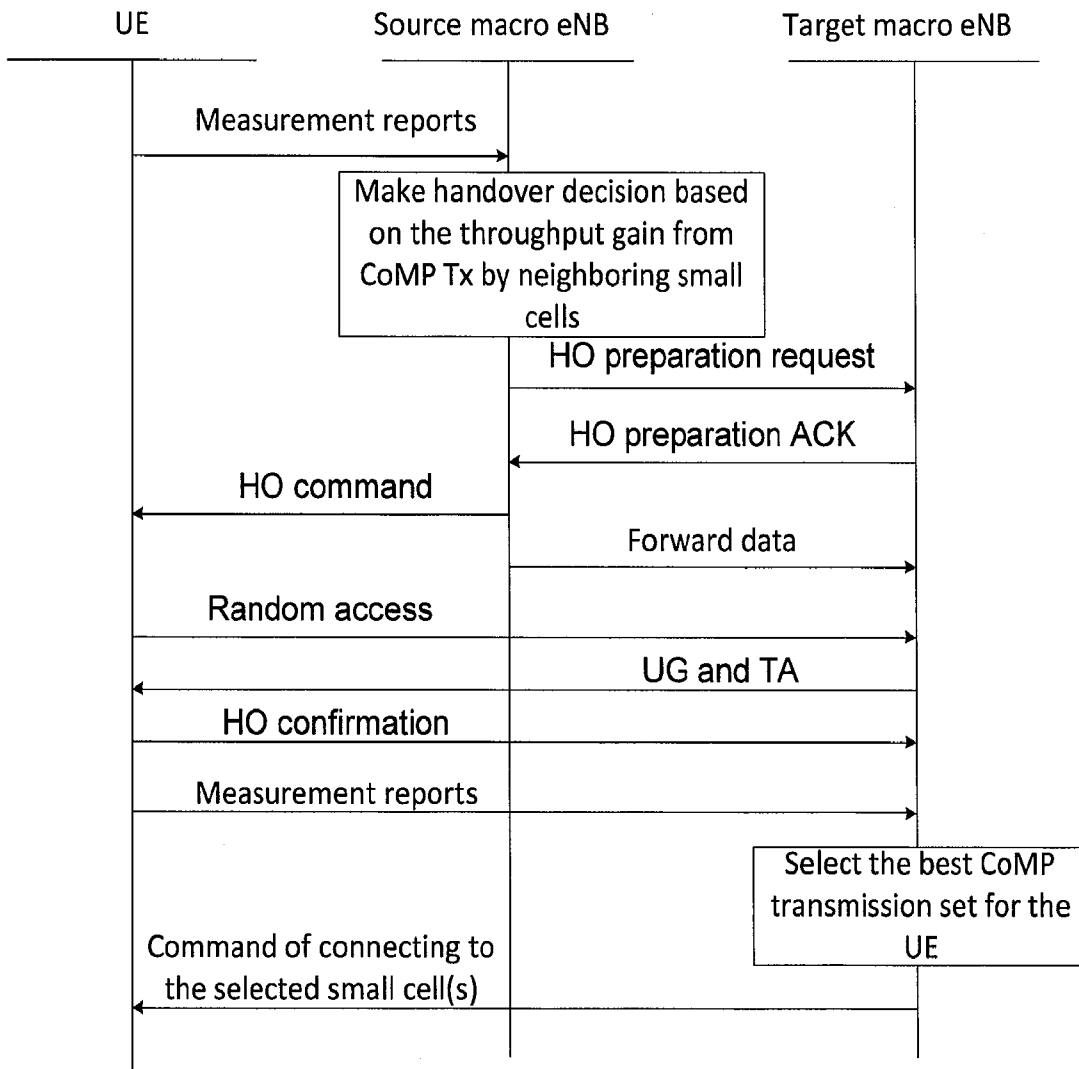


FIG. 8

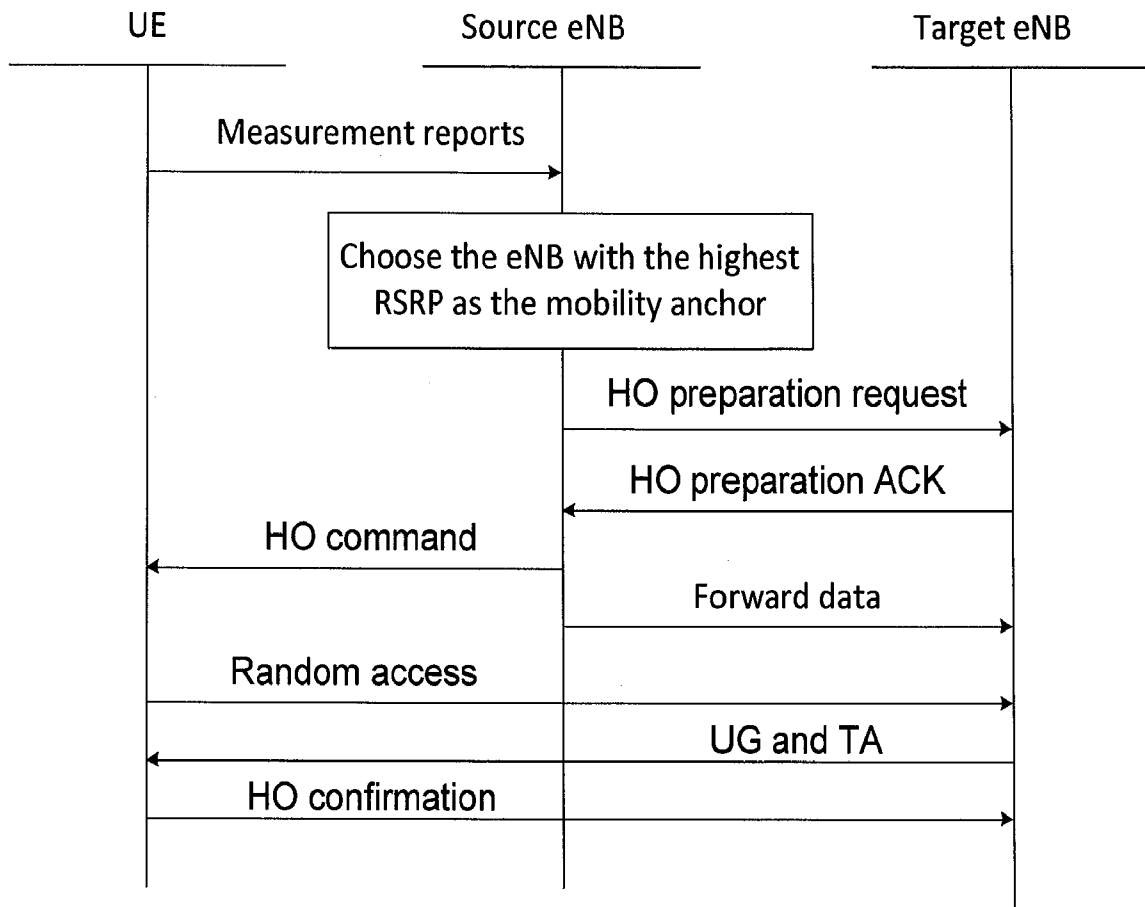
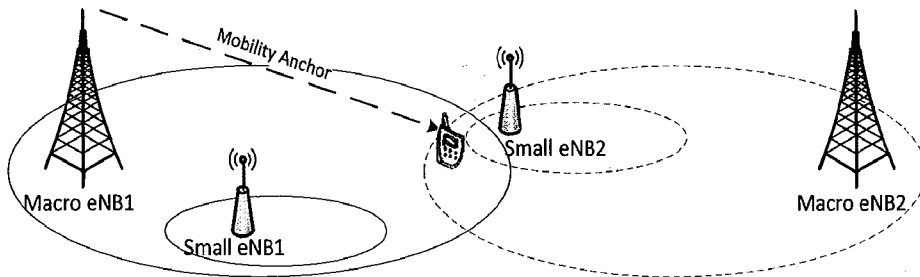
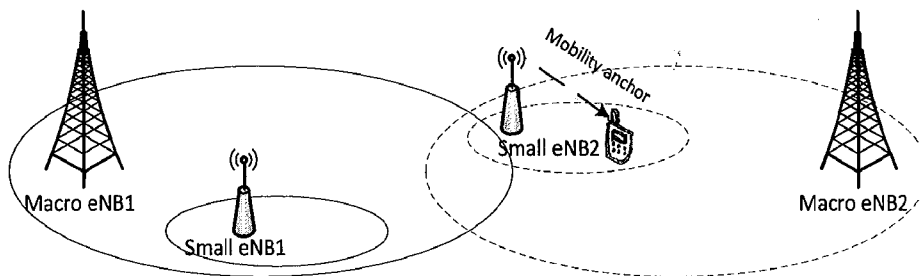


FIG. 9

Step-1



Step-2



Step-3

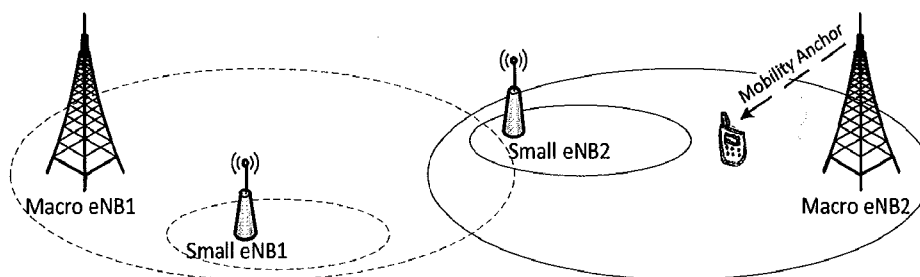


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US13/67402

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - H04W 74/08 (2014.01)
 USPC - 455/507
 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)
 IPC(8) - H04W 74/08; H04W 56/00; H04W 74/00; H04B 7/24; H04W 36/16; H04W 36/30 (2014.01)
 USPC - 455/507; 455/434; 455/436; 455/438

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)
 MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); GooglePatents; IEEE; Proquest
 Keywords: LTE; handover; RSRP; mobility anchor, measurement report

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2012/106798 A1 (EARNSHAW, A et al.) 16 August 2012; Abstract; Figure 1; page 4, lines 23-28; page 5, lines 14-15; page 9, lines 17-18.	1, 3-8 and 10-14
Y		2, 9 and 15
Y	US 2011/0207485 A1 (DIMOU, K et al.) 25 August 2011; Abstract; paragraphs [0033], [0036], [100], [128].	2, 9 and 15
A	US 2012/0129522 A1 (KIM, S et al.) 24 May 2012; whole document.	1-15

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

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“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 8 January 2014 (8.1.2014)	Date of mailing of the international search report 22 JAN 2014
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