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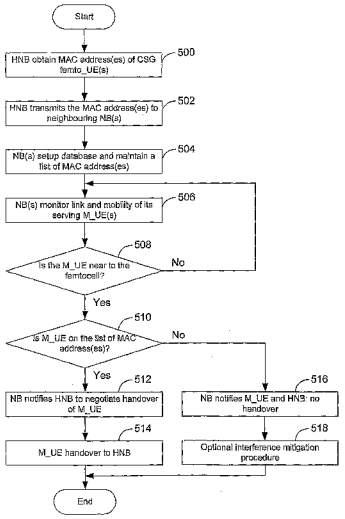
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(54) **Title**: WIRELESS COMMUNICATION METHOD AND APPARATUS

FIGURE 5



(57) **Abstract**: The invention relates to a method of managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the method comprising obtaining, at the base station, identity information of said at least one further wireless device associated with said base station, providing said obtained identity information to said further base station, verifying identity of said wireless device with said provided identity information at said further base station, in an event that said wireless device is in the vicinity of said base station, performing a handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information, wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

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WIRELESS COMMUNICATION METHOD AND APPARATUS

Field of the Invention

The present invention relates to wireless communication. It is particularly, but not exclusively, concerned with managing a handover of a wireless device between a base station and a further base station.

Background of the Invention

Over the last decade mobile communication has become increasingly in demand, particularly due to the growth of multimedia communication services, such as video streaming, video conferencing, packet data transfer and so on. As a result, mobile phones have also become indispensable in everyday life.

It is hence desirable for mobile operators to improve coverage and provide high data rate services in a cost effective manner. In order to ensure that a mobile communication network can service a large geographical area, it is often necessary in practice to locate base stations in every necessary location in order to provide a perfect coverage.

Many wireless communication networks are constructed based on a "cellular" topology, whereby each user terminal or device is assigned to communicate with a subset (typically one) of one or more base stations. The geographical area that is covered by a given base station's transmission is known as a "cell".

Some examples of such cellular systems include second-generation GSM (Global System for Mobile Communications) networks and third generation (3G) UMTS (Universal Mobile Telecommunications System) networks, all of which support wireless transmission of voice and data information.

A macrocell is a cell in a mobile communication network that provides radio coverage served by a power cellular base station tower. In mobile communications system, the term macrocell is used to describe the widest range of cell sizes. Generally, macrocells provide large area coverage, and are found in rural areas or along motorways. The antennas for macrocells are mounted on ground-based masts, rooftops, and existing structures, at a height that provides a clear view over the

surrounding buildings and terrain. Macrocell base stations have power outputs of typically tens of watts.

For a smaller cell area, a microcell is used to describe a cell intended for covering a densely populated urban area. Picocells are employed in areas even smaller than microcells, such as a large office, a shopping mall, or a transport hub. Currently the smallest area of coverage can be implemented with a femtocell in homes or small offices.

A femtocell is a small low power base station designed for use in small coverage areas such as residential or small business environments. In contrast with a macrocell base station, a femtocell base station usually has an output power less than 0.1 watt. A femtocell base station is typically installed by a subscriber in a house or small office/home office (SOHO) to provide access to a closed or opened group of users as configured by the subscriber and/or the access provider.

An overview of a femtocell architecture 12 is shown in figure 1. Femtocell base stations, also known as femtocell access points (or Home Node B – HNB), typically operate in licence spectrum and may be deployed either in the same or different frequency as the macrocell base stations. The femtocell base stations coverage may also overlap the macrocell base stations.

As shown in figure 1 the femtocell 16 is typically deployed on top of the existing macrocell network 14 to improve coverage in limited locations, such as indoor environments. Therefore a femtocell base station (or access point base station) 20 is usually installed at locations where users are experiencing unsatisfactory radio coverage. The femtocell base station 20 is connected to a service provider network via broadband DSL (digital subscriber line) or other IP connection 22 which is in turn connected to a femtocell controller/gateway 24 in order to interface with a GSM or UMTS core packet switched and circuit switched network 10.

The macrocell base station 18 is connected to a radio network controller (RNC) 36 which is responsible for control of the base stations that are connected to it. As known in the art, the responsibilities of the RNC further include radio resource management (RRM) and handoff between BSs. The RNC 36 is in turn connected to a serving GPRS support mode (SGSN) 28 which is connected to a network operator IP network 26. The femtocell gateway 24 is also connected to the operator IP network 26, as shown in

figure 1. The RNC 36 is further connected to a mobile switching centre (MSC) 34 to then be connected to the public switch telephone network (PSTN) 32.

A femtocell BS may belong to one of the following two subscriber types:

- CSG (Closed Subscriber Group) – mobile stations that are not members of the CSG femtocell BSs are not allowed access to CSG BSs. A good candidate identity for the CSG is the unique MAC (medium access control) address of the mobile station. The membership of the CSG can be modified by the service level agreement between the subscriber and access provider. An example of a CSG femtocell BS is in a home or enterprise environment.

- OSG (Open Subscriber Group) – OSG femtocell BSs are open to public access. One example of a publicly accessible femtocell BS is in a coffee shop or an airport lounge.

Throughout the description, the following terms will be used interchangeably:

"Femtocell base station (BS)" may be used interchangeably with "Home Node B (HNB)", "access point base station", or "femtocell access point".

"Macrocell base station (BS)" may be used interchangeably with "Node B (NB)". According to the 3GPP standard definition, a NB is "a logical node responsible for radio transmission or reception in one or more cells to/from the User Equipment".

"Mobile station (MS)" may be used interchangeably with "User Equipment (UE)".

As mentioned above, femtocells are typically deployed on top of macrocells, and they may operate on the same RF channel frequency. Inevitably, co-channel interference may occur. In particular, a CSG femtocell BS can only be accessed by a predefined set of MSs, usually consisting of the subscriber's own MSs. Unauthorised users will not be allowed to handover to a femtocell even if the received signal strength of the femtocell becomes much larger than that of the serving macrocell BS. This can lead to a number of problems as described in the following paragraphs.

When a "passing MS" moves into the coverage range of a CSG femtocell, it will start a handover negotiation process in an attempt to handover to the femtocell. The terms

"M_UE(s)" or "passing MS(s)" are used interchangeably herein to describe a mobile station that is supported by a serving macrocell BS, and it may (or may not) be a member of a CSG femtocell.

The handover requests made by the M_UE (or passing MS) will be rejected by the femtocell BS, if it is identified by the femtocell BS that the M_UE is not a member of the CSG femtocell. Such frequent futile camping/handover attempts made by passing MSs can result in a highly increased network signalling load which has an impact on end user mobility performance, for example, leading to dropped calls. Furthermore, as the M_UE is not handover to the femtocell, the M_UE served by the macrocell BS will cause interference.

A severe interference problem can occur when a MS not belonging to the CSG operates in the vicinity of the femtocell BS. As the MS is not allowed to handover to the femtocell BS, it has to be served by a more distant macrocell BS. As a result, the MS could cause large interference towards the femtocell BS in the uplink (UL) and receive large interference from the femtocell BS in the downlink (DL).

This interference problem is illustrated in figure 2 for the DL case, where the signal 18a received by M_UE 50b from the macrocell NB 18 has low power due to the high path loss. In the meantime, M_UE 50b will also experience high interference 20a from the CSG femtocell HNB 20 if both HNB 20 and NB 18 use non-orthogonal radio resources to serve femto_UE 50a and M_UE 50b respectively. As shown in figure 2, there will also be potential interference 18b at the femto_UE 50a from the NB 18. In this example, the term "femto_UE" is used herein to refer to a UE that is a member of the CSG femtocell.

Similarly, in the UL case as shown in figure 3, M_UE 50b is likely to transmit at high power due to the high path loss to the macrocell NB 18. As a result, the CSG femtocell HNB 20 will experience high interference 20c from M_UE 50b, if both M_UE 50b and femto_UE 50a are assigned non-orthogonal radio resources. Again, there will also be potential interference 18d at the NB 18 from the femto_UE 50a.

According to 3GPP TR 25.820 V1.0.0, 2007:

> *"interference due to the HNB (home node B) is a concern and this report concludes that interference mitigation techniques are required in the case of*

closed access. No single method has been identified that completely eliminates interference while maintaining HNB performance for closed access. It is not the intention to recommend a set of specification or an algorithm that ensures feasibility of the HNB. Rather, it may be feasible to evaluate the effectiveness of interference control with an acceptable trade off between macro layer and HNB performance over a set of deployment configurations."

It has been envisaged that a majority of femtocells deployed will be CSG based. Therefore, it is important to address the problems identified in the preceding paragraphs.

Summary of the Invention

In a first aspect of the invention there is provided a method of managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the method comprising

obtaining, at the base station, identity information of said at least one further wireless device associated with said base station;

providing said obtained identity information to said further base station;

verifying identity of said wireless device with said provided identity information at said further base station, in an event that said wireless device is in the vicinity of said base station;

performing a handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information;

wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

Provision of the identity of said at least on further wireless device to said further base station avoids handover attempts to be made by passing MSs, thereby reduces the network signalling load.

In an embodiment of the above aspect, the method further comprises the step of providing a notification to said base station and/or said wireless device if said verified identity of said wireless device is not included in said provided identity information.

By providing a notification to said base station and/or wireless device allows said base station and/or wireless device to maintain a record of said provided identity information, thereby avoiding any future futile handover negotiation between the passing MSs and said base station.

In a second aspect of the invention there is provided a method of managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the method being performed at said base station, and the method comprising

obtaining identity information of said at least one further wireless device associated with said base station;

providing said obtained identity information to said further base station to allow said further base station to verify identity of said wireless device with said obtained identity information in an event that said wireless device is in the vicinity of said base station;

receiving a request to perform handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information;

wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

In an embodiment of the above aspect, the method further comprises the step of receiving a notification from said further base station if said verified identity of said wireless device is not included in said provided identity information.

In a third aspect of the invention there is provided a method of managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the method being performed at said further base station, and the method comprising

receiving identity information of said at least one further wireless device associated with said base station;

verifying identity of said wireless device with said received identity information, in an event that said wireless device is in the vicinity of said base station;

sending a request to said base station to perform a handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information;

wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

In an embodiment of the above aspect, the method further comprises the step of sending a notification to said wireless network and/or wireless device if said verified identity of said wireless device is not included in said provided identity information.

The notification may include information relating to handover procedure being not required to be performed.

The identity information of said at least one further wireless device may include a MAC address of said at least one further wireless device.

The identity of said wireless device may include a MAC address of said wireless device.

In an embodiment of the above aspects, the method further comprises the step of performing interference mitigation if said verified identity of said wireless device is not included in said provided identity information.

By performing interference mitigation upon verifying that the identity of said wireless device is not included in said provided identity information allows a proactive management of interference, which ensures improved QoS with seamless connectivity.

The step of performing interference mitigation includes obtaining signal strength information.

In an uplink operation, the step of obtaining signal strength information may be carried out at said wireless device to obtain signal strength information of said base station.

In a downlink operation, the step of obtaining signal strength information may be carried out at said base station to obtain signal strength information of said wireless device.

In one embodiment of the above aspect, the method comprises performing an interference mitigation procedure if said obtained signal strength information is above a predetermined threshold.

In a fourth aspect of the invention there is provided a method of managing interference in a network comprising a plurality of communication devices including a femtocell base station being accessible to at least one further wireless device associated therewith, and a macrocell base station being in communication with a wireless device, the method comprising performing an interference mitigation procedure to avoid interference between said plurality of communication devices, wherein said interference mitigation procedure includes determining the capability of said plurality of communication devices.

The interference mitigation procedure further includes determining whether said femtocell base station is operable to perform a MU-MIMO operation for said wireless device and said at least one further wireless device.

In one embodiment of the invention, the method includes performing said MU-MIMO operation at the femtocell base station if said femtocell base station is operable to perform MU-MIMO operation for said wireless device and said at least one further wireless device.

The method further includes determining whether said further wireless device is operable to cancel interference from said macrocell base station.

In one embodiment of the invention, the method includes the step of requesting said macrocell base station to perform interference mitigation procedure if said further wireless device is not operable to cancel interference from said macrocell base station.

The interference mitigation procedure further includes determining whether said femtocell base station is operable to mitigate interference by means of beam forming, if said femtocell base station is not operable to perform MU-MIMO operation for said wireless device and said at least one further wireless device.

The interference mitigation procedure further includes determining whether the wireless device is operable to cancel interference, if said femtocell base station is operable to mitigate interference by means of beam forming.

The femtocell base station may be operable to reduce transmit power, if said wireless device is not operable to cancel interference.

The interference mitigation procedure further includes determining whether there is any available radio resources at said femtocell base station, if said femtocell base station is not operable to mitigate interference by means of beam forming.

In one embodiment of the invention, the method includes blocking the wireless device from said available radio resources, if it is determined that there are available radio resources.

In a fifth aspect of the invention there is provided a method of managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station and not being associated with said base station, the method comprising

obtaining information of said wireless device in an event that said wireless device is in the vicinity of said base station, wherein said information include interference level of said wireless device;

performing a handover of said wireless device from said further base station to said base station if said interference level of said wireless device is above a predetermined threshold level, said performing a handover includes the step of making a handover request from said base station to said further base station.

Allowing a handover of said wireless device to said base station removes any potential interference between the wireless device the base station.

The interference level may be determined based on information of said wireless device including signal strength, PHY parameters, and QoS requirements.

The base station may be a femtocell base station.

The femtocell base station may operate in a closed subscriber group mode.

The further base station may be a macrocell base station.

In a sixth aspect of the invention there is provided an apparatus for managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the apparatus being employed at said base station, and the apparatus comprising

means for obtaining identity information of said at least one further wireless device associated with said base station;

means for providing said obtained identity information to said further base station to allow said further base station to verify identity of said wireless device with said obtained identity information in an event that said wireless device is in the vicinity of said base station;

receiving means for receiving a request to perform handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information;

wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

In an embodiment of the above aspect, the receiving means is further operable to receive a notification from said further base station if said verified identity of said wireless device is not included in said provided identity information.

In a seventh aspect of the invention there is provided an apparatus of managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the apparatus being employed at said further base station, and the apparatus comprising

receiving means for receiving identity information of said at least one further wireless device associated with said base station;

means for verifying identity of said wireless device with said received identity information, in an event that said wireless device is in the vicinity of said base station;

transmitting means for transmitting a request to said base station to perform a handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information;

wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

In an embodiment of the above aspect, the transmitting means is further operable to transmit a notification to said wireless network and/or wireless device if said verified identity of said wireless device is not included in said provided identity information.

The notification may include information relating to handover procedure being not required to be performed.

The identity information of said at least one further wireless device may include a MAC address of said at least one further wireless device.

The identity of said wireless device may include a MAC address of said wireless device.

In an embodiment of the above aspects, the apparatus further comprises interference mitigation means for performing interference mitigation if said verified identity of said wireless device is not included in said provided identity information.

By performing interference mitigation upon verifying that the identity of said wireless device is not included in said provided identity information allows a proactive management of interference, which ensures improved QoS with seamless connectivity.

The interference mitigation means may be operable to obtain signal strength information.

In one embodiment of the above aspect, the interference mitigation means is operable to determine if said obtained signal strength information is above a predetermined threshold.

An aspect of the invention provides a computer program product comprising computer executable instructions which, when executed by a computer, cause the computer to perform a method as set out above. The computer program product may be embodied in a carrier medium, which may be a storage medium or a signal medium. A storage medium may include optical storage means, or magnetic storage means, or electronic storage means.

The above aspects of the invention can be incorporated into a specific hardware device, a general purpose device configure by suitable software, or a combination of both. The invention can be embodied in a software product, either as a complete software implementation of the invention, or as an add-on component for modification or enhancement of existing software (such as, as a plug in). Such a software product could be embodied in a carrier medium, such as a storage medium (e.g. an optical disk or a mass storage memory such as a FLASH memory) or a signal medium (such as a download). Specific hardware devices suitable for the embodiment of the invention could include an application specific device such as an ASIC, an FPGA or a DSP, or other dedicated functional hardware means. The reader will understand that none of the foregoing discussion of embodiment of the invention in software or hardware limits future implementation of the invention on yet to be discovered or defined means of execution.

Description of the drawings

Embodiments of the invention will now be described with reference to the accompanying drawings, wherein:

Figure 1 illustrates a conventional UMTS architecture and the basic elements of a femtocell architecture according to described prior art;

Figure 2 illustrates a typical femtocell downlink interference scenario according to described prior art;

Figure 3 illustrates a typical femtocell uplink interference scenario according to described prior art;

Figure 4 illustrates an exemplary wireless communications device incorporating described embodiments of the invention;

Figure 5 illustrates a flow diagram of a handover method according to an embodiment of the invention;

Figure 6 illustrates an exemplary database for maintaining MAC addresses of wireless communications devices;

Figure 7 illustrates a flow diagram of an interference mitigation method according to described embodiments of the invention;

Figure 8 illustrates a flow diagram of a handover method according to an embodiment of the invention; and

Figure 9 illustrates stages of a method of handover illustrated in figure 8 according to the embodiment of the invention.

Detailed description

Specific embodiments of the present invention will be described in further detail on the basis of the attached diagrams. It will be appreciated that this is by way of example only, and should not be viewed as presenting any limitation on the scope of protection sought.

In the described embodiment, certain assumptions are established:

- The HNB and the NB are well synchronised to minimise the interference due to the mismatch of uplink and downlink.
- The incoming MS into the femtocell coverage area can still communicate with the NB, that is the network can still provide the MS with the service required by the MS.
- The transmission on NB and transmission on HNB employ the same spectrum at the same time.
- The HNB has multiple antennas.

The present invention will now be described with reference to an implementation of a wireless communication device. Figure 4 illustrates schematically hardware operably configured (by means of software or application specific hardware components) as a wireless communication device 100. The reader will appreciate that the actual implementation of the wireless communication device is non-specific, in that it could be a base station or a user terminal.

The device 100 comprises a processor 120 operable to execute machine code instructions stored in a working memory 124 and/or retrievable from a mass storage device 122. By means of a general purpose bus 130, user operable input devices 136 are capable of communication with the processor 120. The user operable input devices 136 comprise, in this example, a keyboard and a mouse though it will be appreciated that any other input devices could also or alternatively be provided, such as another type of pointing device, a writing tablet, speech recognition means, or any other means by which a user input action can be interpreted and converted into data signals.

Audio/video output hardware devices 138 are further connected to the general purpose bus 130, for the output of information to a user. Audio/video output hardware devices 138 can include a visual display unit, a speaker or any other device capable of presenting information to a user.

Communications hardware devices 132, connected to the general purpose bus 130, are connected to antennas 134. In the illustrated embodiment in Figure 4, the working memory 124 stores user applications 126 which, when executed by the processor 120, cause the establishment of a user interface to enable communication of data to and from a user. The applications in this embodiment establish general purpose or specific computer implemented utilities that might habitually be used by a user.

Communications facilities 128 in accordance with the specific embodiment are also stored in the working memory 124, for establishing a communications protocol to enable data generated in the execution of one of the applications 126 to be processed and then passed to the communications hardware devices 132 for transmission and communication with another communications device. It will be understood that the software defining the applications 126 and the communications facilities 128 may be partly stored in the working memory 124 and the mass storage device 122, for convenience. A memory manager could optionally be provided to enable this to be managed effectively, to take account of the possible different speeds of access to data stored in the working memory 124 and the mass storage device 122.

On execution by the processor 120 of processor executable instructions corresponding with the communications facilities 128, the processor 120 is operable to establish communication with another device in accordance with a recognised communications protocol.

Closed access

Consider the case when a non-CSG UE moves into the coverage area of a femtocell. The HNB of the femtocell measures the potential interference from the non-CSG UE to the HNB by monitoring the non-CSG UE to obtain all the necessary information of the UE including CQI (channel quality indicator) and transmission requests (for example: PHY (physical layer) parameters and QoS (Quality of Service) requirements, and so on). If the interference is above a predetermined threshold level, the HNB will commence interference mitigation procedures according to embodiments of the invention as will be described in due course. It will be appreciated by the person skilled in the art that the predetermined threshold level may be adaptive and set to a suitable value based on the QoS of the applications that are provided by the femtocell. For example, a lower threshold may be set for real-time applications with stringent QoS requirements.

When the non-CSG UE (or M_UE) moves into the coverage range of a CSG femtocell, it will start the handover negotiation process in an attempt to handover to the femtocell. The terms "M_UE(s)" or "passing MS(s)" are used interchangeably herein to describe a mobile station that is supported by a macrocell BS, but is not a member of a CSG femtocell (i.e a non-CSG UE).

The handover requests made by the M_UE will be rejected by the femtocell BS. Such frequent futile camping/handover attempts made by passing MSs can result in a highly increased network signalling load and has an impact on end user mobility performance, for example, leading to dropped calls. Furthermore, as the M_UE is not handover to the femtocell, the M_UE served by the macrocell BS will cause interference as described in the preceding paragraphs.

An exemplary method according to a first embodiment of the invention will be discussed with reference to the flowchart of figure 5. The method commences upon network entry (i.e. when a user/subscriber has installed the femtocell base station) with an initialisation process including a HNB obtaining the MAC (Media Access Control) address(es) (or identifier(s)) of MS(s) that are granted exclusive access to the femtocell (step 500). In this example, the MSs that have exclusive access to the femtocell are referred as "femto_UEs". It is appreciated that the number of femto_UEs served by each femtocell is between 1 to *n*, where *n* may be any number greater than 2. In addition, a passing MS is referred as "M_UE" in this example.

In step 502, the recorded list of MAC address(es) is transmitted, either wirelessly or via backhaul, to at least one neighbouring macrocell BS(s) (or NB(s)). A NB, which received the recorded list of MAC addresses, sets up and maintains a database (herein referred to as femto_database) that maps between the femto_UEs MAC addresses and the corresponding femtocell ID (step 504). The database also includes information as to whether the femocell is open access (OSG) or closed access (CSG). An example of the database is shown in figure 6. In figure 6, the database contains the MAC addresses of four femto_UE, the femtocell ID (in this example is 'FD321'), and the information on OSG/CSG. In this example the femtocell is CSG.

As known in the art, a serving NB monitors the link and mobility of its M_UE(s) – step 506. If a M_UE is in the vicinity of the HNB (step 508), the NB that is serving this M_UE will check its femto_database against the MAC address of the MS (step 510). If the MAC address of the M_UE is on the femto_database (i.e. the M_UE is a femto_UE), the NB will notify the HNB to initiate a normal handover procedure (steps 512 and 514).

If the MAC address of the M_UE is not on the femto_database, that is the M_UE does not have access to the femtocell, the NB will notify both the HNB and the M_UE, so as to avoid any potential futile handover negotiation (step 516). Subsequently, interference mitigation measures, which will be discussed in detail in the forthcoming paragraphs, may be carried out (step 518).

The interference mitigation procedure will now be described with reference to figure 7.

To address the DL interference problem discussed above with reference to figure 2, the M_UE carries out measurement of the HNB signal strength and sends this information to its serving NB (steps 700 and 702). Alternatively, the HNB can carry out measurement of the M_UE signal strength and sends this information to the NB (steps 704 and 706). These steps are carried out after the NB has notified both the M_UE and the HNB that no handover procedure is to be carried out.

If the femtocell signal strength is above a predetermined threshold, the NB will request the HNB to mitigate any potential interference, by for example reducing transmission power, and/or blocking some resource region (such as frequency partition). This process can be carried out continuously, such that when the femtocell signal strength

falls below the predetermined threshold, the interference mitigation procedure can be terminated.

In one embodiment of the invention, the HNB is provided with multiple antennas, and is configured to perform multi-user transmission (in the downlink) and/or beamforming (in the uplink).

In one example of the present embodiment, the HNB is operable to perform Multi-User Multiple Input Multiple Output (MU-MIMO) operation (steps 710 and 712). It is known in the art that MU-MIMO technologies generally allows a wireless device to transmit (or receive) signal to (or from) multiple users in the same band simultaneously. In this example, when the MU-MIMO operation is being performed, the M_UE becomes a "virtual user" to the HNB, such that the HNB will fundamentally distinguish the transmission/reception from the M_UE and the femto_UE. In this example, it is assumed the HNB has the capability of identifying all transmissions of the M_UE, or partial transmission condition of the M_UE, such as CSI. It will also be appreciated by the person skilled in the art that any suitable method of performing MU-MIMO may be employed, and therefore details of performing MU-MIMO by the HNB will not be described.

Alternatively, if the HNB is not configured to perform MU-MIMO operation, the HNB may be configured to perform beamforming to mitigate potential interference from the M_UE (step 720). Furthermore, the HNB may also cooperate with the M_UE, such that the M_UE is configured to perform beamforming to cancel interference from the HNB (step 722). Alternatively, the HNB may reduce its transmit power (step 724) in order to eliminate any potential interference to the M_UE.

In the case of potential interference between the NB and the femto_UE, the NB can likewise be configured to carry out beamforming and/or MU-MIMO as described above for the HNB. The potential interference from the NB and the femo_UE may be detected or measured in the beginning of the negotiation procedure between the NB and the HNB.

In the case, that the HNB is not capable of performing beamforming, the HNB will determined whether there are any available resources (in the frequency and/or time domain), such that the relevant resource partition of the M_UE can be blocked accordingly (steps 726 and 728).

Hybrid access

An alternative to the closed access mode is a hybrid access mode which combines the method of open access and closed access mode.

An exemplary method according to a further embodiment of the invention will be discussed with reference to the flowchart of figure 8. In this example, the femtocell HNB normally operates in a CSG mode (step 800). In an event that a M_UE moves into the coverage area of the femtocell, the HNB monitors and obtains information of the UE including signal strength, PHY parameters, and QoS requirements, and so on (steps 802 and 804). If the interference is above a predetermined threshold, the HNB will then communicate with the serving NB of the M_UE to request for handover (steps 806 and 808. In step 810, the NB will notify the M_UE that a handover has been requested to commence a handover process (step 812). In the meantime, HNB may enable a "guest access" procedure according to a predetermined set of requirements such as security policy including authentication and accountability. It is noted that any requirements may be predetermined depending on the application. The crux of this embodiment of the invention is to allow a passing M_UE to become a member of the CSG, thereby avoiding any potential interference which may occur at the HNB and the M_UE.

In contrast with conventional cellular handover procedure, the handover procedure of the invention is initiated by the target base station (in this case the HNB). As illustrated in figure 9, the HNB 902 obtains the interference information 906 of the passing M_UE 900. If the interference is above a predetermined threshold, the HNB 902 will send a handover request 908 to the serving NB 904. If the request is granted, the NB 904 subsequently sends a handover confirmation 910 to the HNB 902. In the meantime, the HB 904 also sends a handover command 912 to the M_UE 900 to start the handover procedure 918. Subsequently, the M_UE 900 will inform the HNB 902 that the handover is completed 914. According, the HNB 902 acknowledges the message by sending a conformation 916 to the M_UE 900.

While the foregoing specific description of an embodiment of the invention has been provided for the benefit of the skilled reader, it will be understood that it should not be read as mandating any restriction on the scope of the invention. The invention should

be considered as characterised by the claims appended hereto, as interpreted with reference to, but not bound by, the supporting description.

CLAIMS:

1. A method of managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the method comprising

obtaining, at the base station, identity information of said at least one further wireless device associated with said base station;

providing said obtained identity information to said further base station;

verifying identity of said wireless device with said provided identity information at said further base station, in an event that said wireless device is in the vicinity of said base station;

performing a handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information;

wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

2. A method according to claim 1 further comprising the step of providing a notification to said base station and/or said wireless device if said verified identity of said wireless device is not included in said provided identity information.

3. A method of managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the method being performed at said base station, and the method comprising

obtaining identity information of said at least one further wireless device associated with said base station;

providing said obtained identity information to said further base station to allow said further base station to verify identity of said wireless device with said obtained identity information in an event that said wireless device is in the vicinity of said base station;

receiving a request to perform handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information;

wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

4. A method according to claim 3 further comprising the step of receiving a notification from said further base station if said verified identity of said wireless device is not included in said provided identity information.

5. A method of managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the method being performed at said further base station, and the method comprising

receiving identity information of said at least one further wireless device associated with said base station;

verifying identity of said wireless device with said received identity information, in an event that said wireless device is in the vicinity of said base station;

sending a request to said base station to perform a handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information;

wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

6. A method according to claim 5 further comprising the step of sending a notification to said wireless network and/or wireless device if said verified identity of said wireless device is not included in said provided identity information.

7. A method according to any one of the preceding claims, wherein the notification includes information relating to handover procedure being not required to be performed.

8. A method according to any one of the preceding claims, wherein the identity information of said at least one further wireless device includes a MAC address of said at least one further wireless device.

9. A method according to any one of the preceding claims, wherein the identity of said wireless device includes a MAC address of said wireless device.

10. A method according to any one of the preceding claims further comprising the step of performing interference mitigation if said verified identity of said wireless device is not included in said provided identity information.

11. A method according to claim 10, wherein the step of performing interference mitigation includes obtaining signal strength information.

12. A method according to claim 11, wherein the step of obtaining signal strength information is carried out at said wireless device to obtain signal strength information of said base station during an uplink operation.

13. A method according to claim 11, wherein the step of obtaining signal strength information is carried out at said base station to obtain signal strength information of said wireless device during a downlink operation.

14. A method according to any one of claims 11 to 13 further comprises performing an interference mitigation procedure if said obtained signal strength information is above a predetermined threshold.

15. A method according to claim 14 wherein said interference mitigation procedure includes determining the capability of said plurality of communication devices.

16. A method of managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station and not being associated with said base station, the method comprising

obtaining information of said wireless device in an event that said wireless device is in the vicinity of said base station, wherein said information include interference level of said wireless device;

performing a handover of said wireless device from said further base station to said base station if said interference level of said wireless device is above a predetermined threshold level, said performing a handover includes the

step of making a handover request from said base station to said further base station.

17. A method according to claim 16, wherein the interference level is determined based on information of said wireless device including signal strength, PHY parameters, and QoS requirements.

18. A method according to any one of the preceding claims, wherein the base station include a femtocell base station.

19. A method according to any one of the preceding claims, wherein the femtocell base station is operable in a closed subscriber group mode.

20. A method according to any one of the preceding claims, wherein the further base station include a macrocell base station.

21. A method of managing interference in a network comprising a plurality of communication devices including a femtocell base station being accessible to at least one further wireless device associated therewith, and a macrocell base station being in communication with a wireless device, the method comprising performing an interference mitigation procedure to avoid interference between said plurality of communication devices, wherein said interference mitigation procedure includes determining the capability of said plurality of communication devices.

22. A method according to claim 21 wherein the interference mitigation procedure includes determining whether said femtocell base station is operable to perform a MU-MIMO operation for said wireless device and said at least one further wireless device.

23. A method according to claim 22 includes performing said MU-MIMO operation at the femtocell base station if said femtocell base station is operable to perform said MU-MIMO operation for said wireless device and said at least one further wireless device.

24. A method according to claim 22 or claim 23, wherein the interference mitigation procedure further includes determining whether said further wireless device is operable to cancel interference from said macrocell base station.

25. A method according to any one of claim 22 to 24, wherein the interference mitigation procedure further includes determining whether said base station is operable to mitigate interference by means of beam forming, if said base station is not operable to perform MU-MIMO operation for said wireless device and said at least one further wireless device.

26. A method according to claim 25, wherein the interference mitigation procedure further includes determining whether the wireless device is operable to cancel interference, if said femtocell base station is operable to mitigate interference by means of beam forming.

27. A method according to claim 26, wherein the femtocell base station is operable to reduce transmit power, if said wireless device is not operable to cancel interference.

28. A method according to any one of claim 25 to 27, wherein the interference mitigation procedure further include determining whether there is any available radio resources at said femtocell base station, if said femtocell base station is not operable to mitigate interference by means of beam forming.

29. A method according to claim 28, wherein the interference mitigation procedure includes blocking the wireless device from said available radio resources, if it is determined that there are available radio resources.

30. An apparatus for managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the apparatus being employed at said base station, and the apparatus comprising

means for obtaining identity information of said at least one further wireless device associated with said base station;

means for providing said obtained identity information to said further base station to allow said further base station to verify identity of said wireless

device with said obtained identity information in an event that said wireless device is in the vicinity of said base station;

receiving means for receiving a request to perform handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information;

wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

31. An apparatus for managing a handover of a wireless device between a base station and a further base station, said base station being accessible to at least one further wireless device associated therewith, and said wireless device being in communication with said further base station, the apparatus being employed at said further base station, and the apparatus comprising

receiving means for receiving identity information of said at least one further wireless device associated with said base station;

means for verifying identity of said wireless device with said received identity information, in an event that said wireless device is in the vicinity of said base station;

transmitting means for transmitting a request to said base station to perform a handover of said wireless device from said further base station to said base station if said verified identity of said wireless device is included in said provided identity information;

wherein subsequent to said handover being performed, said wireless device is in communication with said base station.

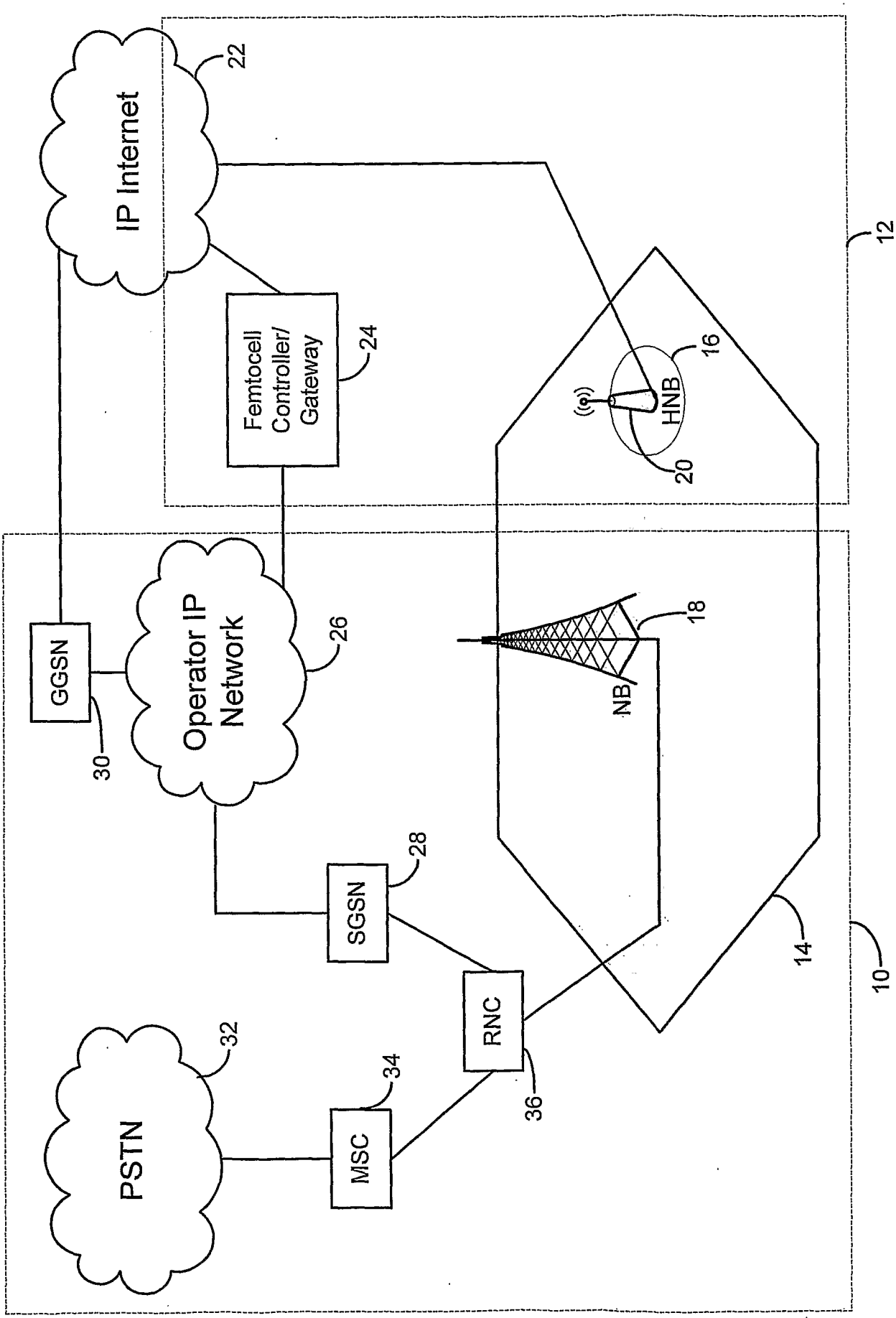

IP Internet
22
Femtocell Controller/ Gateway
24
12
HNB
16
20
GGSN
30
Operator IP Network
26
NB
18
SGSN
28
RNC
36
14
10
PSTN
32
MSC
34

FIGURE 1

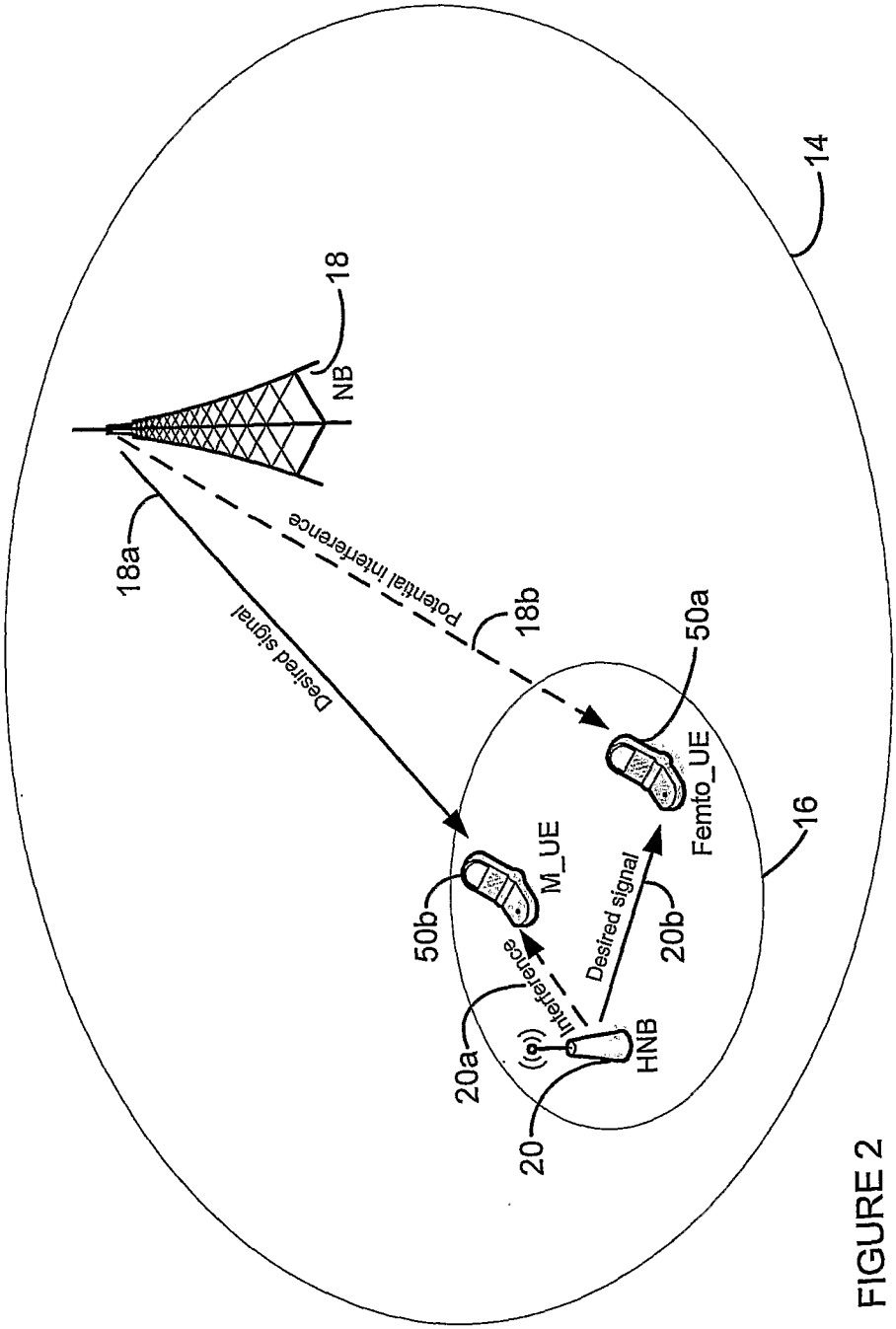

14
18
NB
18a
Potential Interference
18b
Desired signal
50a
Femto_UE
16
M_UE
50b
Interference
Desired signal
20b
20a
HNB
20

FIGURE 2

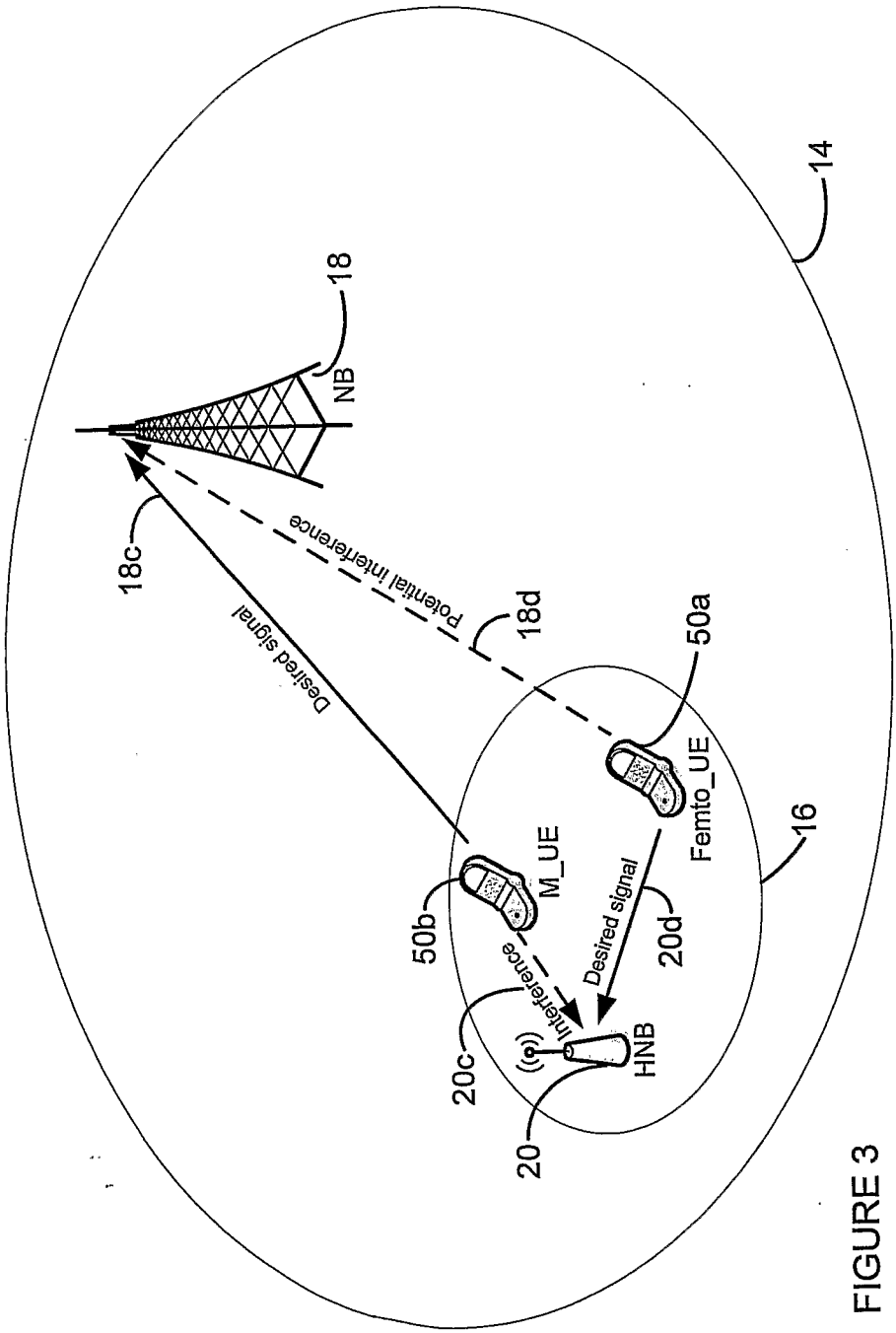

14
18
NB
18c
Potential interference
18d
Desired signal
50a
Femto_UE
16
M_UE
50b
Desired signal
20d
Interference
20c
HNB
20

FIGURE 3

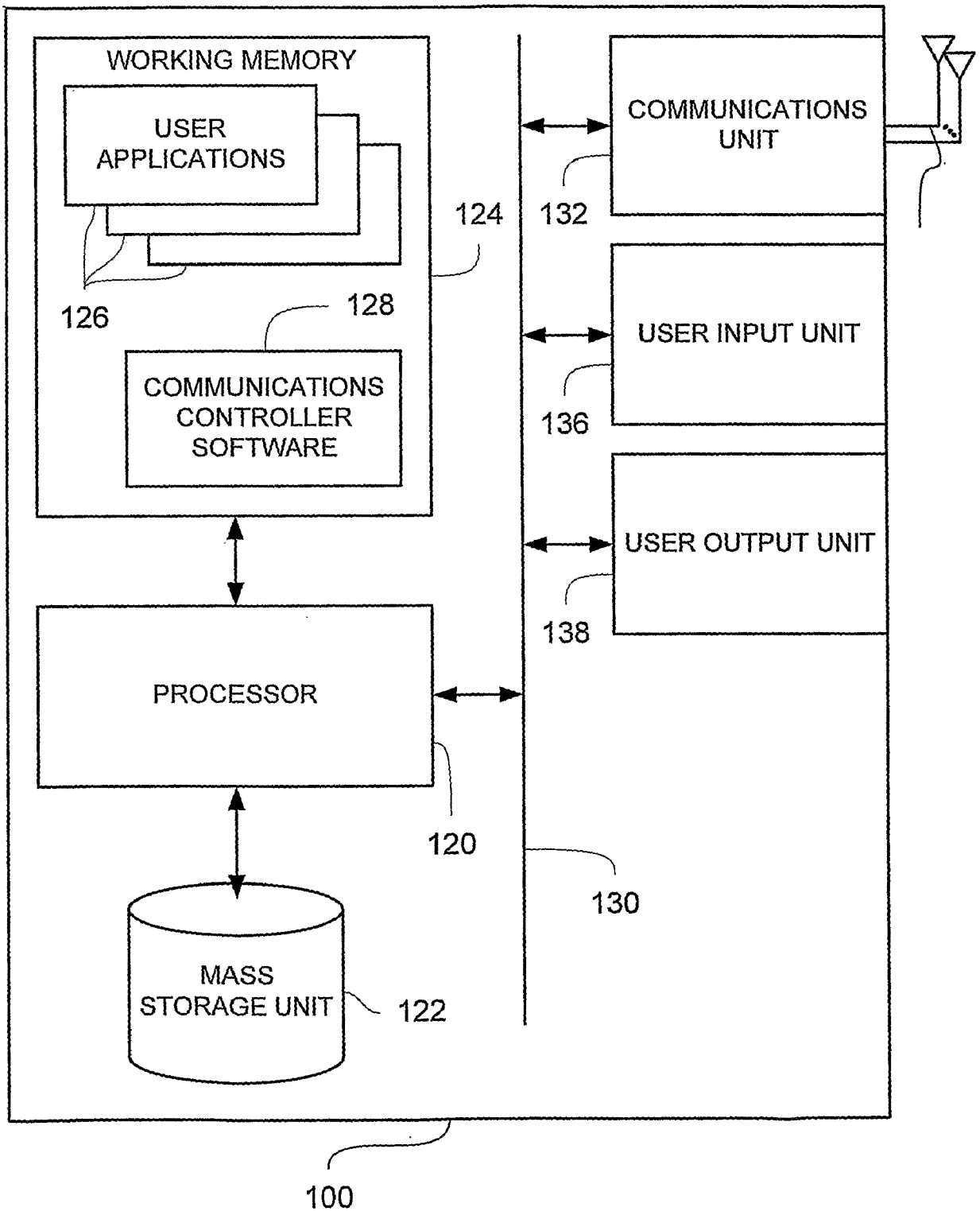

WORKING MEMORY
USER APPLICATIONS
126
128
COMMUNICATIONS CONTROLLER SOFTWARE
124
COMMUNICATIONS UNIT
132
USER INPUT UNIT
136
USER OUTPUT UNIT
138
PROCESSOR
120
130
MASS STORAGE UNIT
122
100

FIGURE 4

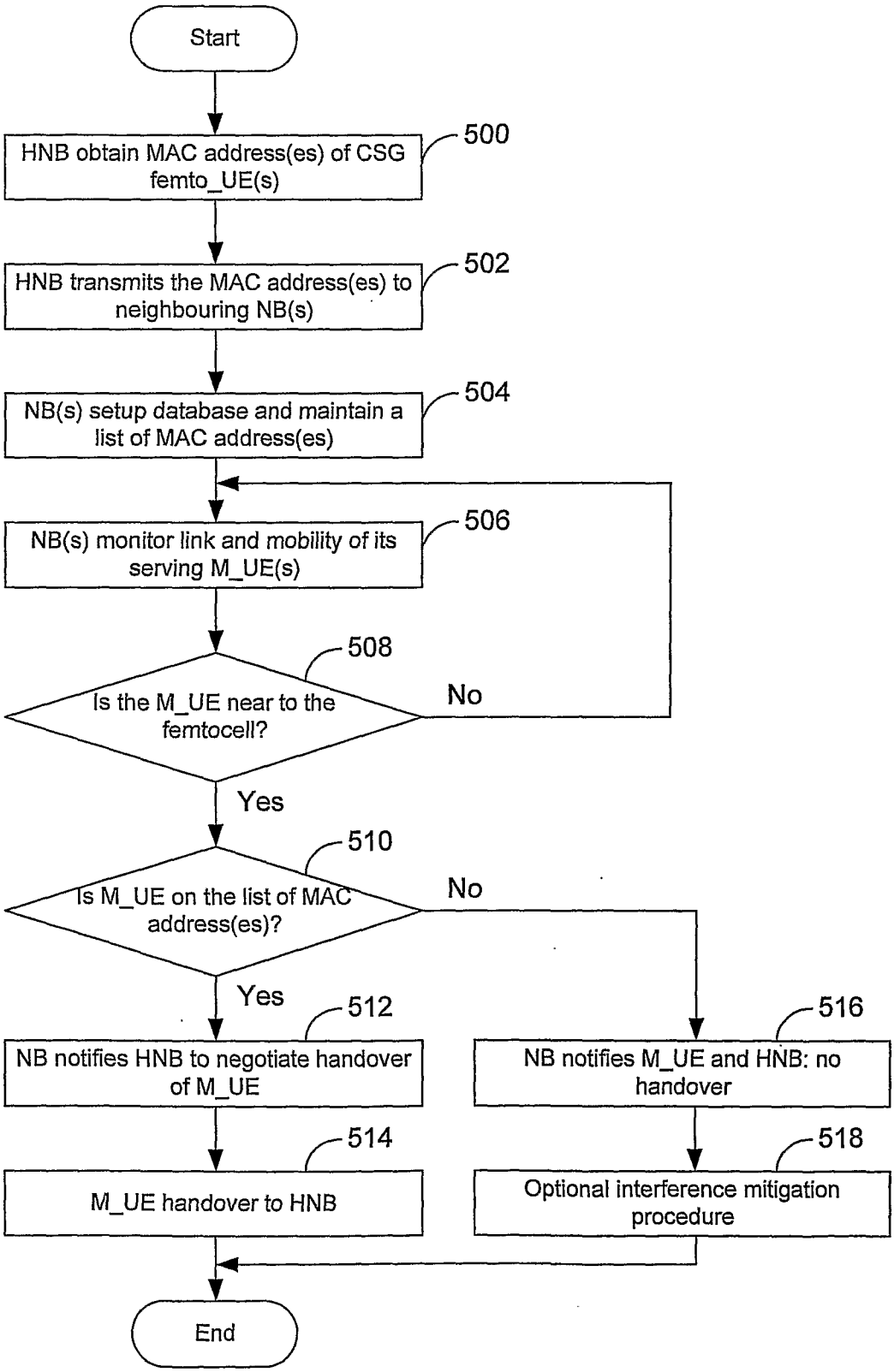

Start
HNB obtain MAC address(es) of CSG femto_UE(s)
500
HNB transmits the MAC address(es) to neighbouring NB(s)
502
NB(s) setup database and maintain a list of MAC address(es)
504
NB(s) monitor link and mobility of its serving M_UE(s)
506
Is the M_UE near to the femtocell?
508
No
Yes
Is M_UE on the list of MAC address(es)?
510
No
Yes
NB notifies HNB to negotiate handover of M_UE
512
M_UE handover to HNB
514
NB notifies M_UE and HNB: no handover
516
Optional interference mitigation procedure
518
End

FIGURE 5

Femto_UE	MAC address	Femtocell ID	O/C
1	00-B0-09-FF	FD321	C
2	00-B0-BB-81	FD321	C
3	00-86-AA-BE	FD321	C
4	00-FB-09-AE	FD321	C

FIGURE 6

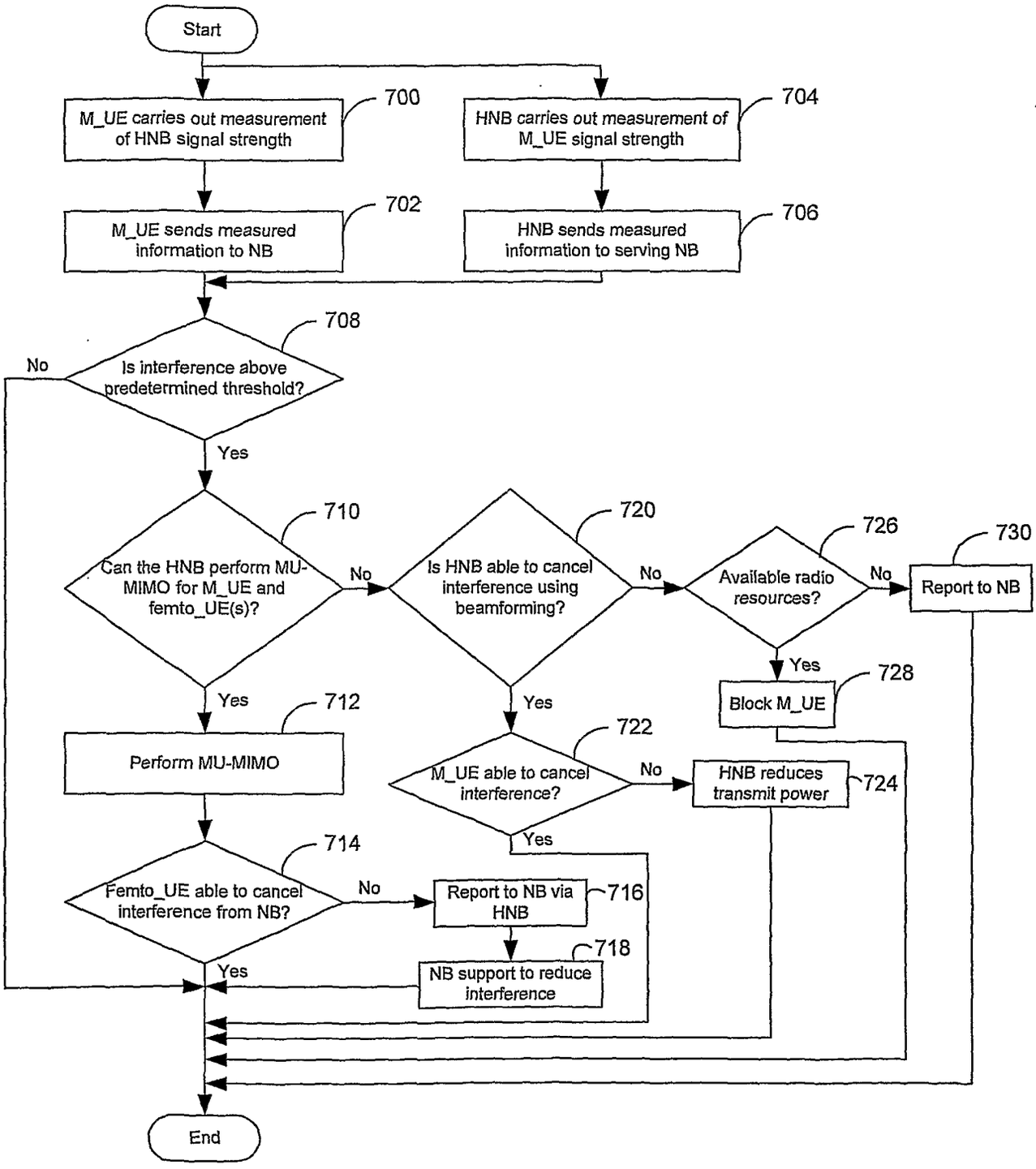

Start
M_UE carries out measurement of HNB signal strength
700
HNB carries out measurement of M_UE signal strength
704
M_UE sends measured information to NB
702
HNB sends measured information to serving NB
706
Is interference above predetermined threshold?
708
No
Yes
Can the HNB perform MU-MIMO for M_UE and femto_UE(s)?
710
No
Is HNB able to cancel interference using beamforming?
720
No
Available radio resources?
726
No
Report to NB
730
Yes
Block M_UE
728
Yes
Perform MU-MIMO
712
Yes
M_UE able to cancel interference?
722
No
HNB reduces transmit power
724
Yes
Femto_UE able to cancel interference from NB?
714
No
Report to NB via HNB
716
NB support to reduce interference
718
Yes
End

FIGURE 7

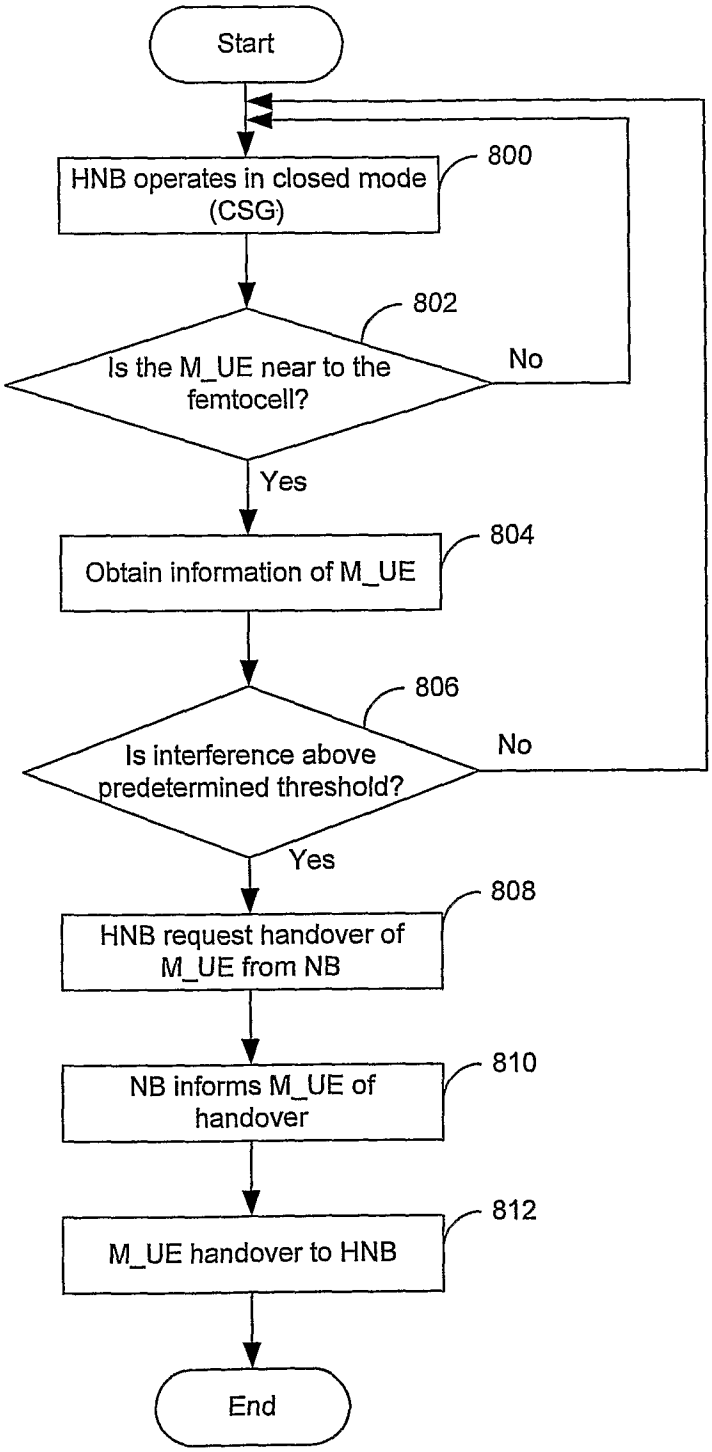

Start
HNB operates in closed mode (CSG)
800
802
Is the M_UE near to the femtocell?
No
Yes
Obtain information of M_UE
804
806
Is interference above predetermined threshold?
No
Yes
HNB request handover of M_UE from NB
808
NB informs M_UE of handover
810
M_UE handover to HNB
812
End

FIGURE 8

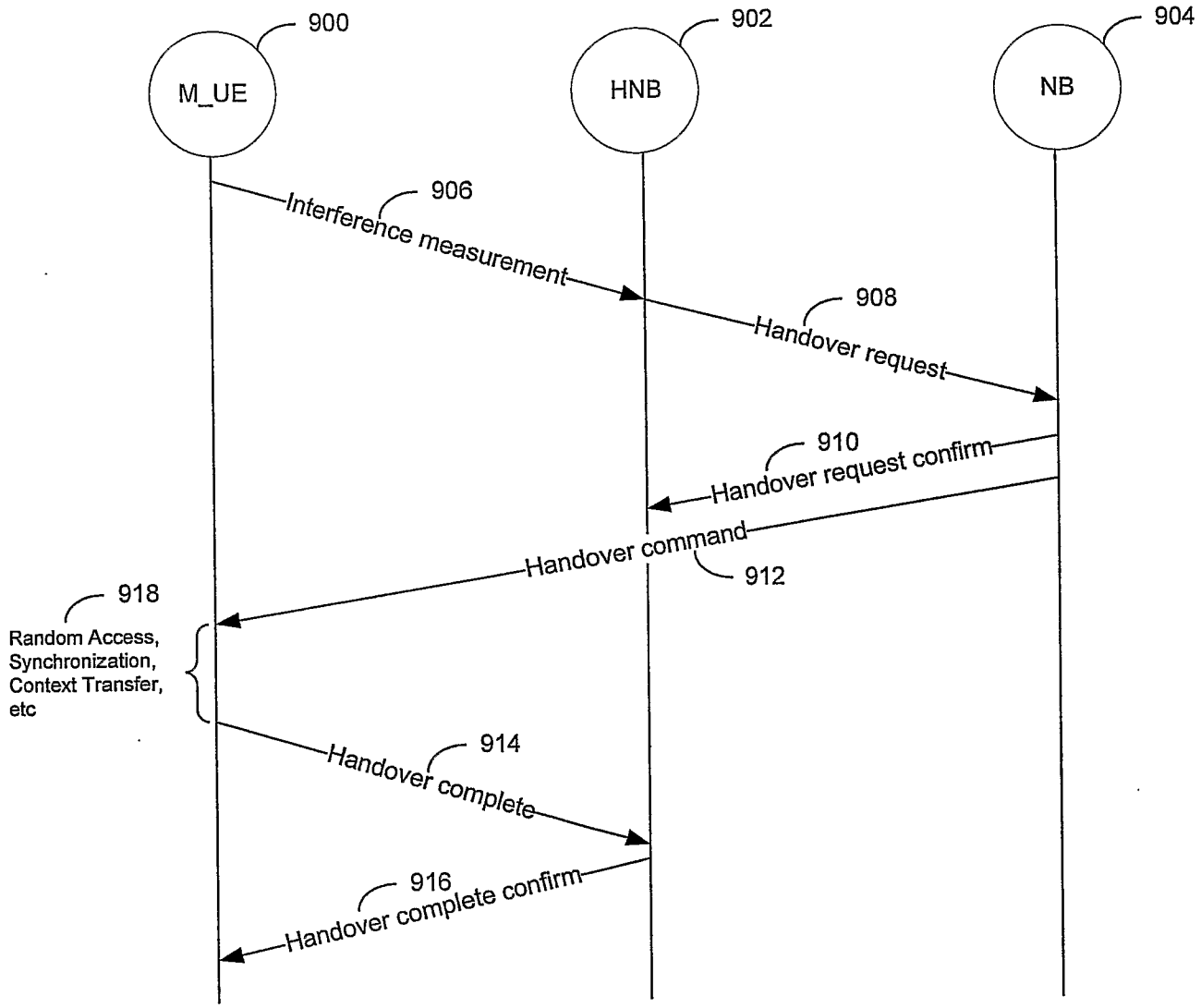

900
M_UE
902
HNB
904
NB
906
Interference measurement
908
Handover request
910
Handover request confirm
Handover command
912
918
Random Access,
Synchronization,
Context Transfer,
etc
914
Handover complete
916
Handover complete confirm

FIGURE 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2009/002118

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W36/04 H04W36/20 H04W84/04 H04L1/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W H04L

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 practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2009/022976 A1 (ERICSSON TELEFON AB L M [SE]) 19 February 2009 (2009-02-19) abstract paragraph [0032] paragraph [0052]	1-15, 18-20, 30,31
Y	WO 2005/065214 A2 (IBIS TELECOM INC [US]; SCHEINERT STEFAN [US]; SAROKA HAROLD GRANT [US]) 21 July 2005 (2005-07-21) paragraphs [0007] - [0010]	1-15, 18-20, 30,31
Y	US 2009/092097 A1 (NYLANDER TOMAS [SE] ET AL) 9 April 2009 (2009-04-09) paragraphs [0007] - [0012] paragraphs [0054] - [0087] paragraphs [0155] - [0157]	1-15, 18-20, 30,31

-/--

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

[X] See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 May 2010	11/08/2010

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

3

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008/153411 A1 (CLAUSSEN HOLGER [GB] ET AL) 26 June 2008 (2008-06-26) paragraph [0008] paragraphs [0013] - [0024] claims 1-3	1-15, 18-20, 30,31
Y	"3GPP TR 25.820 v8.2.0; 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; 3G Home NodeB Study Item Technical Report (Release 8)" 3GPP TR 25.820 V8.2.0,, vol. 25.820, no. v8.2.0, 1 September 2008 (2008-09-01), pages 1-40, XP002525355 page 17-24: section 5.3 page 38, lines 15-16	10-15
E	EP 2 182 757 A1 (IND TECH RES INST [TW]) 5 May 2010 (2010-05-05) paragraphs [0007], [0011] paragraphs [0013] - [0026] paragraph [0059] paragraphs [0053] - [0071]	1,8,9, 18-20, 30,31
A	"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Architecture aspects of Home NodeB and Home eNodeB (Release 9)" 3GPP STANDARD; 3GPP TR 23.830, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. V0.5.0, 1 May 2009 (2009-05-01), pages 1-54, XP050363907 section 6.1.2.1 sections 6.3.6.1, 6.3.6.2	1-15, 18-20, 30,31
A	US 2008/305801 A1 (BURGESS JOHN KENNEY [US] ET AL) 11 December 2008 (2008-12-11) paragraphs [0011] - [0012] paragraph [0020] paragraph [0038] paragraph [0041] paragraph [0043] page 51	1-15, 18-20, 30,31

3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2009/002118

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

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

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

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

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

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

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

see additional sheet

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

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

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

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

1-15, 18-20, 30, 31

Remark on Protest

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

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

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-15, 18-20, 30, 31

Handover access control

---

2. claims: 16, 17, 21-29

Interference mitigation

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2009/002118

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2009022976 A1	19-02-2009	EP 2179614 A1	28-04-2010
		US 2009047960 A1	19-02-2009
WO 2005065214 A2	21-07-2005	CN 101422065 A	29-04-2009
		DE 112004002372 T5	02-11-2006
		GB 2424555 A	27-09-2006
		JP 2007534227 T	22-11-2007
		KR 20070008537 A	17-01-2007
US 2009092097 A1	09-04-2009	EP 2196059 A1	16-06-2010
		WO 2009045149 A1	09-04-2009
US 2008153411 A1	26-06-2008	CN 101548560 A	30-09-2009
		EP 2092778 A1	26-08-2009
		JP 2010512116 T	15-04-2010
		KR 20090091778 A	28-08-2009
		WO 2008088521 A1	24-07-2008
EP 2182757 A1	05-05-2010	NONE	
US 2008305801 A1	11-12-2008	WO 2008153847 A1	18-12-2008