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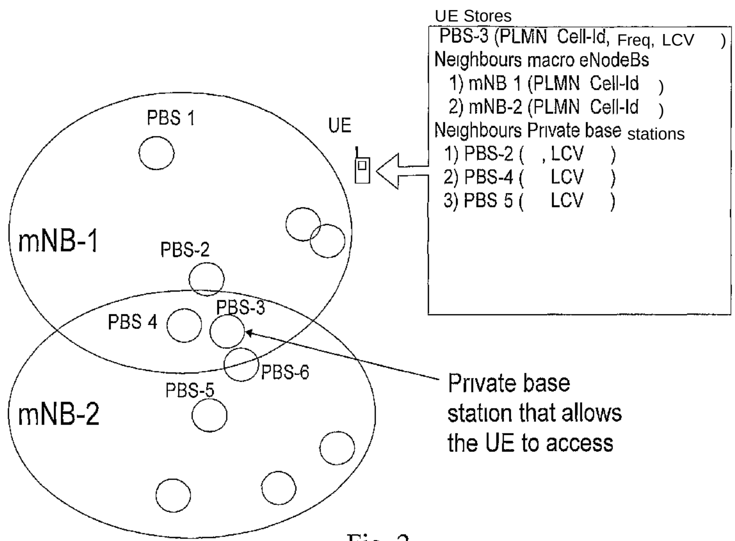

Fig 2

(57) **Abstract:** An improved pπvate cell re selection of a UE is disclosed According to the present invention, a UE being in idle mode in -a public network, the public network including at least one public base station coveπng a public cell, where the UE also is able to communicate with a private network, the pπvate network including at least one private base station covering a private cell and having limited access rights for UEs in the pπvate network, performs cell re selection The UE only performs a private cell re selection search when the UE is in proximity to a pπvate base station to which the UE has access πghts, where a detection of the proximity is based on information being specific for the UE and its relation to the pπvate base station

WO 2008/131591 A1

Proximity based cell re-selection of private base stations with closed user groups

Field of the Technology

The present invention relates to a method of a User Equipment (UE), and of a network node for private cell re-selection of a UE being in idle mode in a public network, the public network including at least one public base station covering a public cell, the UE also being able to communicate with a private network, the private network including at least one private base station covering a private cell and having limited access rights for UEs in the private network.

The present invention also relates to a UE, a network node and a system arranged for performing private cell re-selection of the UE being in idle mode in a public network, the public network including at least one public base station covering a public cell, the UE also being arranged for being able to communicate with a private network, the private network including at least one private base station covering a private cell and having limited access rights for UEs in the private network.

The present invention also relates to a computer program, a computer program product executing the methods of the invention.

Background of the Invention

The present invention relates to a radio communication system, especially to a radio communication system comprising private base stations, such as small home premise equipments, with access restricted for a small group of UEs.

The development of the wireless communication standards for Enhanced Universal Terrestrial Radio Access Network (E-UTRAN), also called Long Term Evolution (LTE), in 3rd Generation Partnership Program (3GPP) is progressing and during this time the need for private small home premise equipments has emerged.

A private base station includes at least radio base station functionality. Typically, a private base station includes radio base station functionality for very small cells, so called femto cells or pico cells. In this document, the private base station concept may include all kinds of small radio base station equipments, e.g. office equipment, and it may also include traditional radio base station equipment for wider area coverage. However, as is stated above, these private radio base station equipments have restricted access rights for UEs in the system.

Furthermore, although 3GPP and E-UTRAN are used as model technologies in this document, the present invention may be applied to any radio access technology as is clear to a skilled person. In this document, the notation "base station" therefore includes any network node covering a network cell, such as a radio base station, a Node-B (NB), a eNB, or the like. Further, the notation UE here includes any mobile entity communicating with such a base station, such as a Mobile Station (MS), a UE, or the like. The term "private cell re-selection" is in this document used for cell re-selection of a UE to a private cell.

Figure 1 shows schematically an example of a 3G E-UTRAN. The architecture of E-UTRAN is simplified compared to UTRAN. In E-UTRAN, as can be seen in figure I, a central Radio Network Controller (RNC) node controlling multiple NBs does not exist. Instead, only two types of nodes are defined, eNBs and Access Gateway (MME/SAE), where the eNB belongs to the E-UTRAN network and the MME/SAE Gateway belongs to the evolved packet core network (EPC), and where there exists a X2 interface between two eNBs and a Sl interface between an eNB and a MME/SAE Gateway. A similar architecture is also used for Universal Mobile Telephony System (UMTS), especially when looking at the evolution of the High Speed Packet Access (HSPA) system where the RNC and NB are collapsed to one node.

When the UE is roaming in idle mode through the network, it uses measurements of identified cells to select the cells that is most suitable to be camped on.

When a UE selects a cell that belongs to another Tracking Area (TA) than the TA on which it is currently camping, it shall send a TA Update (TAU) message to the Core Network (CN) to inform the CN that it has changed its coverage area.

The concept of having private base stations with Closed User Groups (CUG) brings new aspects to the access of the cellular networks. In this document, the notation "limited access rights" refers to these CUGs. There may be a very large number of small cells covered by private base stations in the same area being covered by public base stations of a normal public cellular network. However, a UE may only have right to access one or a few of these private base stations. This makes the solution in UTRAN, where a list of neighbor cells is broadcasted in the cell, unattractive, since the needed information is UE dependent and not common for all UEs. Broadcasting information needed by the UEs for accessing such a private base station would result in a large overhead signaling in the system, since broadcasting is a very inexact way of conveying UE specific information.

In Global System for Mobile communication (GSM), the Cordless Telephony System (CTS) has addressed the idea of small home equipments, see reference document [5], (There is a list of reference documents at the end of this specification.) The mobility control for the mobile stations that want to access a CTS cell is here UE controlled, and the preference for either the GSM or the CTS system can be configured manually or automatic in six different modes.

One background art solution to the problem of restricting the access to a CUG, suggested in reference document [3], is to have a list of TAs, to which a UE is allowed to access, and also to have the private base station sending out information about its access status, i.e. whether it is configured for public or restricted access. One limitation to this suggested solution is that the expected large amount of private base stations in the system could result in that the system runs out of identifiers.

This problem relating to identifiers has been addressed in reference document [2], where a soft distinction between the Tracking Area Code (TAC) and the Cell ID enables the TAC to have a number of bits depending on the number of cells included in the TA.

However, there are problems in the background art solutions presented above relating to excessive idle mode measuring and searching for private base stations as well as the large amount of other signaling needed to be performed in the system in order to handle access of UEs to only the private base stations for which they have access rights.

Further, regarding signaling overhead, in the background art, Neighbor Cell Lists (NCLs) are broadcasted in the cells. For networks including private cells, this would lead to a very large signaling overhead, since such a network probably would have a very large number of such private cells. A NCL including information of all of these cells would be very big and would thus cause a lot of overhead signaling. A large portion of this signaling would also not be useful for a majority of the UEs, since different UEs have access rights to different private base stations. A UE has thus *no* use for all of the broadcasted information relating to private base stations to which it has no access rights.

Summary of the Invention

It is an object of the present invention to provide a private cell re-selection that solves the above stated problems.

The present invention aims to provide a private cell re-selection that needs less measurement, searching, and signaling than the private cell re-selection known in the background art.

The object is achieved by a method of a UE for private cell re-selection of a UE, wherein the UE only performs a private cell re-selection search when the UE is in proximity to a private base station to which the UE has access rights, where a detection of the proximity is based on information being specific for the UE and its relation to the private base station.

The object is also achieved by a method of a network node for private cell re-selection of a UE, wherein the network node is configured to communicate, concerning a private cell re-selection search, with a particular UE having access rights to the private base station, only if the particular UE is in proximity to the private base station, where a detection of the proximity is based on information being specific for the UE and its relation to the private base station.

The object is also achieved by a UE arranged for performing private cell re-selection of the UE, wherein the UE is arranged to only perform a private cell re-selection search when the UE is in proximity to a private base station to which the UE has access rights, where a detection of the proximity is based on information being specific for the UE and its relation to the private base station.

The object is also achieved by a network node arranged for performing private cell re-selection of a UE, wherein the network node is arranged for communicating, concerning a private cell re-selection search, with a particular UE having access rights to the private base station, only if the particular UE is in proximity to the private base station, where a detection of the proximity is based on information being specific for the UE and its relation to the private base station.

The object is also achieved by a system arranged for performing private cell re-selection of a UE, wherein

- the UE is arranged to only perform a private cell re-selection search when the UE is in proximity to a private base station to which the UE has access rights,

- a network node is arranged for communicating, concerning a private cell re-seiection search, with a particular UE having access rights to the private base station, only if the particular UE is in proximity to the private base station, and - detection of the proximity is based on information being specific for the UE and its relation to the private base station.

The object is also achieved by a computer program and a computer program product executing the methods of the invention.

The private cell re-selection according to the present invention is characterized in that a search for a private base station is based on a proximity to a private base station to which a UE has access rights, and that the detection of the proximity is based on information that is specific for the UE and its relation to the private base station.

This is advantageous, since the UE, being in idle mode, does not have to waste cell re-selection searches, measurements and other signaling on private base stations other than the ones to which it has access rights and is close to. Also, the UE can decide whether it is close to a private base station without having a need for broadcasts of large NCLs in the cell. The searches, measurements and other signaling performed in the system are thereby radically decreased.

In an embodiment of the present invention, the proximity detection is performed by the UE.

In an embodiment of the present invention, the proximity detection is performed by a public base station.

In an embodiment of the present invention, the proximity detection is performed by the private base station.

In an embodiment of the present invention, the proximity detection is based on a cell relation between the private cell covered by the private base station to which the

UE has access and neighboring other public or private cells. This has the advantage that the cell relation information results in efficient proximity detection. The cell relation information may further be gathered easily, during normal operation, by the UE or by the network.

Detailed exemplary embodiments and advantages of the private cell re-selection according to the invention will now be described with reference to the appended drawings illustrating some preferred embodiments.

Brief Description of the Drawings

Fig. 1 shows an overall architecture for LTE.

Fig. 2 shows an example of cell relation information.

Fig. 3 shows an example of change of cell relation information after reconfiguration of public network.

Figs. 4 shows an example of a coverage situation.

Detailed Description of the Invention

For systems including private base stations, an efficient procedure for handling access of UEs to such private base stations is requested, especially relating to measuring and searching of the private base stations, and also relating to other signaling in the network.

The wanted requirements of the private base stations for LTE have, by some operators, been addressed in reference document [I]. Specifically, the following requirement is in reference document [1] stated for idle mode mobility:

I. It shall be possible to avoid UEs in LTE-IdIe from accessing a particular cell, if they are not allowed to use the private base station covering that particular cell.

II. It shall be possible to avoid UEs in LTE-IdIe from camping on a particular cell, if they are not allowed to access the private base station covering that particular cell.

III. It shall be possible to minimize the quantity of measurements which UEs in LTE-idle perform on a private base station, if they are not allowed to access that specific private base station.

IV. It shall be possible to minimize the quantity of measurements, which UEs in any cell re-selection state in another Radio Access Technology (RAT) perform on a private base station, if they are not allowed to access that specific private base station.

V. It shall be possible to set the re-selection parameters for UEs which are allowed to access the cell, such that they prioritize the private base station.

An analysis of reference document [5] shows that there is no means for avoiding UEs to search for the CTS cell when not being in the vicinity of the CTS cell. Thus, the solution in accordance with reference document [5] does not fulfill requirements I-V stated above.

Further, the solution presented in reference document [2] does not provide any means to control how the measurement of the private base station can be minimized. Thus, the solution in accordance with reference document does not fulfill requirements III-IV stated above.

A UE may here be able to communicate with two telecommunication systems, one system having private base stations and one system having public base stations, public base stations here being normal base stations covering a larger area without restricted access rights, such as a wide area macro cell of a normal public telecommunication system. Such a wide area macro cell might have hundreds of private cells within its coverage area. To not overload the broadcast channels of overlaid macro cells, it is a further requirement that the proximity detection do not solely depend on broadcasted neighbor cell lists, which has been the traditional method to control cell re-selection in background art.

According to the present invention, the use of a proximity parameter is included in a cell re-selection procedure for a UE in idle mode. A UE should then search for a private cell, concerning cell re-selection, based on UE proximity to this private base station, the private base station being one that the UE can access. Thus, the search for a private base station is, according to the present invention, based on a proximity to a private base station to which a UE has access rights. Further, the decision whether the UE is close to a private base station or not is made based on information specific for the UE and its relation to the private base station. That is, the decision is based on information that concerns the particular UE in question. Thus, no signaling overhead increasing NCL broadcasting is needed in the cell, which dramatically decreases the overhead in the cell, since broadcasting of large NCL would need a lot of signaling.

According to different embodiments of the present invention, the proximity parameter used for private cell re-selection may be detected by the UE, the private base station, the public base station, or by other means. If proximity is not detected by the UE itself, it needs to be indicated to the UE by the one detecting it.

A proximity indication is, according to the present invention, an indication that a UE having access rights, for camping, for active mode sessions or both, to a particular private base station is getting close to that particular base station, or has entered the area covered by that private base station.

According to the present invention, a UE should only perform a cell re-selection search for a private base station when the UE is in proximity to a private base station to which the UE has access rights.

This has the advantage that the UE in idle mode does not have to waste cell re-selection searches, measurements and other signaling on private base stations other than the ones to which it has access rights and is close to. By this, the searches, measurements and other signaling performed in the system is radically decreased. Further, the idle mode cell re-selection procedure according to the present invention fulfills the operator requirements I-V stated above.

There are a number of different possible proximity detection mechanisms that may be implemented in the system. The proximity detection may, for example, be hierarchical, where a coarse proximity mechanism could trigger the usage of a more fine-grained mechanism. This may be implemented such that the more fine-grained mechanism is used after recognizing, for instance, a location area, a tracking area, or a routing area.

According to an embodiment of the present invention, proximity detection is performed by the UE. That is, a UE detects its proximity to a private base station that it has access rights to. This detection may be based on storing and recognizing information regarding cells that are neighbors to or are in the vicinity of the particular private cell. Thus, the UE would then store cell information and cell relation information for the private cell and other cells in the surroundings of the private cell. This information can be stored in the Subscriber Identity Module (SIM) card of the

UE or in another storage facility in the UE. The UE could, for example, build this information by reading information from the nearby cells in active mode, while camping on the private cell, or while leaving the private cell.

Alternatively, the network could provide this information to the UE based on an Operations and Maintenance (O&M) network model. The information can be updated in the UE when the network O&M model changes, or when subscription information changes, for example by SMS using "SIM-toolkit" (not so often), on-demand (mobility based) or at TAU (when the UE enters a TA where there is a private cell).

Figure 2 shows an example of what the cell relation information can look like, As can be seen in figure 2, the UE stores information relating to a private base station to which it is allowed to access, PBS-3 in figure 2, and information relating to neighboring public cells, macro cells mNB-1 and mNB-2, as well as information relating to other private base station, to which the UE has no access rights, PBS-2 to PBS-5.

The cell relation information may also be stored in a network node, such as a public base station or a private base station.

Cell relation information may, wherever it is stored, include information relating to at least one private base station to which said UE has access rights, at least one neighboring private base station, at least one neighboring public base station, a Logical Cell Value (LCV), a frequency, a Cell-ID, or a Public Land Mobil Network (PLMN).

The UE then keeps track of the neighboring cells as it roams through the network and when the UE identifies one or several of the cells defined in its cell relation mapping table it starts to look for the private base station that it has access rights to. In other words, when a UE finds out that it is within any one of the cells being adjacent to the private base station, to which it has access rights, the UE can, from analyzing its cell relation information, come to the conclusion that it is close to the private base station it has access rights to. The UE may then start to perform cell re-selection searches for this private base station.

To base the proximity detection on information relating cells and cell relations has the advantage that this information may easily, during normal operation, be gathered by the UE or by the network and may further result in efficient proximity detection.

As a further alternative, the UE may detect proximity to a private base station that it has access rights to based on a location application, e.g. a Global Positioning System (GPS) location application or a Galileo positioning system application. This has the advantage that an exact geographical positioning is very easily achieved.

As a further alternative, the UE may detect proximity by the use of another UE application. If the UE is able to run other applications, such as Wireless Local Area Network (WLAN), Bluetooth, or the like, the use of such applications may be used by the UE for detection of proximity. For example, the UE may recognize a known short range radio network, e.g. Bluetooth or WLAN network, and may then be able to use this recognition in the proximity detection. The UE may also run a particular UE application, which may give the UE information relating to its proximity to a private base station. As an example, this could be used in cases when the UE is used also as a remote control to open garage, the front door, or any other remote controlled device.

A cell plan of the public network sometimes need to be updated, either due to additions of new cells or other cell layout reconfigurations. When this happens, there might also be changes in the cell relations between the private cell and the cells in the public network. An example of this is shown in figure 3.

As can be seen in figure 3, the private cell overlaps with different cells in the public network, public cell 1 and public cell 2, before and after the cell layout reconfiguration.

In a situation as the one shown in figure 3, the UE may try to use its cell relation information to search for the private base station, but since the cell layout has changed the UE will not search for the private base station, since the proximity indication is not invoked.

In an embodiment of the present invention, the cell information broadcast from the cells after the cell layout reconfiguration contains both the new cell information and also cell information about the previous configuration of the cell, i.e. the old cell information. This extra information can be broadcasted for a period of time, such that the UEs can understand that they should update their cell relation information.

In case the UE does not obtain the extra information during this period of time, it might have to manually select the private cell and then update the cell relation information. This could also be used for a situation, in which the owner has moved the private base station to another place in the home or in the building, which also could change the cell relations.

The methods, according to the present invention, for keeping the cell relation information updated have the advantage that the proximity detection always can be made on the basis of cell relation information constantly being up to date.

According to an embodiment of the present invention, the proximity detection can be initiated or performed by a node in the public network.

There are, in the network, typically a large number of UEs in idle mode present, having limited interaction with the network. It is thus necessary to try to avoid excessive signaling load from this large number of idle mode UEs.

Therefore, according to an embodiment of the present invention, the network provides search parameters ordering the UE to search for private cells that the UE can access, when the UE is registered in the TA that is covering the same geographical area as the private cell is covering. This is preferably done in the TA Update (TAU) response message from the network.

To use TA signaling for providing search parameters has the advantage that existing signaling interactions are reused, e.g. tracking area (TA) update signaling, which is advantageous since they already exist in the system.

However, since the TA can have a rather large coverage area, this might not always be very battery power efficient because of the fact that the UE will here search for its private cell in the whole TA.

According to an embodiment of the present invention, the CN sends a further request to the UE as a response to a TAU. The request is asking the UE to send an additional TAU message when entering a specific cell in the TA (or any cell in a list of several cells). The cell where the UE is requested to send the additional TAU, when the UE enters the cell, is here a cell which is near to or directly neighboring the particular private cell, for which the UE has access rights. A last TAU response from the network, responding to the additional TAU message, then contains search parameters ordering the UE to search for the particular private cell.

Further, the network can build and update the cell relation information for a specific private cell based on measurement reports from UEs in active mode that are in the vicinity of the private cell. Especially the measurement reports of neighboring cells from UEs belonging to the CUG that is allowed to use the private base station are useful for the maintenance of the cell relation information to be used for proximity detection.

A network controlled proximity detection or a network controlled cell re-selection, as described above, dedicated to each UE, both have the advantage that they are very easy to implement together with closed user groups.

Also, a hybrid approach of proximity detection may be performed such that the network provides, e.g. in the TAU update response message, to the UE, a cell relation information relating to cells surrounding the private cell, for private base stations that the UE can access. Then, the step of deciding when to start searching for a private base station is then left up to the UE to decide.

The hybrid approach has the advantage that the signaling overhead for the hybrid approach is less than for the pure network controlled approach. Also, the UE does not need to store network information and possibly closed user group information for long periods of time, thereby reducing the risk that the information stored by the UE is out of date.

According to an embodiment of the invention, the network node generating the proximity detection could also be an external electronic entity, identifying a user presence in the coverage area of the private cell. For example, such external electronic entities, functioning as proximity detectors, may be burglar alarms, e.g. motion detectors, alarm activation/de-activation, garage port activation, electronic key system, car detection, refrigerator opening detector, sound detector, Stereo/radio/pc/light on detectors, or the like.

As is clear to a skilled person, there is a large number of external electronic entities possibly including sensors that may be used to locate a user of a UE. A skilled person realizes that the present invention may easily be adapted to sensors included in any other external electronic entities than the ones listed above.

These proximity detections generated by external electronic entities indications can then trigger the network to send additional information to the UE regarding the availability of the private cell. The UE can then use this additional information when making decisions relating to search for and measurement of a private base station accessible for the UE and close to where the UE is, as described above.

The use of external electronic entities for proximity detection has the advantage that it makes use of inexpensive sensor technology that already is present in most homes and is expected to be present in a very large number of home devices in the future.

In an embodiment of the present invention, the proximity detection is performed by the private base station. In this embodiment of the invention, the private base station provides, via a public base station, information related to the detection to the UE in the same ways as when the proximity is detected by a public base station. The private base station may thus, via the public base station, inform the UE that proximity is detected and it may also order the UE to search for a private base station.

For the present, the ownership of the private cells is not decided, but one probable scenario is that the home owners will also own the private base stations in their homes. Home owners cannot be expected to perform the same complex network planning and configuration of the private cells as a network operator would do. It is therefore required that the private cells can be autonomously configured from the viewpoint of the home owners. Since the owners can place the private base station where they find suitable, the coverage of the private cell will be unplanned from a network operator point of view.

Figure 4 shows an example of this, where there are two private cells covered by private base stations (cells 1 and 2) and a public cell (cell 3).

A private cell might have no direct coverage relation to the surrounding cells, as can be seen for private cell 2 in figure 4, i.e. it might have no direct neighbor. This could for example be a possible scenario when the private base station is placed in the basement of a house.

A UE in idle mode roaming from cell 3 to cell 2 in figure 4 would experience a period of time when it cannot maintain the contact with the network, and when it cannot be reached by paging, i.e. the UE is "out of coverage". In a public telecommunication system, when the UE finds itself out of service, it will try to find its old cell (cell 3) during a period of time and then perform a cell search for any other cell.

According to an embodiment of the invention, the UE bases the detection of proximity on a status of a coverage situation of such a public cell. In particular, as a special case of UE detected proximity, the UE prioritizes the search for private cells which it knows about, and which it is allowed to access, when the UE experiences an out of service condition. More specifically, the UE prioritizes the search for private cells which it knows have no direct neighbor.

Also, in accordance to the use of cell relation information described above, if the UE has further knowledge about the surrounding cells, it can use this knowledge to further identify which private cell to search for.

It has been suggested in reference document [4] that explicit cell priorities can be sent to a UE. In this embodiment of the present invention, however, this idea has been extended to also include the proximity indication to be used as a selection prioritization.

By including the parameter of the status of the coverage situation in the proximity detection, in accordance with this embodiment of the present invention, the UE is likely to regain service significantly quicker, than if the UE had no clues for what to search for.

In an embodiment of the present invention, a time interval between two private cell re-selection searches depends on a distance between the UE and the private base station, using a relatively short time interval when the distance is short, and a relatively long time interval when the distance is long.

In an embodiment of the invention the UE is informed or stores additional information about the status of the private cell coverage situation, i.e. if it is "in service" or "out of service". This additional information is used by the UE so that it does not search for the private cell when the UE is in coverage of other cells and the private base station is "out of service". Thus, no unnecessary searches for private base stations being "out of service" have to be performed according to this embodiment of the present invention.

Further, in the case where the private cell is deploying an interference reduction mode, the private base station might be invisible for the UE.

According to an embodiment of the present invention, the UE$_5$ possibly having the knowledge that it is in the proximity to a private base station, can still try to find the Discontinuous Transmission (DTX) pattern of the private base station and then send a random access burst to the private base station, possibly with a special preamble, to bring the private base station into a normal operation mode. This method can be used if the private base station is turned off or is in any other power saving mode in a private base station cell being out of service.

Especially, this can be very important for the case where a UE needs to be able to send emergency call requests to a private base station that is out of service. Thus, by the use of this embodiment of the present invention, the possibility of being able to make emergency calls in private cells being "out of service" is improved.

Thus, the invention relates to a system arranged for performing private cell re-selection of a User Equipment (UE) being in idle mode in a public network, the public network including at least one public base station covering a public cell, the UE also being arranged for being able to communicate with a private network, the private network including at least one private base station covering a private cell and having limited access rights for UEs in the private network, wherein

- the UE is arranged to only perform a private cell re-selection search when the UE is in proximity to a private base station to which the UE has access rights,

- a network node is arranged for communicating, concerning a private cell re-selection search, with a particular UE having access rights to the private base station, only if the particular UE is in proximity to the private base station, and

- detection of the proximity is based on information being specific for the UE and its relation to the private base station.

The invention also relates to corresponding apparatus of and methods for the UE and the network node for performing the cell re-selection.

The UE and the network node performing the private cell re-selection of the invention can be adapted to perform any of the steps of the methods of the invention. A trivial requirement is of course that such a step does involve such a UE or network node.

The private cell re-selection according to the invention may be modified by those skilled in the art, as compared to the exemplary embodiments described above.

Reference documents

[1] 3GPP TSG RAN, RP-070209, "Requirements for LTE Home eNodeBs"

[2] 3GPP TSG RAN WG2, R2-071349, "Use of tracking area- and cell identity for private networks/home cells"

[3] 3GPP TSG RAN WG2, R2-071428, "Use of home & private eNBs"

[4] PCT/CN2007/000037 Patent application, "Cell search in a cellular communications system"

3GPP TS 42.056 vó.0.0, "GSM Cordless Telephony System (CTS), Phase 1; Service description; Stage 1"

Claims

1. Method of a User Equipment (UE) for private cell re-selection of a UE being in idle mode in a public network, said public network including at least one public base station covering a public cell, said UE also being able to communicate with a private network, said private network including at least one private base station covering a private cell and having limited access rights for UEs in the private network,

characterized in that said UE only performs a private cell re-selection search when said UE is in proximity to a private base station to which said UE has access rights, where a detection of said proximity is based on information being specific for said UE and its relation to said private base station.

2. Method as claimed in claim 1, wherein said detection of said proximity, for a particular one of said at least one private base station, is based on a cell relation between a private cell, covered by said particular private base station, and other public or private cells in a vicinity of the private cell.

3. Method as claimed in claim 2, wherein said cell relation is detected and stored during active mode operation of said UE.

4. Method as claimed in claim 3, wherein said cell relation is based on measurement reports from said UE.

5. Method as claimed in claim 2, wherein said cell relation is detected and stored during idle mode operation of said UE.

6. Method as claimed in claim 2, wherein when a cell plan for said private or said public network is updated, said UE receives a cell information broadcast from a public base station in the public network, said cell information broadcast including both a new cell information and an old cell information, said UE using said new and old cell information to update the stored cell relation.

7. Method as claimed in claim 2, wherein said UE controls if its stored cell relation needs to be updated, and if the stored cell relation needs to be updated, said UE requests a cell information transmission from a public base station in the public network, said cell information transmission including both a new cell information and an old cell information, said UE using said new and old cell information to update the stored cell relation.

8. Method as claimed in claim 2, wherein said UE controls if its stored cell relation needs to be updated, and if the stored cell relation needs to be updated, said UE itself collects cell information, using said cell information to update the stored cell relation.

9. Method as claimed in claim 2, wherein said public base station informs said UE if the stored cell relation needs to be updated, and if the stored cell relation needs to be updated, said UE itself collects a cell information, using said cell information to update the stored cell relation.

10. Method as claimed in claim 2, wherein said cell relation includes information of at least one of the entities or parameters in the group: at least one private base station to which said UE has access rights, at least one neighboring private base station, at least one neighboring public base station, Logical Cell Value (LCV), frequency, Cell-ID, Public Land Mobil Network (PLMN).

11. Method as claimed in claim 1, wherein said detection of said proximity to a private base station is performed by the UE.

12. Method as claimed in claim 11, wherein said detection is based on a status of a coverage situation of said at least one public cell.

13. Method as claimed in claim 12, wherein said status is related to if a geographical area, in which said UE is present, is covered by one of said at least one public cells or not.

14. Method as claimed in claim 13, wherein said UE is configured to search for a private base station when said UE enters a geographical area not covered by one of said at least one public cells and being in proximity to said private base station.

15. Method as claimed in claim 12, wherein said UE stores information relating to said status.

16. Method as claimed in claim 12, wherein said UE receives information relating to said status from a public base station in said public network.

17. Method as claimed in claim 11, wherein said detection is based on information provided to said UE by a public base station in said public network.

18. Method as claimed in claim 17, wherein said public base station orders said UE to perform said detection of said proximity.

19. Method as claimed in claim 11, wherein said detection is based on information provided by a location application.

20. Method as claimed in claim 19, wherein said location application is a Global Positioning System (GPS) application.

21. Method as claimed in claim 19, wherein said location application is a Galileo positioning system application.

22. Method as claimed in claim 11, wherein said detection is based on a discovery of an electronic equipment.

23. Method as claimed in claim 22, wherein said electronic equipment is any one of the electronic equipments in the group: a UE application; a local radio network, such as a Bluetooth network or Wireless Local Area Network (WLAN).

24. Method as claimed in claim 1, wherein said detection of said proximity to a private base station is performed by a public base station in said public network.

25. Method as claimed in claim 24, wherein information related to said detection is provided to said UE by said public base station.

26. Method as claimed in claim 25, wherein said public base station informs said UE that proximity is detected.

27. Method as claimed in claim 25, wherein said UE is ordered by said public base station to search for a private base station.

28. Method as claimed in claim 25, wherein said UE is ordered by said public base station to send an additional Tracking Area Update (TAU) message when said UE enters a particular public cell in a Tracking Area (TA), and as a response to said additional TAU, said UE is ordered by said public base station to search for a particular private base station.

29. Method as claimed in claim 24, wherein a location of said UE is detected by the use of an external electronic entity.

30. Method as claimed in claim 29, wherein said external electronic entity is any one in the group of: alarm entities, such as burglar alarms, motion detectors, alarm activation, alarm deactivation; household entities, such as door or garage port activation, kitchen appliance activation, electronic equipment activation.

31. Method as claimed in claim 1, wherein said detection of said proximity to a private base station is performed by said private base station.

32. Method as claimed in claim 31, wherein information related to said detection is provided to said UE by said private base station, via a public base station.

33. Method as claimed in claim 32, wherein said information is used for informing said UE that proximity is detected.

34. Method as claimed in claim 32, wherein said information is used for ordering said UE to search for a private base station.

35. Method as claimed in claim 1, wherein a UE sends a Tracking Area Update (TAU) message when said UE enters a particular public cell in a Tracking Area (TA), and as a response to said TAU message a public base station sends information relating to a cell relation between a private cell, covered by said particular private base station, and other public or private cells in a vicinity of the private cell.

36. Method as claimed in claim 1, wherein, when said private base station is in an interference reduction mode, and said UE being in proximity to said private base station, said private base station detects a Discontinuous Transmission (DTX) pattern and sends a random access burst to bring said private base station into normal operation mode.

37. Method as claimed in claim 1, wherein a time interval between two of said private cell re-selection searches depends on a distance between said UE and said private base station.

38. Method as claimed in claim 37, wherein said time interval is relatively short when said distance is short.

39. Method as claimed in claim 37, wherein said time interval is relatively long when said distance is long.

40. Method as claimed in claim 1, wherein said private network is of the same type as said public network.

41. Method as claimed in claim 1, wherein said private network and said public network are of a different types.

42. Method of a network node for private cell re-selection of a User Equipment (UE) being in idle mode in a public network, said public network including at least one public base station covering a public cell, said UE also being able to communicate with a private network, said private network including at least one private base station covering a private cell and having limited access rights for UEs in the private network,

characterized in that said network node is configured to communicate, concerning a private cell re-selection search, with a particular UE having access rights to said private base station, only if said particular UE is in proximity to said private base station, where a detection of said proximity is based on information being specific for said UE and its relation to said private base station.

43. Method as claimed in claim 42, wherein said network node provides information to said UE, said UE performing said detection of said proximity based on said information.

44. Method as claimed in claim 43, wherein, when a cell plan for said private or said public network is updated, said information being provided to said UE includes both new cell information and old cell information, said information being transmitted by said network node in a cell information transmission.

45. Method as claimed in claim 44, wherein said cell information transmission is requested by said UE.

46. Method as claimed in claim 44, wherein said cell information transmission is a broadcast transmission.

47. Method as claimed in claim 43, wherein said network node provides information relating to a status of a covering situation of said at least one public cells.

48. Method as claimed in claim 42, wherein a detection of said proximity is performed by said network node.

49. Method as claimed in claim 48, wherein information related to said detection is provided to said UE.

50. Method as claimed in claim 49, wherein said network node informs said UE that proximity is detected.

51. Method as claimed in claim 49, wherein said network node orders said UE to search for a private base station.

52. Method as claimed in claim 48, wherein a location of said UE is detected by the use of an external electronic entity.

53. Method as claimed in claim 52, wherein said external electronic entity is any one in the group of: alarm entities, such as burglar alarms, motion detectors, alarm activation, alarm deactivation; household entities, such as door or garage port activation, kitchen appliance activation, electronic equipment activation.

54. Method as claimed in claim 42, wherein said network node is said private base station.

55. Method as claimed in claim 42, wherein said network node is a public base station.

56. Method as claimed in claim 55, wherein said public base station orders said UE to send an additional Tracking Area Update (TAU) message when said UE enters a particular cell in a Tracking Area (TA).

57. A User Equipment (UE) arranged for performing private cell re-selection of said UE being in idle mode in a public network, said public network including at least one public base station covering a public cell, said UE also being arranged for being able to communicate with a private network, said private network including at least one private base station covering a private cell and having limited access rights for UEs in the private network,

characterized in that said UE is arranged to only perform a private cell re-selection search when said UE is in proximity to a private base station to which said UE has access rights, where a detection of said proximity is based on information being specific for said UE and its relation to said private base station.

58. A network node arranged for performing private cell re-selection of a User Equipment (UE) being in idle mode in a public network, said public network including at least one public base station covering a public cell, said UE also being arranged for being able to communicate with a private network, said private network including at least one private base station covering a private cell and having limited access rights for UEs in the private network,

characterized in that said network node is arranged for communicating, concerning a private cell re-selection search, with a particular UE having access rights to said private base station, only if said particular UE is in proximity to said private base station, where a detection of said proximity is based on information being specific for said UE and its relation to said private base station.

59. The network node as claimed in claim 58, wherein said network node is said private base station.

60. The network node as claimed in claim 58, wherein said network node is a public base station.

61. A system arranged for performing private cell re-selection of a User Equipment (UE) being in idle mode in a public network, said public network including at least one public base station covering a public cell, said UE also being arranged for being able to communicate with a private network, said private network including at least one private base station covering a private cell and having limited access rights for UEs in the private network,

characterized in that

- said UE is arranged to only perform a private cell re-selection search when said UE is in proximity to a private base station to which said UE has access rights,

- a network node is arranged for communicating, concerning a private cell re-selection search, with a particular UE having access rights to said private base station, only if said particular UE is in proximity to said private base station, and

- detection of said proximity is based on information being specific for said UE and its relation to said private base station.

62. The network node as claimed in claim 61, wherein said network node is said private base station.

63. The network node as claimed in claim 61, wherein said network node is a public base station.

64. Computer program, characterized in code means, which when run in a computer causes the computer to execute the method according to any of the claims 1-56.

65. Computer program product including a computer readable medium and a computer program according to claim 64, wherein said computer program is included in the computer readable medium.

66. Computer program product according to claim 65, characterized in that said computer readable medium consists of one or more from the group: ROM (Read-Only Memory), PROM (Programmable Read-Only Memory), EPROM (Erasable PROM), Flash memory, EEPROM (Electrically Erasable PROM), hard disk drive.

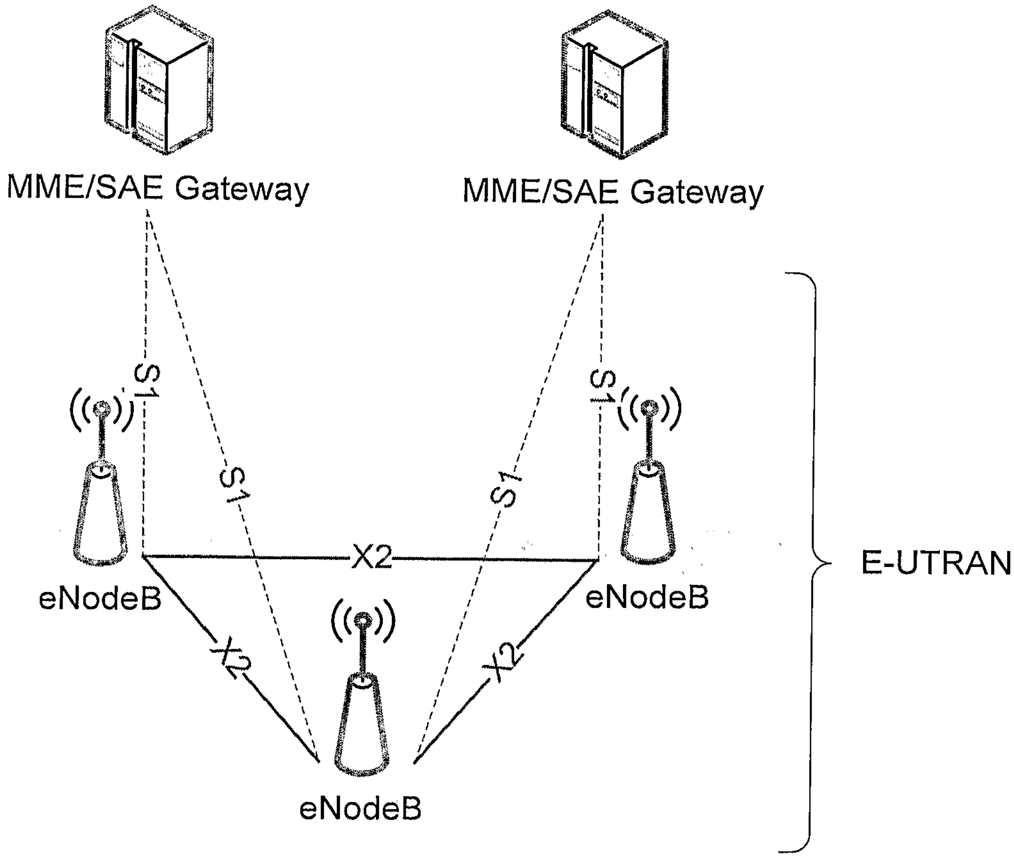
MME/SAE Gateway
MME/SAE Gateway
S1
S1
S1
S1
X2
X2
X2
eNodeB
eNodeB
eNodeB
E-UTRAN

Fig. 1

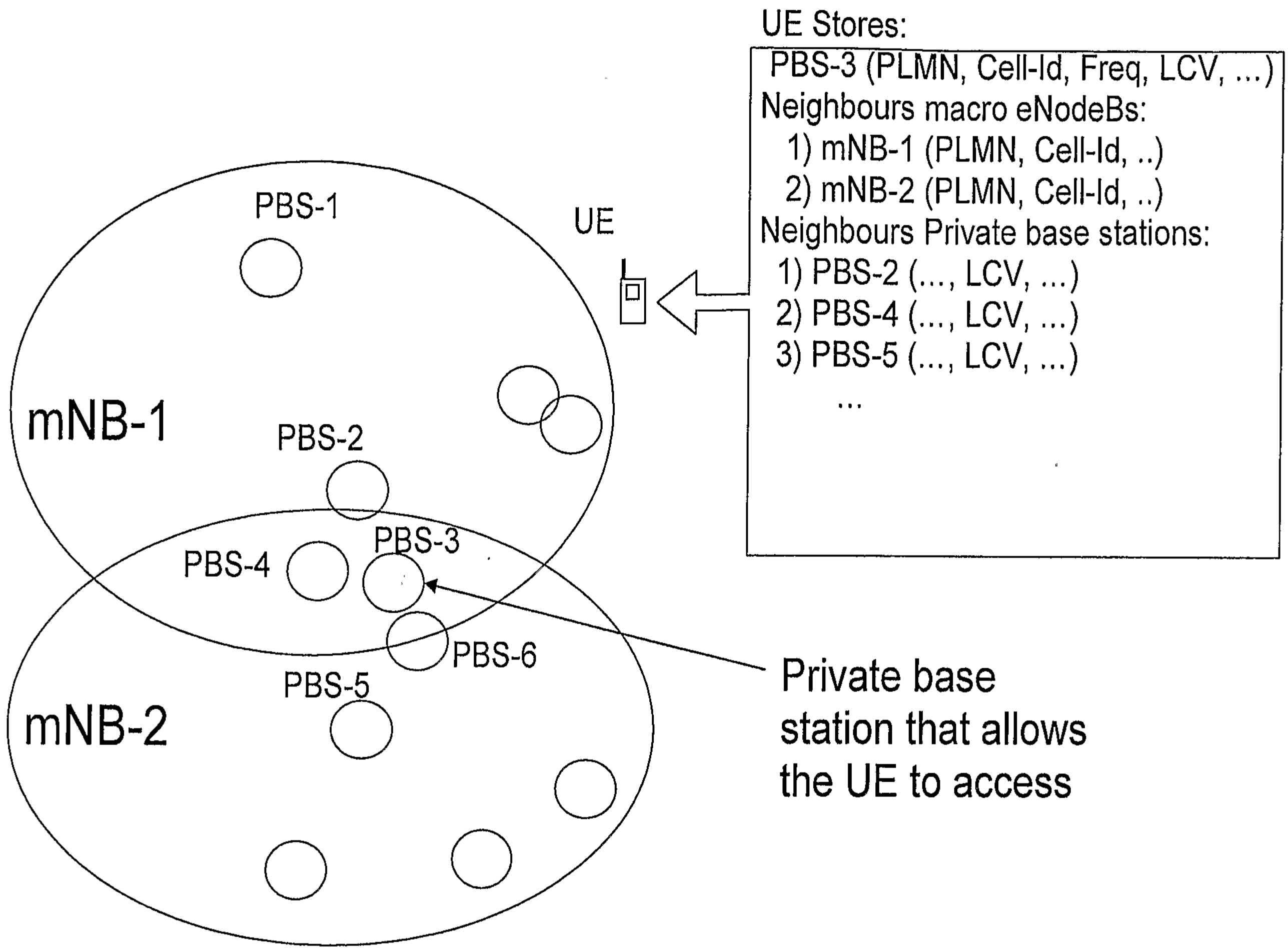
UE Stores:
PBS-3 (PLMN, Cell-Id, Freq, LCV, ...)
Neighbours macro eNodeBs:
1) mNB-1 (PLMN, Cell-Id, ..)
2) mNB-2 (PLMN, Cell-Id, ..)
Neighbours Private base stations:
1) PBS-2 (..., LCV, ...)
2) PBS-4 (..., LCV, ...)
3) PBS-5 (..., LCV, ...)
...
UE
PBS-1
mNB-1
PBS-2
PBS-3
PBS-4
PBS-6
PBS-5
mNB-2
Private base station that allows the UE to access

Fig. 2

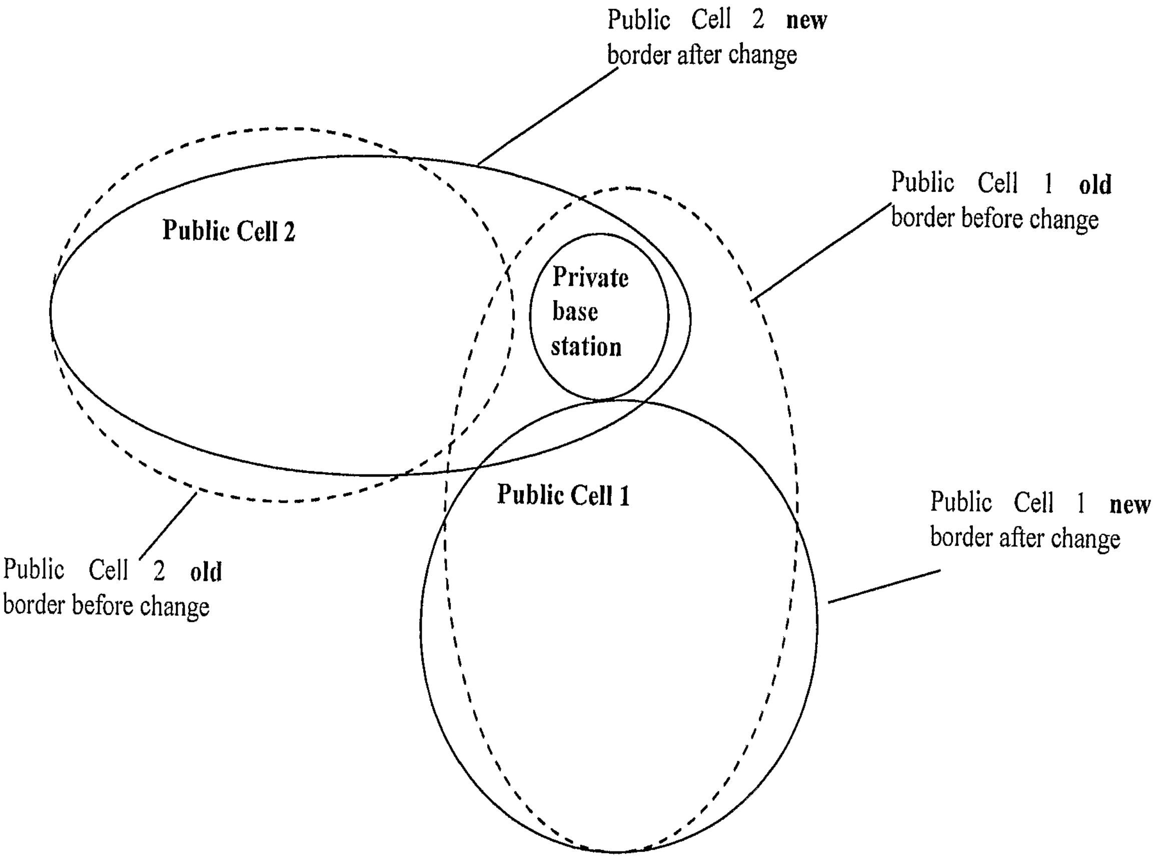
Public Cell 2 new
border after change
Public Cell 1 old
border before change
Public Cell 2
Private
base
station
Public Cell 1
Public Cell 1 new
border after change
Public Cell 2 old
border before change

Fig. 3

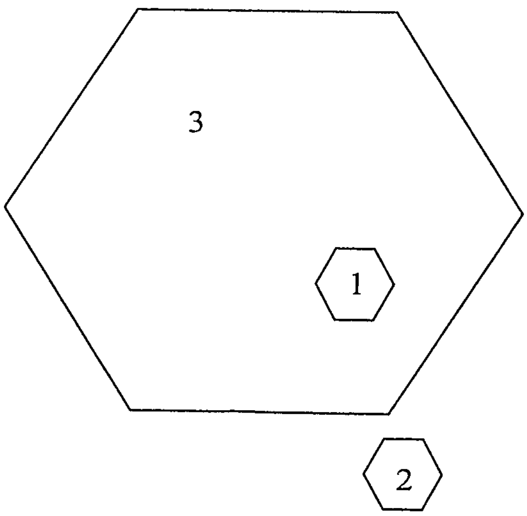
3
1
2

Fig. 4

INTERNATIONAL SEARCH REPORT	International application No. PCT/CN2007/001436

A. CLASSIFICATION OF SUBJECT MATTER

H04Q7/38 (2006.01) i

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:H04Q/-; H04BΛ; H04L/-; H04M/-; H04J/-

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)

WPI, EPODOC, PAJ, CPRS (public w network?, public w cell? public w BS?, public w base w station?, public w BTS?, private w network?, private w cell?, private w BS?, private w base w station?, private w BTS? +select+, handover, handoff, access,)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US6801772B1 (BRITISH TELECOMM), 05 October 2004 (05.10.2004) Abstract, column 5, line 12-column 9, line 23,claims 1-21, figs. 1-4	1,11,24,31,40-43,48,54,55, 57-66
A	US6058302A (ERICSSON TELEFON AB L M), 02 May 2000 (02.05.2000) Abstract, column 1, line 10- column 7, line 4, figs. l-3c	1-66
A	US68264 14B 1 (ORANGE PERSONAL COMM SERV LTD), 30 November 2004 (30. 11.2004) The whole document	1-66
A	US5448619A (ORION INDUSTRIES), 05 September 1995 (05.09.1995) The whole document	1-66

□ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 January 2008(21.01.2008)	31 Jan. 2008 (31.01.2008)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 5 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer ZHAO Hongyan Telephone No. (86-10)624 11391

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2007/001436

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
US6801772B1	05/10/2004	JP2002532989T T	02/10/2002
		EP1135949A1	26/09/2001
		CN1329805A	02/01/2002
		WO0035230A1	15/06/2000
US6058302A	02/05/2000	WO9914974A1	25/03/1999
		AU9195198A	05/04/1999
		GB2346048A	26/07/2000
		BRPI9812473A	19/09/2000
		TW429729B B	11/04/2001
		MXPA00002403A	01/10/2000
		AU742329B B2	20/12/2001
		GB2346048B	05/06/2002
		INDEL9802699A	21/10/2005
		CA2303367A	25/03/1999
US6826414B1	30/11/2004	GB2315193A	21/10/1998
		WO9802008A2	15/01/1998
		AU1608997A	02/02/1998
		ZA9705864A	31/03/1999
		EP0910924A2	28/04/1999
		CN1225224A	04/08/1999
		TW378442A	01/01/2000
		JP2000514267T T	24/10/2000
		GB2315193B	15/11/2000
		AU728172B B2	04/01/2001
		EP0910924B1	08/06/2005
		DE69733475D D1	14/07/2005
		CN1175687C	10/11/2004
		DE69733475T T2	16/03/2006
		ES2243975T T3	01/12/2005
		INCHE9701515A	02/03/2007

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2007/001436

Continuation of the "information on patent family members"

		JP3995105B2 B2	24/10/2007
		DE69733475T T2	16/03/2006
		AT297642T T	15/06/2005
US5448619A	05/09/1995	NONE	