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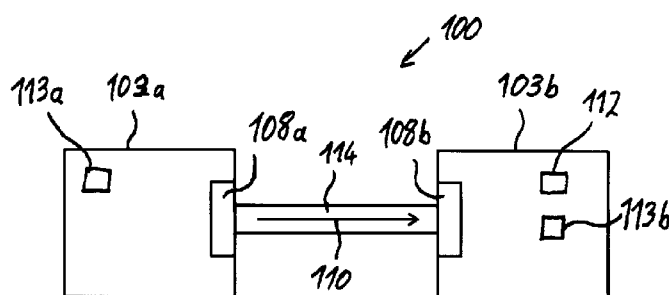


Fig. 2

(57) Abstract: A base station (first base station) (103a) of a cellular communication system (100) is provided, and the base station (103a) comprising an interface (108a) which is configured for providing position data (110) to a second base station (103b). The second base station (103b) comprises an interface (108b) for receiving the position data (110) from the first base station, wherein the position data may be related to a base station different from the first base station. Further, the second base station (103b) comprises a determination unit (112) for generating a first output signal which depends on the position data (110) received from the first base station (103a) and on position data which are related to the second base station (103b). The position data may include own position data which are related to the first base station (103a), e.g. to a geographical position of at least one cell served by the first base station. Further, the position data may indicate a spatial extent of a service area of a cell served by a first base station (103a), or the spatial extent of a unique identifier area of a cell served by the first base station (103a).



DESCRIPTION

Neighbour base station and neighbour cell determination in
cellular communication systems

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Field of the invention

The present invention relates to the field of cellular commu-
10 nication systems and in particular to determination of
neighbour base stations and neighbour cells in cellular com-
munication systems/networks.

15 Art background

In cellular communication systems it is known that if a user
equipment has an activated service in a base station and is
moving towards the boundary of the service area of the base
20 station, the quality of the radio connection can deteriorate
resulting in the service has to be handed over to a
neighbouring base station. To be able to perform this hand-
over, it is necessary that the current base station knows its
own neighbouring cells. In current radio communications sys-
25 tems this information is transmitted to each base station via
O&M.

For the Long-Term Evolution (LTE) mobile network for 3GPP
(3rd Generation Partnership Project) release 8 it is known to
30 provide an automatic neighbour relation function. The basics
of Automatic Neighbour Relation (ANR) are defined in 3GPP
36.300, with further details in 3GPP 36.413 and 3GPP 36.331.

The ANR function allows for each base station, referred to as eNB in the LTE mobile network, to detect its own neighbouring eNBs, to establish connections to those neighbouring base stations directly, via the so-called X2 interface described in 3GPP 36.423, and then, when necessary, hand over a user equipment to a neighbour base station using the so-called "handover procedure". The ANR function avoids the tedious task for the O&M system to distribute and maintain a huge amount of neighbour information data and reduces costs.

In particular the ANR basic mechanism is as follows: First, it is assumed that a user equipment is connected to a first base station eNB-A. In case the user equipment is near the service area border to a second base station eNB-B, the user equipment detects cells served by the second base station and reports the related Physical Cell ID (PCI) of the cells in an RRC (Radio Resource Control): Measurement report message to the first base station eNB-A. If the first base station eNB-A realizes that its database does not include the reported PCI, the first base station eNB-A instructs the user equipment to measure a global cell identity, e.g. an E-UTRAN Cell Global Identity (ECGI) of the newly discovered cell. Measuring the cell global identity is necessary in cases where the PCI is ambiguous: for example, in LTE only 512 PCIs are available and hence the PCIs are to be reused within the LTE radio network. Only neighbouring LTE cells have different PCI values. The ECGI however provides this unique identification of the cell in the network and can therefore be used by the LTE system for routing purposes. However determination of ECGI requires a complex measurement procedure. Further, the user equipment reads the PCI and the ECGI from a broadcast channel (BCCH) of the neighbour cell. Usually, BCCH is an open channel which does not include any integrity information. In a next step of the ANR procedure, the first base station eNB-A

retrieves the IP address of the base station which serves the cell identified by ECGI, i.e. of the second base station eNB-B), using S1 interface procedures S1: eNB configuration transfer and S1: MME configuration transfer, as described in 3GPP 36.413. Once the IP address of the second base eNB-B station is available, the first base station eNB-A is able to contact the second base station eNB-B and to establish the X2 interface using the X2 set up procedure (see 3GPP 36.423). Included in X2 set up request message, the first base station eNB-A sends two types of cell information to the second base station eNB-B: First, information about the cell supported by the first base station eNB-A and, second, information about neighbour cells known to the first base station eNB-A. Equivalently, the second base station eNB-B sends with X2 setup response message information about cells supported by it and also the neighbour cells known to it to the first base station eNB-A. Finally, the first base station eNB-A and the second base station eNB-B store the information received from the peer entity (eNB-B, eNB-A). Subsequently, handover procedures between cells supported by the first base station and those cells supported by the second base station are possible. It should be noted that depending on the actual implementation, further requirements may be required to be fulfilled for handover.

However, the ANR mechanism suffers from a number of drawbacks. Part of the ANR mechanism consists of neighbour cell resolution by UEs using cell global identity (CGI) measurements that they take. However, this is inefficient since it is time consuming and degrades provided service for UEs.

Summary of the invention

The inventor has further discovered that the CGI measurement may also result in a security breach, allowing e.g. denial-of-service attacks.

5 In view of the above-described situation, there exists a need for an improved technique that enables to provide for a cellular communication system with improved characteristics, while substantially avoiding or at least reducing one or more of the above-identified problems.

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This need may be met by the subject-matter according to the independent claims. Advantageous embodiments of the herein disclosed subject-matter are described by dependent claims.

15 According to a first aspect of the herein disclosed subject-matter, there is provided a base station of a cellular communication system. The base station according to the first aspect is referred to as first base station and comprises an interface configured for providing position data to a second
20 base station. According to an embodiment, the term "base station" as used herein refers to a network entity which serves and controls at least one cell of the cellular base station. According to a further embodiment, a base station is a network entity that provides the functionality which enables a
25 user equipment to access network services over an air interface. For example, the base station may comprise a base station controller and at least one base transceiver station. According to a further embodiment, the base station is a start-point and/or an end-point of a handover procedure.

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According to an embodiment of the first aspect, the first base station comprises, in addition to the interface or alternatively hereto, a control unit which is configured for providing position data to a second base station.

One basic idea of this aspect of the herein disclosed subject-matter is that the availability of position data can be used to determine whether a particular base station is a neighbour base station or not. In this way, the efficiency and/or security of the cellular communication system can be increased.

According to an embodiment, the interface is an X2 interface or an S1 interface of a LTE system.

According to a further embodiment of the first aspect, the position data include own position data which are related to the first base station. For example, the first base station may be configured so as to provide the desired position data. According to a further embodiment the position data include own position data which are related to a geographical position of the first base station. According to a further embodiment, the own position data are related to at least one cell served by the first base station. According to a further embodiment, the own position data indicate a geographical position of at least one cell served by the first base station. According to a further embodiment, the own position data are related to a geographical position of two or more cells served by the first base station. According to an embodiment of the first aspect, the position data is related to a base station different from the first base station. For example, the position data may be related to the second base station or to another, third base station. According to a further embodiment, the position data include own position data which are related to a geographical position of a cell served by the first base station.

According to a further embodiment of the first aspect, the position data indicate a spatial extent of a service area of a cell served by the first base station. Herein, a service area is an area within which the first base station is able to perform wireless communication with a user equipment.

According to a further embodiment of the first aspect, the position data indicate a spatial extent of a unique identifier area of the cell served by the first base station, wherein the unique identifier area is an area with (a) within which the first base station is able to perform wireless communication with the user equipment and (b) within which a local cell identifier of the first base station is unique among local cell identifiers of other base stations surrounding the first base station. According to an embodiment, the base stations which surround the first base station are base stations having a service area which overlaps with the service area of the first base station. Further, the service area of the first base station refers to, according to an embodiment, the common service area which is covered by all cells which are served by the respective base station under consideration.

According to a further embodiment of the first aspect, the position data include foreign position data which are related to a third base station which is different from the first base station and the second base station. According to a further embodiment, the foreign position data are related to a geographical position of at least one cell served by the third base station.

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Providing foreign position data to the second base station may further improve the efficiency of the cellular communication system.

According to a further embodiment of the first aspect, the first base station comprises a control unit which is configured for performing a setup of a communication link between the first base station and the second base station via the interface. Further, the control unit is configured for providing the position data to the second base station during the setup of the communication link between the first base station and the second base station. According to an embodiment, the communication link is a direct communication link without relay entity between the first base station and the second base station. An example of a direct communication link is the X2 link, the setup of which is described in 3GPP 36.423.

This embodiment allows for an efficient implementation of embodiments of the herein disclosed subject-matter since it uses an existing data transfer which is modified so as to include position data, thereby implementing embodiments of the herein disclosed subject-matter. However, it should be understood that instead of using the setup procedure for setting up a communication link, any other existing data transfer between two base stations may be modified to provide the functionality according to embodiments of the herein disclosed subject-matter. For example, according to another embodiment, a control unit of the first base station may be configured for transmission of configuration data from the first base station to the second base station via the interface, wherein the configuration data include the position data. For example, such a transmission of configuration data may be an Enhanced NodeB (eNB)/Mobility Management Entity (MME) configuration transfer procedure as defined in 3GPP 36.413 for the S1 interface.

Hence, any existing data transmission can be modified so as to be in accordance with embodiments of the herein disclosed subject-matter. Further, it should be understood that such data transmissions may occur directly between base stations, i.e. without further relay entities therebetween, or via such further relay entities, as for example a mobility management entity.

According to a second aspect of the herein disclosed subject-matter, a base station of a wireless communication system is provided, the base station being referred to as second base station and comprising an interface for receiving position data from a first base station, e.g. from a first base station as described with regard to the first aspect of the herein disclosed subject-matter. Accordingly, the position data received by the second base station may be of any type described with regard to the first aspect or an embodiment thereof, or vice versa.

For example, according to an embodiment of the second aspect, the position data include own position data which are related to the first base station.

According to an embodiment of the second aspect, the second base station comprises, in addition to the interface or alternatively hereto, a control unit which is configured for receiving position data from a second base station.

The second base station further comprises a determination unit for generating an output signal, referred to as first output signal, which depends on the position data received from the first base station and on position data which are related to the second base station. According to an embodiment, the determination unit comprises an output and is con-

figured for providing the first output signal at the output of the determination unit.

In response to the first output unit, further action may be performed. According to an embodiment, the base station comprises a respectively configured control unit for performing the further action. For example, according to one embodiment, the first base station is added to a neighbour list of the second base station or is removed from the neighbour list of the second base station, depending on the first output signal. However, these are only some examples of possible further actions and it should be understood that the first output signal can be used in numerous ways in order to improve the cellular communication system or at least provide alternative implementations of a cellular communication system.

According to a further embodiment of the second aspect, the own position data which are related to the first base station indicate a geographical position of a cell served by the first base station and the position data related to the second base station indicate a geographical position of a cell served by the second base station. Further, according to an embodiment the determination unit is configured for generating the first output signal if the distance between the geographical position of the cell served by the second base station and the geographical position of the cell served by the first base station is below a threshold. The threshold may be a preprogrammed threshold or may be based on measurements, just to give some examples. According to further embodiment, the determination unit is configured for generating a second output signal if the distance between the geographical position of the cell served by the second base station and the geographical position of the cell served by the first base station is equal or above the threshold.

According to an embodiment, the first output signal indicates that the first base station is a neighbour base station of the second base station whereas the second output signal indicates that the first base station is not a neighbour base station of the second base station. For example, according to an embodiment, the first output signal indicates that the first base station is a possible handover candidate.

According to another embodiment, the determination unit is configured to use the geographical position of the base stations itself instead of using the geographical positions of the cell served by the base stations for deciding whether the first output signal or the second output signal is provided.

According to a further embodiment of the second aspect, the position data which are related to the first base station indicate a spatial extent of a service area of a cell served by the first base station and the position data related to the second base station indicate a geographical position of a cell served by the second base station. As mentioned before, the service area of a cell of the first base station is an area within which the cell of the first base station is able to perform wireless communication with the user equipment and the service area of a cell of the second base station is an area within which the cell of the second base station is able to perform wireless communication with the user equipment. According to an embodiment, the determination unit is configured for generating the first output signal if the service area of the cell served by the first base station and the service area of the cell served by the second base station overlap each other, and the determination unit is configured for generating the second output signal otherwise.

According to other embodiments, a unique identifier area as defined with regard to the first aspect is used instead of the service area.

5 According to a further embodiment of the second aspect, the position data of the first base station include foreign position data which are related to a third base station which is different from the first base station and the second base station. For example, according to another embodiment, the
10 foreign position data are related to a geographical position of one or more cells served by the third base station. According to another embodiment, the determination unit is configured for generating a further output signal which depends on position data related to the second base station and the
15 position data related to the third base station. Again, it should be understood that instead of position data relating to a base station, position data relating to a cell served by the respective base station may be used.

20 According to a further embodiment of the second aspect, the second base station comprises a control unit which is further configured for performing a setup of a communication link between the first base station and the second base station and which is further configured for receiving the position data
25 from the first base station during the setup of the communication link between the first base station and second base station.

According to a third aspect of the herein disclosed subject-
30 matter, a cellular communication system is provided, the cellular communication system comprising a first base station according to the first aspect or an embodiment thereof, and a second base station according to the second aspect or an embodiment thereof.

A fourth aspect of the herein disclosed subject-matter provides a method of operating a base station of a cellular communication system, the base station being referred as first
5 base station, wherein the method comprises providing position data to a second base station. Generally, the position data of the fourth aspect may be one of those described with regard to the first aspect, the second aspect, and embodiments thereof, or at least of the same type. Further embodiments of
10 the fourth aspect of the herein disclosed subject-matter may include any feature disclosed with regard to the first aspect, the second aspect or embodiments thereof.

According to a fifth aspect of the herein disclosed subject-matter, a method of operating a base station of a wireless
15 communication system is provided, wherein the base station is referred to as second base station and the method comprises receiving position data from a first base station and generating a first output signal which depends on position data
20 being related to the second base station and on the position data received from the first base station. Embodiments of the fifth aspect of the herein disclosed subject-matter may include any feature disclosed with regard to the first aspect, the second aspect or embodiments thereof.

25
According to a sixth aspect of the herein disclosed subject-matter there is provided a computer program for processing a physical object, namely position data, the computer program, when being executed by a data processor, is adapted for controlling the method as set forth in the fourth aspect or an
30 embodiment thereof.

According to a seventh aspect of the herein disclosed subject-matter, a computer program for processing a physical ob-

ject, namely position data, is provided, the computer program, when being executed by a data processor, is adapted for controlling the method as set forth in the fifth aspect or an embodiment thereof.

5

According to an eighth aspect of the herein disclosed subject matter, a network element is provided, the network element being configured for providing to a base station of a cellular communication system own position data which are related to the base station. To this end, according to an embodiment the network element comprises an interface which is configured for providing to a base station of a cellular communication system/network own position data which are related to the base station. According to an embodiment, the network element may be a mobility management entity (MME) or an operation and maintenance center, providing to each base station associated with it the own position data of the base station.

20 According to a further embodiment, the network element further comprises a further interface for receiving the position data from a base station which is referred to as first base station in some embodiments. Accordingly, the base station to which the network element provides the position data may be referred to as second base station. Accordingly, the network element interface for receiving the position data is referred to as first interface of the network element and the network element interface for providing the position data to the second base station is referred to as second interface of the network element in some embodiments.

30

According to a further embodiment, the network element comprises a control unit for relaying the position data received from the first base station via the first interface of the

network element to the second base station via the second interface of the network element.

The interface(s) of the network element may be configured similar or identical to the interfaces of the base station according to the first and second aspect or an embodiment thereof. For example, the interfaces may be configured for receiving/transmitting position data as disclosed with regard to the first and second aspect or an embodiment thereof.

As used herein, reference to a computer program is intended to be equivalent to a reference to a program element and/or a computer-readable medium containing instructions for controlling a computer system to coordinate the performance of the above-described methods. The computer program may be implemented as a computer-readable instruction code by use of any suitable programming language, such as, for example, JAVA, C++, and may be stored on a computer-readable medium (removable disk, volatile or non-volatile memory, embedded memory/processor, etc.). The instruction code is operable to program a computer or any other programmable device to carry out the intended functions and/or methods. The computer program may be available from a network, such as the World-WideWeb from which it may be downloaded. The herein disclosed subject matter may be realized by means of a computer program respectively software. However, the herein disclosed subject matter may also be realized by means of one or more specific electronic circuits respectively hardware. Furthermore, the invention may also be realized in a hybrid form, i.e. in a combination of software modules and hardware modules.

In the following, there will be described exemplary embodiments of the subject-matter disclosed herein with reference to a first base station, to a second base station and to

methods for operating a first base station or a second base station. It has to be pointed out that of course any combination of features relating to different aspects of the herein disclosed subject-matter is also possible. In particular, some embodiments have been described with reference to apparatus claims whereas other embodiments have been described with reference to method type claims. However, a person skilled in the art will gather from the above and the following description that, unless otherwise notified, in addition to any combination of features belonging to one aspect also any combination between features relating to different aspects or embodiments, for example even between features of apparatus type claims and features of method type claims is also considered to be disclosed with this application. Further, features which have been described with regard to the first aspect may also be combined with embodiments of the second aspect, and vice versa. For example, it should be understood that any feature relating to the position data disclosed with regard to the first aspect may correspondingly implemented also in an embodiment of the second aspect, since the second base station receives the position data which is provided by the first base station according to the first aspect or an embodiment thereof.

The aspects and embodiments defined above and further aspects and embodiments of the herein disclosed subject-matter are apparent from the examples to be described hereinafter which are explained with reference to the drawings but to which the invention is not limited.

Brief description of the drawings

Fig. 1 schematically shows part of a network configuration of a cellular communication system according to embodiments of the herein disclosed subject-matter.

5 Fig. 2 schematically shows a first base station and a second base station in accordance with embodiments of the herein disclosed subject-matter.

Fig. 3 schematically shows part of a cellular communication
10 system in accordance with embodiments of the herein disclosed subject-matter.

Fig. 4 schematically illustrates message transfers in a cellular communication system in accordance with embodiments of
15 the herein disclosed subject-matter.

Detailed Description

20 The illustration in the drawings is schematic. It is noted that in different figures, similar or identical elements are provided with the same reference signs or with reference signs, which are different from the corresponding reference signs only within the first digit or within an appended character.
25

Fig. 1 schematically shows part of a cellular communication system 100 in accordance with embodiments of the herein disclosed subject-matter. The cellular communication system 100
30 comprises a plurality of cells, some of which are indicated at 102 in Fig. 1. Having regard to an arbitrary one of the plurality of cells 102, hereinafter referred to as first cell 102a, some basic features of the cellular communication sys-

tem are described in the following. The first cell 102a is served by a first base station 103a.

The cellular communication system 100 further comprises core
5 network elements and in particular a pool of Mobility Management Entities (MMEs) which are identified at 104 in Fig. 1. Each of the core network elements and the base station of each cell comprises a communication interface 106 for establishing a respective communication link between the base sta-
10 tion 103a, 103b and the associated network element 104. In the case of LTE one such interface between a network element 104 and a base station 103a, 103b is a so-called S1 interface. The cell under consideration (first cell 102a) has a number of neighbour cells 102b, e.g. six neighbour cells as
15 shown in the simplified illustration in Fig. 1. The neighbour cells each are served by a respective second base station 103b, 103c. Between two cells a direct communication may be provided via a respective interface, one of which is exemplarily indicated at 108 in Fig. 1. The direct communication in-
20 terface 108 may be for example a so-called X2 interface as defined for LTE. The direct communication interface 108 allows for data exchange between two cells, respectively between the base stations which serve the cells. Further, as shown in the configuration depicted in Fig. 1, according to a
25 further embodiment, the data exchange between two cells, for example between the first cell 102a and one of the second cells 102b may be performed via the communication interface 106, i.e. via a further network element 104, or may be performed directly by using the direct communication interface
30 108.

According to an embodiment, one or more of the interfaces 106, 108 which are provided for a data communication between two cells 102a, 102b are configured for providing position

data to the second base station 103b which serves the second cell 102b.

In the following, some exemplary embodiments for the position data are discussed.

For example, according to an embodiment, the position data provided by the interface 106, 108 of the first base station 103a are own position data which are related to the first base station 103a. However, according to other embodiments, the position data include foreign position data which are related to a third base station 103c which is different from the first base station 103a and the second base station 103b. The third base station may be for example a further neighbour base station 103c, or may be another, more distant base station, such as a next nearest neighbour base station 103d.

In the exemplary embodiment, the position data are related to a geographical position of a cell 102a served by a certain base station 103a under consideration. According to another embodiment, the position data which are related to the base station 103a under consideration indicate the geographical position of the base station 103a under consideration.

It should be understood that the functionality of both, a first base station and a second base station in the sense of the herein disclosed subject matter may be implemented in a single base station. This allows for a bidirectional exchange of position data between base stations.

Fig. 2 exemplarily shows two base stations 103a, 103b of the cellular communication system 100 of Fig. 1 in greater detail. The base stations 103a and 103b are configured in accordance with embodiments of the herein disclosed subject-

matter. For example, the first base station 103a comprises an interface 108a which is configured for providing position data, indicated at 110 in Fig. 2, to the second base station 103. Further, the second base station comprises an interface 5 108b for receiving the position data 110 from the first base station 103a. The second base station 103b further comprises a determination unit 112 for generating a first output signal which depends on the position data 110 received from the first base station 103a and on position data which are re- 10 lated to the second base station 103b. For example, the determination unit 112 may include a storage having stored therein the position data which are related to the second base station 103b. The position data which are related to the second base station 103b may be provided for example by an 15 operation and maintenance center (O&M) of the cellular communication system. However, it should be understood that the way how the position data is obtained for a base station of the herein disclosed subject-matter is not critical and any suitable way of providing such position data is also possible. 20 ble.

According to a further embodiment, the first base station 103a comprises a control unit 113a which is configured for performing a setup of a communication link 114 between the 25 first base station 103a and the second base station 103b via the interface 108a. Likewise, the second base station 103b comprises a control unit 113b which is configured for performing the setup of the communication link 114 between the first base station 103a and the second base station 103b. Ac- 30 cording to a further embodiment, the control unit 113a of the first base station 103a is configured for providing the position data 110 to the second base station 103b during the setup of the communication link 114. The control unit 113b of the second base station 103b is, according to one embodiment,

configured for receiving the position data 110 from the first base station 103a during the setup of the communication link 114. According to other embodiments, the control unit 113a of the first base station is configured for providing the position data 110 to the second base station after successfully setting up the communication link 114. Accordingly, the control unit 113b of the second base station may be configured for receiving the position data 110 from the first base station after successfully setting up the communication link 114.

Although the interfaces 108a, 108b of the base stations 103a, 103b shown in Fig. 2 are interfaces for establishing a direct communication link between two base stations, it should be understood that this particular example has been only chosen for illustrative purposes. Hence, in other embodiments the communication link 114 may be established over further network elements (not shown in Fig. 2), for example mobility management entities, as described with regard to Fig. 1.

According to a further embodiment, the control unit 113a of the first base station may be configured for transmission of configuration data from the first base station 103a to the second base station 103b via the interface 108a, wherein the configuration data include the position data 110. Likewise, according to a further embodiment, the control unit 113b of the second base station 103b is configured for reception of the configuration data from the first base station via the interface 108b, the configuration data including the position data 110, as described before.

Fig. 3 schematically shows part of a cellular communication system 200 according to embodiments of the herein disclosed subject-matter.

In order to illustrate further embodiments of position data, Fig. 3 shows four base stations 203a, 203b, 203c, 203d, each of which serves one cell 202a, 202b, 202c, 202d. It should be understood that according to other embodiments, each base station may serve two or more cells. Further, according to still other embodiments, two or more base stations may be provided for serving one cell.

According to an embodiment of the herein disclosed subject-matter, the position data indicate a spatial extent of a service area of a cell which is served by its corresponding base station. Herein, the service area is an area within which different base station is able to perform wireless communication with the user equipment. In Fig. 3, the service area borders of the cells 202a, 202b, 202c, 202d are indicated at 220a, 220b, 220c, 220d, respectively. For example, according to an embodiment, the border of a service area may be defined as geographical position where the signal strength of the base station falls below a certain threshold.

According to another embodiment, the position data indicate a spatial extent of a unique identifier area of a cell served by its base station. To this end, base station 203b of Fig. 3 is considered as a first base station in the sense of the herein disclosed subject-matter. The service area of the first base station 203b is indicated by the solid line 220b in Fig. 3. In order to further illustrate the unique identifier area of the first base station 203b, it is assumed that a local cell identifier of the cell 202b and the neighbour cell 202a are unique compared to each other. Moreover, it is assumed that the local cell identifier of cell 202d of Fig. 3 is the same as the local cell identifier of the cell 202b served by the first base station 203b. In the illustrated em-

bodiment, the unique identifier area is defined as the area within which a local cell identifier of the first base station is unique among local cell identifiers of other base stations 203b, 203c, 203d surrounding the first base station, the service areas of which overlap with the service area of the first base station 203a. Hence, the area where the service areas of the cells 202b, 202d with the same local cell identifier overlap does not belong to the unique identifier area. The overlap area between cell 202b and cell 202d is hedged in Fig. 3. Hence, the unique cell identifier area of the base station 203b is given by the service area 202b without the overlap area 222. It should be emphasized that the situation depicted in Fig. 3 is schematic and for illustration purposes only. Real radio cells of a cellular communication system may have a different and more complicated shape depending on the environment of the respective base stations.

The position data which are related to a spatial extent of a service area/unique identifier area may be provided as describing the real shape of the service area or unique identifier area of a cell. However, according to other embodiments only a radius may be provided as position data indicating the spatial extent of a service area or of a unique identifier area, wherein the radius is an estimate of the real spatial extent of the service area. For example, in an embodiment the radius corresponds to the smallest distance of the respective area border from the base station serving the cell or is at least within the service area. According to other embodiments, the spatial extent of a service area may be classified into a number of different sizes. For example, the spatial extent of a service area may be classified as "small", "medium" or "large", wherein each size corresponds to a predefined service area radius.

In the following, a possible realization of embodiments of the herein disclosed subject matter in an LTE system as an example of a cellular communication system are discussed. For example, in an embodiment the position data include the geographical position of the first base station and the radius of a service area of the cell served by the first base station. To this end, it is proposed to adapt the 3GPP specification for the S1 interface (i.e. recommendation 3GPP 36.413) and/or X2 interface (i.e. recommendation 3GPP 36.423) to allow the exchange of position data. More detailed:

According to an embodiment, to each eNB of the LTE network, position data of the own eNB are provided via O&M. In an alternative embodiment, a base station may determine or receive its own position data from any other source. If an eNB decides to contact another eNB, the adaption of 3GPP c-plane signalling (via S1 and/or X2 interface) allows both eNBs to exchange their respective position data.

For the exchange of position data, the following options are seen:

- Position data exchange via eNB/MME Configuration Transfer procedure: The eNB/MME Configuration Transfer procedures are defined in 3GPP 36.413 for the S1 interface and are currently used for the exchange of Transport layer addresses between eNBs. Possible enhancement of 3GPP 36.413: Add position data to the information element 'SON Information Reply'.
- Position Data exchange via X2 Setup procedure: The X2 Setup procedure which is already applied for exchange of configuration parameters of the eNBs could be enhanced with Position Data IE. For example, position data including the geographical position of the base station and the

radius of the serving area of the cell may be added to
'Served Cell Information' IE (cf. to 36.423, section
9.2.8). If the position data include foreign position
data, a position data IE may also be added to the
5 neighbour information IE included in X2 Setup Request/ Re-
sponse messages (cf. to 36.423, section 9.1.2.3 /
9.1.2.4).

Fig. 4 schematically illustrates part of a cellular communi-
10 cation system 300, further indicating communication between
the entities of the cellular communication system 300. For
illustrative purposes reference is made to entities of an LTE
system. However, the described embodiments are not limited
hereto.

15 The communication system 300 shown in Fig. 4 comprises an op-
eration and maintenance (O&M) unit 304 and three base sta-
tions (enhanced NodeBs, ENB, according to LTE) 303a, 303b,
303c. Further, an exemplary user equipment 330 is considered
20 in Fig. 4.

In the following, a situation is described which may arise
e.g. when a new base station is brought into an existing net-
work or if the base station has to restore its database e.g.
25 after a maintenance shutdown. According to an embodiment
shown in Fig. 4, own position is provided to each base sta-
tion by the O&M unit 304. For example, if the second base
station is brought into the existing network comprising base
stations 303a and 303c, own position data of the second base
30 station 303b are provided to the second base station by the
O&M unit 304, indicated at 439. It is assumed that the other
base stations 303a, 303c of the network have already stored
their own position data.

To start the automatic neighbour cell resolution according to the herein disclosed subject-matter, the second base station 303b needs information about one available neighbour base station, e.g. the first base station 303a. According to an embodiment shown in Fig. 4, such information is retrieved via ECGI measurement from the user equipment 330. The ECGI measurement performed by the user equipment 330 is indicated at 440 in Fig. 4. In response hereto, the information about an available neighbour base station, e.g. ECGI in the present case, is provided to the second base station 303b in a neighbour identification message 441. According to other embodiments, the information about an available neighbour base station, e.g. a global cell identifier, may be provided by O&M unit at 439 or by a further network element, e.g. a mobility management entity (MME) to the second base station 303b. In an embodiment, information about an available neighbour base station may be or may include an IP address of the available neighbour base station 303a.

By using the information about the available neighbour base station (first base station 303a in the scenario shown in Fig. 4), the second base station 303b contacts the first base station 303a, requesting position data with a position data request message 442a. In response to the position data request message 442a, the first base station retrieves its own position data which are released to the second base station 303b. The retrieval of the position data is indicated at 443a in Fig. 4. The own position data may be retrieved e.g. from a storage of the first base station 303a. In response to the position data retrieval, the first base station 303a provides the own position data to the second base station in a position data response message 444a. In response to receiving the own position data of the first base station 303a, the second base station 303b may perform further actions depending on

the position data related to the first base station 303a and the position data related to the second base station 303b. Such further actions are indicated at 445a in Fig. 4.

5 Such further actions 445a may be any action disclosed herein or any other suitable action which takes into account the received position data. For example, by comparison of the position data related to the first base station 303a and the position data related to the second base station 303b, the second
10 base station 303b is able to decide (and may be respectively configured to do so) if the first base station is a valid candidate for its own neighbourhood. For example, in the case the distance between both base stations is much larger than the serving radius of the first base station plus
15 the serving radius of the second base station, the second base station would not permanently keep a direct communication link (e.g. X2 link) to the first base station. Further, the position data received from the first base station can be used to correlate local cell identifiers. For example, the
20 position data received from the first base station 303a can be used to correlate PCI values included in measurement report messages from the user equipment 330 to the neighbour cells. According to another embodiment, the further action may comprise generating, by the determination unit (see Fig.
25 2) the first signal if the service area of the cell served by the first base station and a service area of a cell served by the second base station overlap each other; and generating, by the determination unit, a second signal otherwise. According to other embodiment, a unique identifier area as defined
30 with regard to the first aspect is used instead of the service area; further, the embodiments may be combined, generating, in an embodiment, two or more different first signals.

According to a further embodiment, the retrieval of position data, indicated at 443a in Fig. 4, does not include only retrieval of own position data, but also retrieval of foreign position data, e.g. of neighbour base stations of the first base station 303a. Such a foreign neighbour base station is exemplarily indicated at 303c in Fig. 4. As described with regard to the first base station 303a, in order to determine whether the foreign, third base station 303c is a valid candidate for the neighbourhood of the second base station 303b, the second base station 303b may send a position data request message 442b to the third base station 303c. In response hereto, the third base station 303c retrieves own position data (and possibly, according to another embodiment, also foreign position data) in a position data retrieval 443b, and reports the retrieved position data in a position data response message 444b to the second base station 303b. The position data retrieval 443b may be for example reading position data from a storage of the third base station 303c. In response to the reception of the position data response message 444b, the second base station 303b performs further actions, indicated at 445b in Fig. 4. These further actions may be of the type disclosed with regard to the further actions 445a above.

In another embodiment, instead of foreign position data only foreign identification data are provided by a second base station. This at least allows the first base station to contact the foreign base station and to request position data from the foreign base station.

As is apparent from the above description and in particular from the description of Fig. 4, embodiments of the herein disclosed subject-matter have the advantage, even if the first cell has to be learned via e.g. ECGI measurement, the

number of required ECGI measurements is drastically reduced, since further neighbour base stations can be determined by exchanging position data with the already known base stations. It should be noted that from ECGI measurements, the node serving the cell can always be deduced since the global eNodeB identifier is part of ECGI. Further, as described above, by comparing position data of the foreign base stations with the own position data allows the second base station to identify those foreign base stations which are potential neighbours of it. To those base stations which are potential neighbours, the second base station may automatically establish a communication link, e.g. an X2 link or an S1 link, and adds the cells served by the potential neighbour base station to the own neighbour cell database which contains information about the neighbour base stations and/or the neighbour cells. Consequently, the second base station does not have to perform measurements, e.g. ECGI measurements for determining the cells served by the foreign base stations which are potential neighbours. By iteration of the above described procedures, the second base station is capable to resolve its complete own neighbourhood without repetition of global identifier measurements such as ECGI measurements.

This is advantageous because measurements of ECGI is problematic because of the following reasons: First as long as a base station is waiting for some ECGI measurement, a service provided to user equipments may be degraded, because a large number of user equipments may be engaged with strongest cell measurements for determining the strongest cell received by an individual user equipment. Further, in order to measure ECGI, even for interfrequency LTE cells it is necessary to use Discontinuous Reception (DRX) with a very long DRX cycle of, e.g., approximately 160 ms. As is known, by employing DRX, the user equipment listens only to the paging channels

within its DRX group and the network will only page the user equipment in that group of paging channels. Further, searching ECGI for interfrequency LTE cells may also be problematic because interfrequency measurements have to be activated for a large number of user equipments, what is not done during normal operation, and because even longer DRX cycles are needed. Another reason why ECGI measurements are problematic is that it may take considerable time for a base station to get an ECGI measurement from a user equipment since a number of conditions have to be fulfilled before an ECGI measurement can be successful. First, the user equipment (UE) has to be in a Radio Resource Control (RRC) connected state. Further, the UE has to roam in the correct region of the serving cell (i.e. in the border area between serving cell and the cell whose ECGI has to be measured) and the UE has to stay sufficiently long in this region. Further, the UE has to support ECGI measurement, wherein especially during an introduction phase of LTE it is expected that only a small percentage of UEs support ECGI measurement. Further it is required that the UE has no interfering service activated, for example, if the UE has a Guaranteed Bit Rate (GBR) service, then an ECGI measurement can not be performed by the user equipment.

Having in particular regard to the X2 interface of LTE and to the X2 setup procedure, it is noted that this procedure allows exchange of information of all cells served by the eNodeBs, i.e. not only information about the searched cell is exchanged. However, because PCI values are in general not unique, the ECGI measurement has to be repeated even in case the PCI is already known in the eNodeB due to an early X2 setup procedure. For example, if it is assumed that two eNodeBs ENB#1 and ENB#2 each serve ten cells and that from each cell of ENB#1 there are two cells of ENB#2 visible, then in ENB#1 has to resolve 20 times the ECGI of some PCI value

even though the data may be available after one ECGI measurement and successful X2 setup.

It is further noted, that the comparison of the own position data related to a base station with the position data related to other base stations allows the identification of distant base stations which in turn allows to improve the security of the cellular communication system. For example, without detection of distant base stations, the measurement of a cell global identifier may be a security breach which allows e.g. denial of service attacks by a malicious equipment. In this regard, it should be noted that valid combinations of PCI/ECGI can easily be obtained by scanning of broadcast channels (BCCH) of LTE cells because - as for other mobile communication systems - BCCH of LTE is not enciphered. Hence, if a malicious equipment sends a PCI/ECGI pair to an eNodeB, this eNodeB may try to retrieve information about the corresponding cell which is indeed too far away to be useful for the ENB. Such an operation may result in an overflow of number of X2 links. The number of X2 interfaces supported by an eNodeB is limited as reasonable for an eNodeB having correlation to only its neighbours (under normal circumstances not more than 15 - 20 X2 interfaces shall be required). If malicious equipment makes an eNodeB believe that distant eNodeBs are considered as neighbours to an eNodeB, the maximum number of X2 links which can be supported by the eNodeB may not be sufficient. As a consequence, if the eNodeB is unable to keep all X2 links, the eNodeB may be provoked to release an X2 link to a real neighbour and handover procedures to such a neighbour ENB would not be possible.

Further, the operation of an eNodeB may be constrained by PCI collisions. For example, if a PCI retrieved from a distant eNodeB collides with a PCI already available in an eNodeB un-

der consideration, the eNodeB under consideration may be provoked to remove the correct PCI from its database. Further, if an eNodeB under consideration has established an X2 link to a distant eNodeB and later on a new neighbour eNodeB becomes operable which uses the same PCI as the distant eNodeB, then the eNodeB under consideration would send an X2 "application protocol: handover request message" to the distant eNodeB instead of sending it to the real neighbour eNodeB. Further, the operation of an eNodeB under consideration may be constrained because of PCI confusion. If the PCI distributed by the malicious equipment is identical to a PCI known to the eNodeB under consideration and if the radio conditions of the user equipment are bad, the measurement reports from the user equipment may cause the eNodeB under consideration to handover its user equipment to the wrong neighbour eNodeB.

In all these cases, a comparison of the position data of the eNodeB under consideration and with the position data of another eNodeB allows the identification of distant base stations, i.e. a malicious equipment can not provoke a base station to establish and keep useless X2 links.

It should be understood that the above analysis is valid not only for an LTE system, but also for any other applicable cellular communication system.

According to embodiments of the herein disclosed subject-matter, any component of the cellular communication system, e.g. a determination unit, an interface, or a control unit is provided in the form of respective computer program products which enable a processor to provide the functionality of the respective elements as disclosed herein. According to other embodiments, any such component may be provided in hardware. According to other - mixed - embodiments some components may

be provided in software while other components are provided in hardware.

It should be noted that the term "comprising" does not exclude other elements or steps and the "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

In order to recapitulate the above described embodiments of the present invention one can state:

A base station of a cellular communication system is provided, and the base station comprising an interface which is configured for providing position data to a second base station. The second base station comprises an interface for receiving the position data from the first base station, wherein the position data may be related to a base station different from the first base station. Further, the second base station comprises a determination unit for generating a first output signal which depends on the position data received from the first base station and on position data which are related to the second base station. The position data may include own position data which are related to the first base station, e.g. to a geographical position of at least one cell served by the first base station. Further, the position data may indicate a spatial extent of a service area of a cell served by a first base station, or the spatial extent of a unique identifier area of a cell served by the first base station.

List of reference signs:

	100	cellular communication system
	102, 102a, 102b	cell of 100
5	103a, 103b, 103c, 103d	base station
	104	network element
	106	interface
	107	communication link between network element and base station
10	108, 108a, 108b	interface between base stations
	110	position information
	112	determination unit
	113, 113a, 113b	control unit
	114	communication link between base stations
15	200	cellular communication system
	202a, 202b, 202c, 202d	cell of 200
	203a, 203b, 203c, 203d	base station
	220a, 220b, 220c, 220d	service area borders
	222	overlap area
20	300	cellular communication system
	304	network element
	303a, 303b, 303c	base station
	330	user equipment
	439	providing own position data of a base station to the
25		base station
	440	global identifier measurement
	441	neighbour identification message
	442a, 442b	position data request message
	443a, 443b	position data retrieval
30	444a, 444b	position data response message
	445a, 445b	further actions

CLAIMS:

1. Base station of a cellular communication system (100, 200, 300), hereinafter referred to as first base station (103a, 203a, 303a), comprising:
 - an interface (106, 108, 108a) configured for providing position data (110) to a second base station (103b, 203b, 303b).
2. Base station according to claim 1,
 - wherein the position data (110) include own position data which are related to the first base station (103a, 203a, 303a).
3. Base station according to claim 1 or 2,
 - wherein the position data (110) indicate a geographical position of a cell (102a, 202a) served by the first base station (103a, 203a, 303a).
4. Base station according to one of the preceding claims,
 - wherein the position data (110) indicate a spatial extent of a service area (220a) of a cell (202a) served by the first base station (103a, 203a, 303a),
 - wherein the service area (220a) is an area within which the first base station (103a, 203a, 303a) is able to perform wireless communication with a user equipment.
5. Base station according to one of the preceding claims,
 - wherein the position data (110) indicate a spatial extent of a unique identifier area of the cell (102a, 202a) served by the first base station (103a, 203a, 303a),
 - wherein the unique identifier area is an area

- o within which the first base station (103a, 203a, 303a) is able to perform wireless communication with a user equipment and
- o within which a local cell identifier of the first
5 base station (103a, 203a, 303a) is unique among local cell identifiers of other base stations surrounding the first base station (103a, 203a, 303a).

6. Base station according to one of the preceding claims,

- 10 - wherein said position data (110) include foreign position data which are related to a third base station (103c, 103d, 303c) which is different from the first base station (103a, 203a, 303a) and the second base station (103b, 203b, 303b).

15

7. Base station according to one of the preceding claims, further comprising:

- a control unit (113a) being configured
 - o for performing a setup of a communication link
20 (114) between the first base station (103a, 203a, 303a) and the second base station (103b, 203b, 303b) via the interface, and
 - o for providing the position data (110) to the second
25 base station (103b, 203b, 303b) during said setup of the communication link (114) between the first base station (103a, 203a, 303a) and the second base station (103b, 203b, 303b).

8. Base station according to one of the preceding claims,

30 further comprising:

- a control unit (113a) being configured for transmission of configuration data from the first base station (103a,

203a, 303a) to the second base station (103b, 203b, 303b) via the interface,

- wherein said configuration data include said position data (110).

5

9. Base station of a wireless communication system, hereinafter referred to as second base station (103b, 203b, 303b), comprising:

- an interface (106, 108, 108b) for receiving position data (110) from a first base station (103a, 203a, 303a);
- a determination unit (112) for generating an first output signal which depends on the position data (110) received from the first base station (103a, 203a, 303a) and on position data which are related to the second base station (103b, 203b, 303b).

15

10. Base station according to claim 9,

- the position data (110) from the first base station (103a, 203a, 303a) include own position data which are related to the first base station (103a, 203a, 303a).
- wherein the own position data which are related to the first base station (103a, 203a, 303a) indicate a geographical position of a cell served by the first base station (103a, 203a, 303a);
- wherein the position data related to the second base station (103b, 203b, 303b) indicate a geographical position of a cell served by the second base station (103b, 203b, 303b);
- wherein the determination unit (112) is configured for generating the first signal if the distance between the geographical position of the cell served by the second base station (103b, 203b, 303b) and the geographical posi-

30

tion of the cell served by the first base station (103a, 203a, 303a) is below a threshold; and

- wherein the determination unit (112) is configured for generating a second signal if the distance between the geographical position of the cell of the second base station (103b, 203b, 303b) and the geographical position of the cell served by the first base station (103a, 203a, 303a) is equal or above the threshold.

11. Base station according to one of claims 9 or 10,

- wherein said position data (110) of the first base station (103a, 203a, 303a) include foreign position data which are related to a third base station which is different from the first base station (103a, 203a, 303a) and the second base station (103b, 203b, 303b); and

- wherein the determination unit (112) is configured for generating a further output signal which depends on position data related to the second base station (103b, 203b, 303b) and the position data related to the third base station.

12. Network element of a cellular communication system, the network element comprising:

- an interface which is configured for providing to a base station of the cellular communication system own position data which are related to the base station.

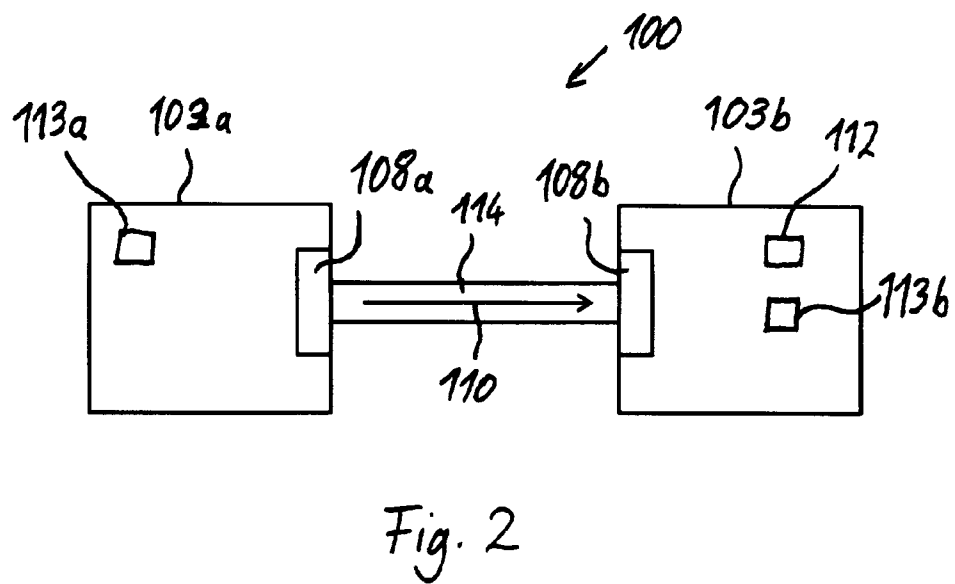
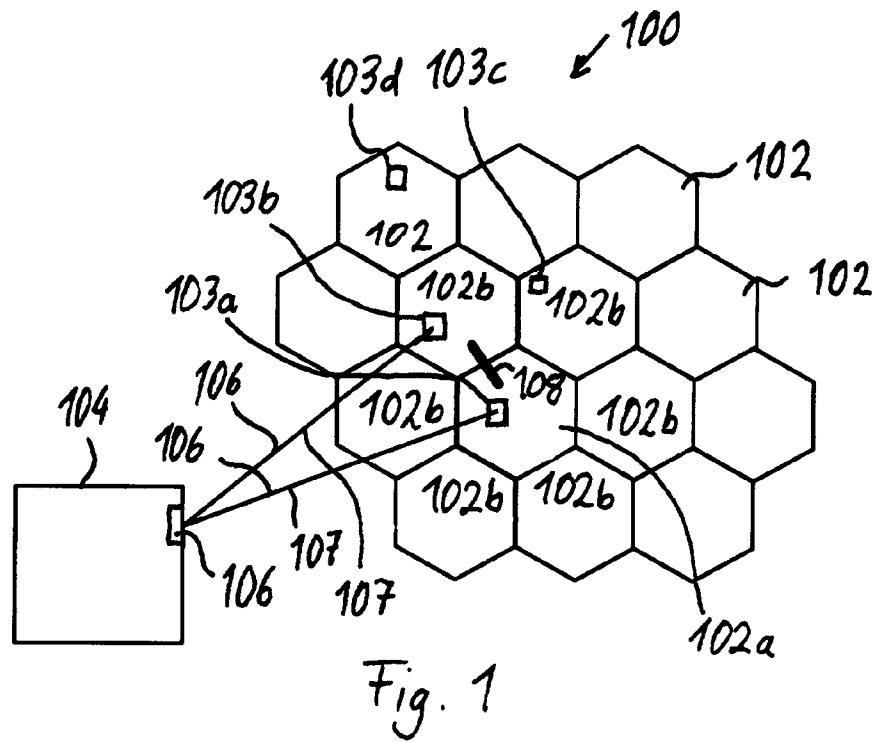
13. Cellular communication system comprising a first base station (103a, 203a, 303a) according to one of claims 1 to 8 and a second base station (103b, 203b, 303b) according to one of claims 9 to 12.

14. Method of operating a base station of a cellular communication system, hereinafter referred to as first base station (103a, 203a, 303a), comprising:

- providing position data (110) to a second base station (103b, 203b, 303b).

15. Method of operating a base station of a wireless communication system, the base station being hereinafter referred to as second base station (103b, 203b, 303b), the method comprising:

- receiving position data (110) from a first base station (103a, 203a, 303a),
- generating an output signal which depends on position data being related the second base station (103b, 203b, 303b) and the position data (110) received from the first base station (103a, 203a, 303a).



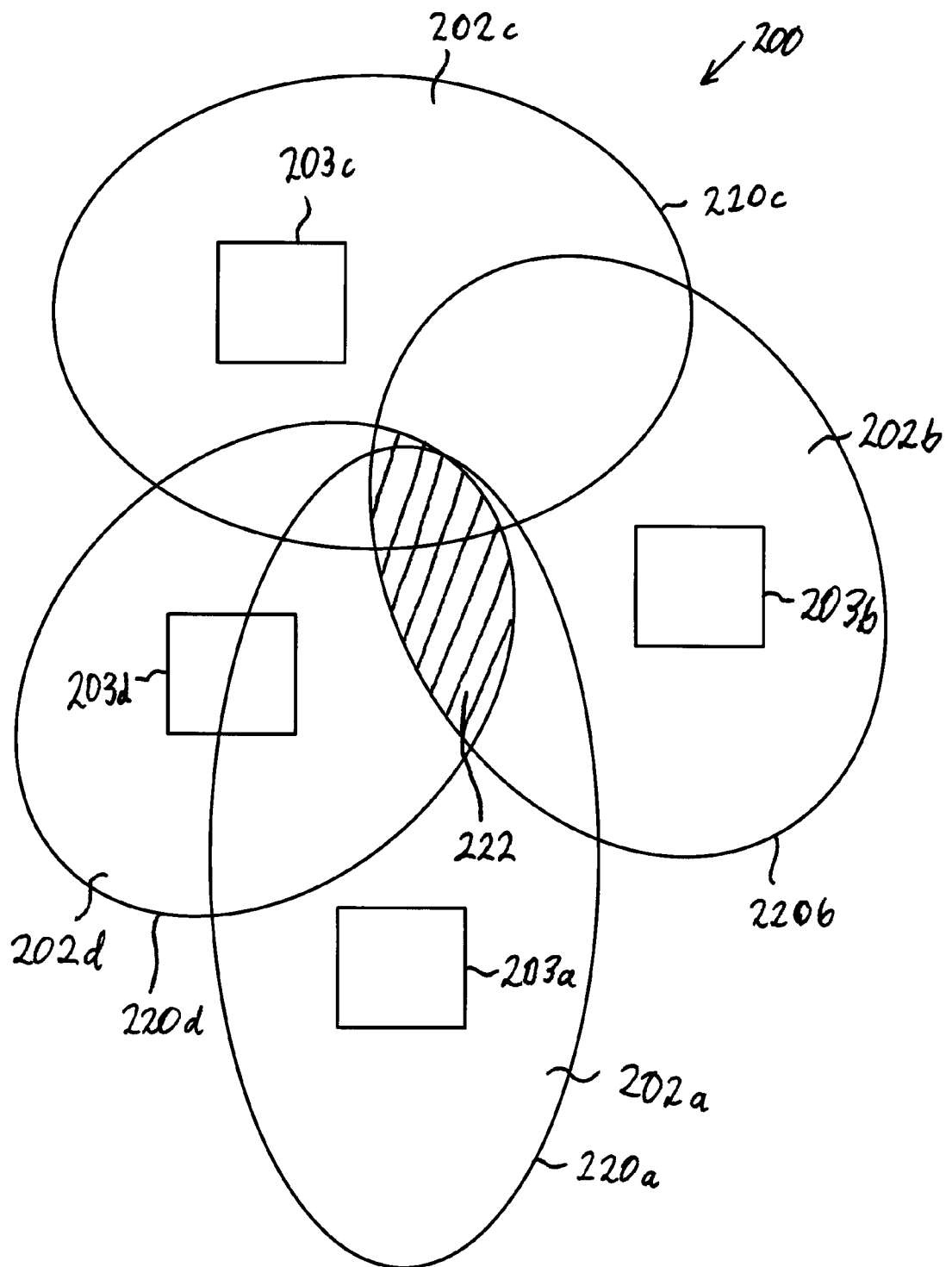


Fig. 3

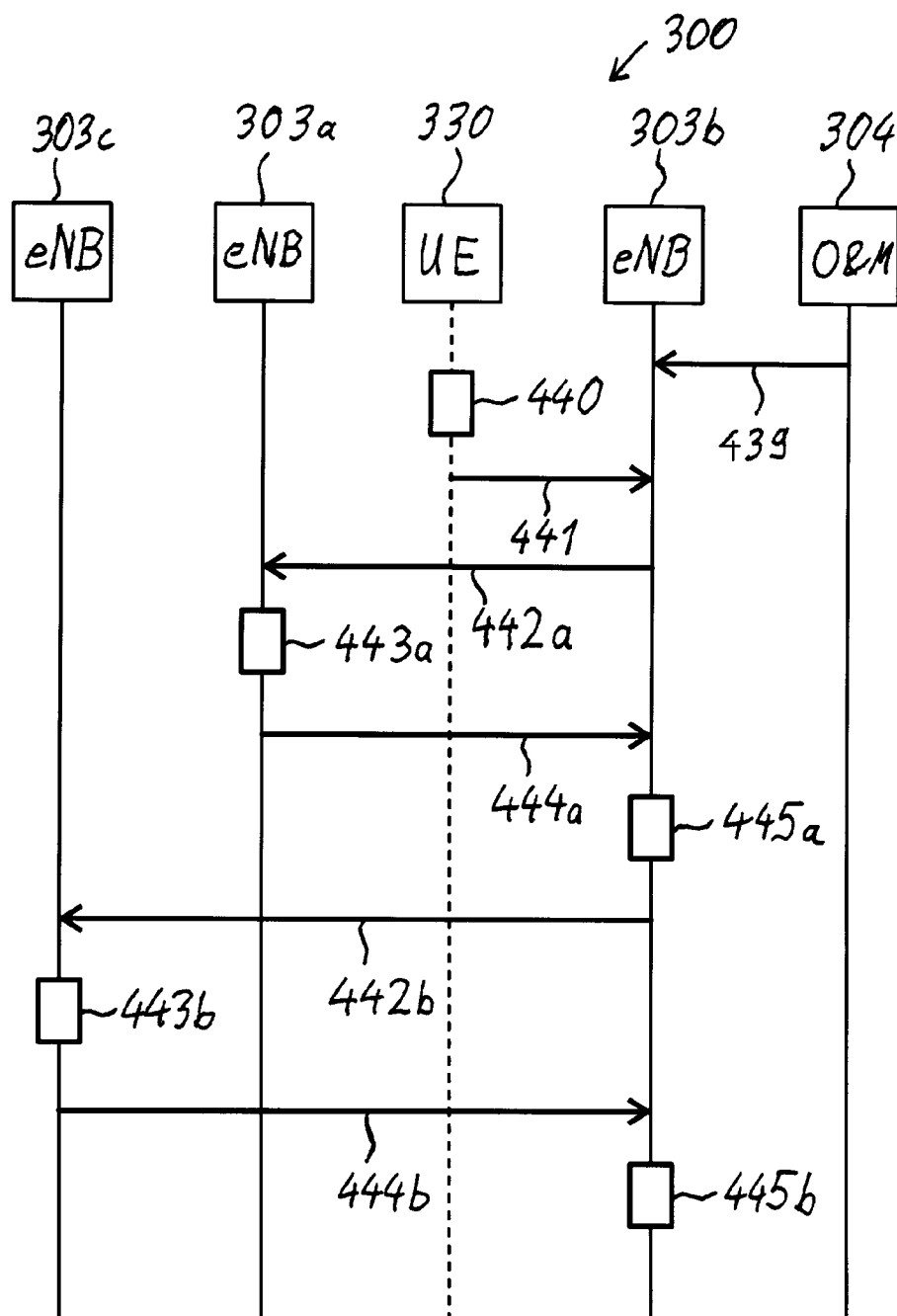


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/063982

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W24/04 H04W64/00
ADD.

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	NOKIA SIEMENS NETWORKS: "Automatic Physical Cell ID Assignment" 3GPP DRAFT; S5-081171, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. SA WG5, no. Sophia Antipolis, France; 20080701, 1 July 2008 (2008-07-01), XP050307766 [retrieved on 2008-07-01]	1-9, 11-15
Y	page 3, paragraph C page 1 section 3 page 4, paragraph C ----- -/--	10

☒ 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 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.

G document member of the same patent family

Date of the actual completion of the international search

9 July 2010

Date of mailing of the international search report

20/07/2010

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/063982

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 1 947 811 A1 (NOKIA SIEMENS NETWORKS GMBH [DE]; SIEMENS AG [DE]) 23 July 2008 (2008-07-23) paragraphs [0047], [0 48], [0 53], [0 54], [0 55] -----	10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2009/063982

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
EP 1947811	A1	23-07-2008	CN 101636985 A	27-01-2010
			WO 2008090133 A1	31-07-2008
			US 2010142403 A1	10-06-2010