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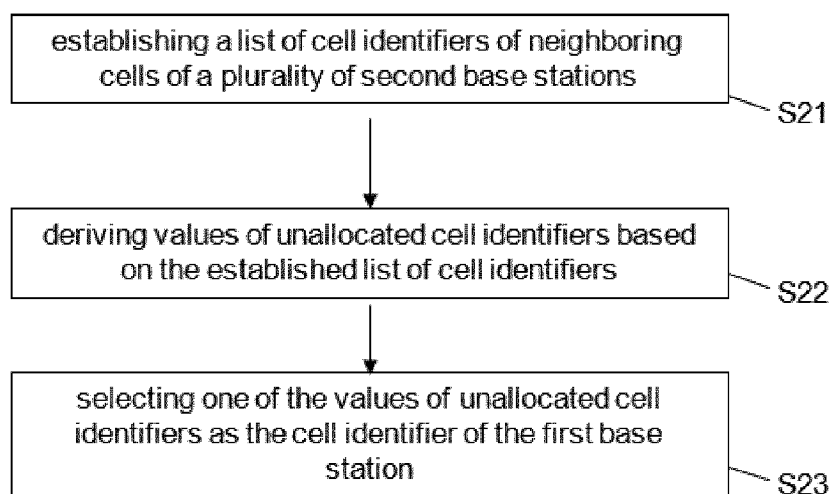
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- (54) **Title:** PHYSICAL CELL IDENTIFIER ALLOCATION

Fig. 2



(57) **Abstract:** The present invention provides a method, apparatus and computer program product relating to physical cell identifier allocation. The present invention includes establishing, at a network element, for a cell of first base station, a list of cell identifiers of neighboring cells of a plurality of second base stations, deriving values of unallocated cell identifiers based on the established list of cell identifiers, and selecting one of the values of unallocated cell identifiers as the cell identifier of the first base station.

DESCRIPTION

Physical cell identifier allocation

Field of the invention

The present invention relates to physical cell identifier allocation. In particular, the present invention relates to an apparatus, method and a program for physical cell identifier allocation.

Background of the invention

The invention relates to a mobile communication network with coexisting macro (high power) and small cell (low power) nodes.

Fig. 1 illustrates a scenario to which certain aspects of the present invention are applicable.

As shown in Fig. 1, the mobile communication network includes, as an example, at least one macro base station according to a wireless wide-area communication system, like e.g. macro eNB 11 according to Long Term Evolution / Long Term Evolution Advanced (LTE-/LTE-A) and a plurality of base stations, like e.g. small cell base stations, like e.g. pico eNBs 21, 22 and 23 according to LTE-/LTE-A. It is noted that the above described scenario is merely illustrated as an example and that the invention is of course not limited to such a scenario.

In general, when a new base station is deployed in the field, a Physical Cell Identity (PCI) needs to be selected for each of its supported cells. The PCI assignment shall fulfill the following conditions, as described in document [1]:

The PCI assignment should be collision-free, that means that the PCI is unique in the area that the cell covers for a given carrier frequency. In the example shown

in Fig. 1, this means that pico eNBs 21 and 22, the coverage area of which are overlapping should not have the same PCI so as to avoid collision.

Further, the PCI assignment should be confusion-free, that means that all intra-frequency neighbors of a cell should be uniquely identified by their PCI. In the example shown in Fig. 1, this means that pico eNBs 21, 22 and 23 and macro eNB 11 as well as any neighboring macro eNB should not have the same PCI so as to avoid confusion.

The problem of allocating PCIs to new cells is well known and similar to allocating frequencies in Global System for Mobile Communication (GSM) or scrambling codes in Wideband Code Division Multiple Access (WCDMA). Traditionally, a proper PCI allocation is derived from radio network planning during the evaluation of neighbor relationships between cells. However, because of inaccuracies in the models there can be a mismatch between theory and practice. The 3rd Generation Partnership Project (3GPP) has acknowledged the issue and PCI confusion can be resolved by instructing the terminal to read the unique Cell Global Identifier (CGI) of the target cell in question. After that, the PCI can be reconfigured by operation, administration and management (OAM). Such a PCI reconfiguration might require that the cell is restarted.

This approach makes sense for macro deployments, where new cells are mostly added because of coverage reasons (so there is no information available on PCIs already in use at the deployment location) and the number of nodes is relatively small. Planning (global knowledge), in this case cannot be avoided.

On the other hand, when deploying high numbers of low power nodes, the advantages of a distributed self-configuration approach making use of local knowledge become obvious.

Currently, there are two classes of methods for initial PCI allocation:

On the one hand, there is a centralized approach, as the one implemented in high level operations and maintenance (O&M), post processing of a planning tool or the like, which requires estimation of neighbor relationships using planning tools as an input. Based on the foreseen neighbor list and some rules on the preferred allocation of PCIs (e.g. modulo 3/6/30 (mod3/6/30) collision avoidance or maximization of reuse distance), a value for the new cells is derived.

Mod3/6 collision should be avoided to guarantee orthogonality of downlink (DL) reference signals (there are 3 different sequences used for Primary Synchronization Channels and 6 possible frequency shifts of DL reference symbols). Mod30 collision should be avoided to guarantee orthogonality of UL reference signals (there are 30 sequence groups), as described in document [2].

On the other hand, there exists a fully distributed approach, based on the capability to detect the PCIs already in use and derive a usable value. Detection can either be done by the new node going on air as a terminal first or by using a temporary PCI from a restricted range just for the time necessary to collect terminal measurements.

The first method assumes having global knowledge in order to try and select an appropriate value of PCI. The second has the advantage of not requiring planning and being suitable for deployment of large numbers of small nodes, but does not make best usage of the information already available in the deployed nodes.

Both methods are susceptible to errors, the first because of the inherent limitations of the models in depicting coverage in real environment, the second because the knowledge that the new node derives from own or terminal measurements reflects the situation in the surrounding area and as such is good to avoid collisions but does not consider the possibility of confusion among neighbor cells of the new cell's neighbors. In the heterogeneous network (Hetnet) scenario, it is probable that it is sufficient to avoid reusing PCIs of the macro cell neighbors, since this list will include other small cell neighbors as well.

References:

- [1]: "LTE Self-Organising Networks (SON)", Seppo Hamalainen, Henning Sanneck, Cinzia Sartori, December 2011;
- [2]: Practical Introduction to LTE Radio Planning, J. Salo, M. Nur-Alam, K. Chang, Nvoember 2010.

Summary of the Invention

It is therefore an object of the present invention to overcome the above mentioned problems and to provide methods, apparatuses and a program for physical cell identifier allocation.

According to an aspect of the present invention there is provided a method comprising:

establishing, at a network element, for a cell of first base station, a list of cell identifiers of neighboring cells of a plurality of second base stations of neighboring cells,

deriving, at the network element, values of unallocated cell identifiers based on the established list of cell identifiers, and

selecting, at the network element, one of the values of unallocated cell identifiers as the cell identifier of the first base station.

According to further refinements of the present invention as defined under the above aspect

- the method further comprises obtaining, at the network element, a cell identifier of each of cells of the plurality of second base station from each of the neighboring cells of the second base stations of the neighboring cells, and establishing the list of cell identifiers based on the obtained cell identifiers;
- the method further comprises requesting, by the network element, the cell identifiers from each of the neighboring cells of the plurality of second base stations of the neighboring cells;

- the method further comprises obtaining, at the network element, information on a cell type of the plurality of neighboring cells;
- deriving values of unallocated cell identifiers additionally takes into account the obtained information on a cell type of the plurality of neighboring cells.
- establishing the list of cell identifiers takes into account the obtained information on a cell type of the plurality of neighboring cells;
- cell identifiers in the established list of cell identifiers that cause mod3/mod6/mod30 collision are not derived considered when deriving unallocated cell identifiers;
- informing the first base station of the selected one of the values of cell identifiers;
- the network element is located in the first base station;
- the first base station is a small cell base station and the second base stations are macro base stations and/or small base stations.

According to another aspect of the present invention there is provided an apparatus, comprising:

- at least one processor,
- at least one interface to at least one other network element, and
- at least one memory for storing instructions to be executed by the processor, wherein

- the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least to perform:

- establishing, for a cell of a first base station, a list of cell identifiers of neighboring cells of a plurality of second base stations of neighboring cells,

- deriving values of unallocated cell identifiers based on the established list of cell identifiers, and

- selecting one of the values of unallocated cell identifiers as the cell identifier of the first base station.

According to further refinements of the present invention as defined under the above aspect

- the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus to perform obtaining, at the first base station, a cell identifier of each of cells of the plurality of second base station from each of the neighboring cells of the second base stations of the neighboring cells, and establishing the list of cell identifiers based on the obtained cell identifiers;
- the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus to perform requesting, by the first base station, the cell identifiers from each of the neighboring cells of the plurality of second base stations of the neighboring cells;
- the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus to perform obtaining, at the first base station, information on a cell type of the plurality of neighboring cells;
- deriving values of unallocated cell identifiers additionally takes into account the obtained information on a cell type of the plurality of neighboring cells;
- establishing the list of cell identifiers takes into account the obtained information on a cell type of the plurality of neighboring cells;
- cell identifiers in the established list of cell identifiers that cause mod3/mod6/mod30 collision are not derived considered when deriving unallocated cell identifiers;
- the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus to perform informing the first base station of the selected one of the values of cell identifiers;
- the apparatus is part of the first base station;
- the first base station is a small cell base station and the second base stations are macro base stations and/or small base stations.

According to another aspect of the present invention there is provided an apparatus, comprising:

means for establishing, for a cell of a first base station, a list of cell identifiers of neighboring cells of a plurality of second base stations of neighboring cells,

means for deriving values of unallocated cell identifiers based on the established list of cell identifiers, and

means for selecting one of the values of unallocated cell identifiers as the cell identifier of the first base station.

According to another aspect of the present invention there is provided a computer program product comprising code means adapted to produce steps of any of the methods as described above when loaded into the memory of a computer.

According to a still further aspect of the invention there is provided a computer program product as defined above, wherein the computer program product comprises a computer-readable medium on which the software code portions are stored.

According to a still further aspect of the invention there is provided a computer program product as defined above, wherein the program is directly loadable into an internal memory of the processing device.

Brief Description of the Drawings

These and other objects, features, details and advantages will become more fully apparent from the following detailed description of aspects/embodiments of the present invention which is to be taken in conjunction with the appended drawings, in which:

Fig. 1 is an overview illustrating a scenario to which certain aspects of the present invention are applicable;

Fig. 2 is a flowchart illustrating an example of a method according to certain aspects of the present invention;

Fig. 3 is a diagram illustrating an example of an apparatus according to certain aspects of the present invention.

Detailed Description

In the following, examples and embodiments of the present invention are described with reference to the drawings. For illustrating the present invention, the examples and embodiments will be described in connection with a cellular communication network based on a 3GPP based communication system, for example an LTE/LTE-A based system. However, it is to be noted that the present invention is not limited to an application using such a type of communication system, but is also applicable in other types of communication systems supporting handover, and the like.

Basic system architecture of a communication network where examples of embodiments of the invention are applicable may comprise a commonly known architecture of one or more communication systems comprising a wired or wireless access network subsystem and a core network. Such an architecture may comprise one or more access network control elements, radio access network elements, access service network gateways or base transceiver stations, such as a base station or eNB, which control a coverage area also referred to as a cell and with which one or more communication elements or terminal devices such as a UE or another device having a similar function, such as a modem chipset, a chip, a module etc., which can also be part of a UE or attached as a separate element to a UE, or the like, are capable to communicate via one or more channels for transmitting several types of data. Furthermore, core network elements such as gateway network elements, policy and charging control network elements, mobility management entities and the like may be comprised.

The general functions and interconnections of the described elements, which also depend on the actual network type, are known to those skilled in the art and described in corresponding specifications, so that a detailed description thereof is

omitted herein. However, it is to be noted that several additional network elements and signaling links may be employed for a communication to or from a communication element or terminal device like a UE and a communication network control element like a base transceiver station or eNB, besides those described in detail herein below.

Furthermore, the described network elements, such as terminal devices like UEs, communication network control elements of a macro cell, like an MeNB, communication network control elements of a small (pico, micro, femto etc.) cell, like an PeNB and the like, as well as corresponding functions as described herein may be implemented by software, e.g. by a computer program product for a computer, and/or by hardware. In any case, for executing their respective functions, correspondingly used devices, nodes or network elements may comprise several means and components (not shown) which are required for control, processing and communication/signaling functionality. Such means may comprise, for example, one or more processor units including one or more processing portions for executing instructions, programs and for processing data, memory means for storing instructions, programs and data, for serving as a work area of the processor or processing portion and the like (e.g. ROM, RAM, EEPROM, and the like), input means for inputting data and instructions by software (e.g. floppy disc, CD-ROM, EEPROM, and the like), user interface means for providing monitor and manipulation possibilities to a user (e.g. a screen, a keyboard and the like), interface means for establishing links and/or connections under the control of the processor unit or portion (e.g. wired and wireless interface means, an antenna, etc.) and the like. It is to be noted that in the present specification processing portions should not be only considered to represent physical portions of one or more processors, but may also be considered as a logical division of the referred processing tasks performed by one or more processors.

This invention addresses the allocation of PCIs for low power nodes inserted because of capacity. That means there is overlaying macro coverage. The

problem arises here, as this inserts additional relations between pre-planned and allocated PCIs which may lead to PCI collision or confusion without coordination effort.

According to certain aspects of the present invention, there is proposed a process with which the new low power node requests the list of PCIs allocated to the intra-frequency neighbors of the cells detected during the sensing phase and builds up an own list of available PCIs. The request is performed as part of the normal X2 setup procedure (eNB Configuration Request-Response, as described in 3GPP TS 36.423). That is, as described in TS 36.423, the newly added eNB sends an X2 Setup Request message to a neighboring eNB and this message includes an request to be informed about the PCI of the neighboring eNBs.

Then, the neighboring eNB sends an X2 Request Response back to the newly added eNB and this message includes the PCI of the neighboring eNBs.

Thus, in this manner, the newly added eNB establishes a list of PCIs that are used by the neighboring eNBs using the same frequency.

This method covers cases where small cells are added because of capacity (i.e. there is overlapping macro coverage).

Then, the list(s) of PCIs of the received neighbor lists are used to derive the values of unallocated PCIs that can be selected by the new cell. Additionally, PCIs that would cause Mod3/Mod6/Mod30 collisions can be excluded as well. Finally, one value is selected out of the remaining PCI pool.

According to further certain aspects of the present invention, as an optimization, when some information on the cell type can be transferred using the same X2 setup message for all involved cells, the PCI allocation algorithm can be simplified by taking into account only the PCIs of neighbors of the detected macro cell(s) and those of the sensed pico cells.

The above information can also be used to define the initial neighbor list of the new cell, based on the sensed macro and pico cells.

Fig. 2 is a flowchart illustrating an example of a method according to certain embodiments of the present invention.

According to certain aspects of the present invention, the method comprises establishing, at a network element, for a cell of a first base station, a list of cell identifiers of neighboring cells of a plurality of second base stations in a step S21, deriving values of unallocated cell identifiers based on the established list of cell identifiers in a step S22 and selecting one of the values of unallocated cell identifiers as the cell identifier of the first base station in a step S23.

According to certain aspects of the present invention, the method further comprises obtaining, at the network element, a cell identifier of each of cells of the plurality of second base station from each of the second base stations of the neighboring cells, and establishing the list of cell identifiers based on the obtained cell identifiers.

According to certain aspects of the present invention, the method further comprises requesting, by the network element, the cell identifiers from each of the plurality of second base stations of the neighboring cells.

According to certain aspects of the present invention, the method further comprises obtaining, at the network element, information on a cell type of the plurality of neighboring cells.

According to certain aspects of the present invention, deriving values of unallocated cell identifiers additionally takes into account the obtained information on a cell type of the plurality of neighboring cells.

According to certain aspects of the present invention, establishing the list of cell identifiers takes into account the obtained information on a cell type of the plurality of neighboring cells.

According to certain aspects of the present invention, cell identifiers in the established list of cell identifiers that cause mod3/mod6/mod30 collision are not considered when deriving unallocated cell identifiers.

According to certain aspects of the present invention, the method further comprises informing the first base station of the selected one of the values of cell identifiers.

According to certain aspects of the present invention, the network element is located in the first base station.

Thus, according to certain aspects of the present invention, the above described steps are implemented by the network element provided separate from the first base station and the base station is informed about the selected value.

As an alternative, only some of the steps of the above described method are implemented in the network element provided separate from the first base station. For example, the step of establishing is performed by the network element and then the established list is supplied to the first base station which performs the steps of deriving and selecting.

As a further alternative, the network element may be located in the first base station or may be a part of the first base station such that the above mentioned steps are performed in the first base station.

According to certain aspects of the present invention, the first base station is a small cell base station and the second base stations are macro base stations and/or small base stations.

Fig. 3 is a block diagram showing an example of an apparatus according to certain aspects of the present invention.

In Fig. 3, a block circuit diagram illustrating a configuration of an apparatus 30, such as of a base station or a network element, is shown, which is configured to implement the above described aspects of the invention. It is to be noted that the apparatus 30 shown in Fig. 3 may comprise several further elements or functions besides those described herein below, which are omitted herein for the sake of simplicity as they are not essential for understanding the invention. Furthermore, even though reference is made to a base station or network element, the apparatus may be also another device having a similar function, such as a chipset, a chip, a module etc., which can also be part of a base station or attached as a separate element to a base station, or the like.

The apparatus 30 may comprise a processing function or processor 31, such as a CPU or the like, which executes instructions given by programs or the like related to the flow control mechanism. The processor 31 may comprise one or more processing portions dedicated to specific processing as described below, or the processing may be run in a single processor. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors or processing portions, such as in one physical processor like a CPU or in several physical entities, for example. Reference sign 32 denotes transceiver or input/output (I/O) units (interfaces) connected to the processor 31. The I/O units 32 may be used for communicating with one or more communication network control elements like the MeNB 11 or PeNBs 21, 22 and 23. The I/O units 32 may be a combined unit comprising communication equipment towards several network elements, or may comprise a distributed structure with a plurality of different interfaces for different network elements. Reference sign 33 denotes a memory usable, for example, for storing data and programs to be executed by the processor 31 and/or as a working storage of the processor 31.

The processor 31 is configured to execute processing related to the above described aspects. In particular, the processor 31 comprises a sub-portion 310 as a processing portion which is usable for establishing a list of cell identifiers of neighboring cells of a plurality of second base stations. The portion 310 may be configured to perform processing according to step S21 of Fig. 2, for example. Furthermore, the processor 31 comprises a sub-portion 311 usable as a portion for deriving values of unallocated cell identifiers based on the established list of cell identifiers. The portion 311 may be configured to perform processing according to step S22 of Fig. 2, for example. Furthermore, the sub-portion 312 is usable as a portion for selecting one of the values of unallocated cell identifiers as the cell identifier of the first base station. Thus, the portion 311 may be configured to perform processing according to step S23 of Fig. 2, for example.

According to certain aspects of the present invention, the processor 31 may be configured to obtain a cell identifier of each of cells of the plurality of second base station from each of the neighboring cells of the second base stations, and to establish the list of cell identifiers based on the obtained cell identifiers.

According to certain aspects of the present invention, the processor 31 may be configured to request the cell identifiers from each of the neighboring cells of the plurality of second base stations.

According to certain aspects of the present invention, the processor 31 may be configured to obtain information on a cell type of the plurality of neighboring cells.

According to certain aspects of the present invention, sub-portion 311 of the processor 31 may be configured to derive values of unallocated cell identifiers while additionally taking into account the obtained information on a cell type of the plurality of neighboring cells.

According to certain aspects of the present invention, sub-portion 310 of the processor 31 may be configured to establish the list of cell identifiers while taking into account the obtained information on a cell type of the plurality of neighboring cells.

According to certain aspects of the present invention, sub-portion 311 of the processor 31 may be configured such that cell identifiers in the established list of cell identifiers that cause mod3/mod6/mod30 collision are not considered when deriving unallocated cell identifiers.

According to certain aspects of the present invention, the processor 31 may be configured to inform the first base station of the selected one of the values of cell identifiers.

According to certain aspects of the present invention, the apparatus is part of the first base station.

According to certain aspects of the present invention, the first base station is a small cell base station and the second base stations are macro base stations and/or small base stations.

In the foregoing exemplary description of the apparatus, only the units/means that are relevant for understanding the principles of the invention have been described using functional blocks. The apparatus may comprise further units/means that are necessary for its respective operation. However, a description of these units/means is omitted in this specification. The arrangement of the functional blocks of the apparatus is not construed to limit the invention, and the functions may be performed by one block or further split into sub-blocks.

When in the foregoing description it is stated that the apparatus (or some other means) is configured to perform some function, this is to be construed to be equivalent to a description stating that a (i.e. at least one) processor or

corresponding circuitry, potentially in cooperation with computer program code stored in the memory of the respective apparatus, is configured to cause the apparatus to perform at least the thus mentioned function. Also, such function is to be construed to be equivalently implementable by specifically configured circuitry or means for performing the respective function (i.e. the expression "unit configured to" is construed to be equivalent to an expression such as "means for").

For the purpose of the present invention as described herein above, it should be noted that

- method steps likely to be implemented as software code portions and being run using a processor at an apparatus (as examples of devices, apparatuses and/or modules thereof, or as examples of entities including apparatuses and/or modules therefore), are software code independent and can be specified using any known or future developed programming language as long as the functionality defined by the method steps is preserved;
- generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the aspects/embodiments and its modification in terms of the functionality implemented;
- method steps and/or devices, units or means likely to be implemented as hardware components at the above-defined apparatuses, or any module(s) thereof, (e.g., devices carrying out the functions of the apparatuses according to the aspects/embodiments as described above) are hardware independent and can be implemented using any known or future developed hardware technology or any hybrids of these, such as MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), TTL (Transistor-Transistor Logic), etc., using for example ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) components, CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components;
- devices, units or means (e.g. the above-defined apparatuses, or any one of their respective units/means) can be implemented as individual devices, units or

means, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device, unit or means is preserved;

- an apparatus may be represented by a semiconductor chip, a chipset, or a (hardware) module comprising such chip or chipset; this, however, does not exclude the possibility that a functionality of an apparatus or module, instead of being hardware implemented, be implemented as software in a (software) module such as a computer program or a computer program product comprising executable software code portions for execution/being run on a processor;
- a device may be regarded as an apparatus or as an assembly of more than one apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

In general, it is to be noted that respective functional blocks or elements according to above-described aspects can be implemented by any known means, either in hardware and/or software, respectively, if it is only adapted to perform the described functions of the respective parts. The mentioned method steps can be realized in individual functional blocks or by individual devices, or one or more of the method steps can be realized in a single functional block or by a single device.

Generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the present invention. Devices and means can be implemented as individual devices, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device is preserved. Such and similar principles are to be considered as known to a skilled person.

Software in the sense of the present description comprises software code as such comprising code means or portions or a computer program or a computer program product for performing the respective functions, as well as software (or a computer program or a computer program product) embodied on a tangible

medium such as a computer-readable (storage) medium having stored thereon a respective data structure or code means/portions or embodied in a signal or in a chip, potentially during processing thereof.

It is noted that the aspects/embodiments and general and specific examples described above are provided for illustrative purposes only and are in no way intended that the present invention is restricted thereto. Rather, it is the intention that all variations and modifications which fall within the scope of the appended claims are covered.

CLAIMS

1. A method, comprising:

establishing, at a network element, for a cell of a first base station, a list of cell identifiers of neighboring cells of a plurality of second base stations,

deriving, at the network element, values of unallocated cell identifiers based on the established list of cell identifiers, and

selecting, at the network element, one of the values of unallocated cell identifiers as the cell identifier of the first base station.

2. The method according to claim 1, further comprising

obtaining, at the network element, a cell identifier of each of cells of the plurality of second base station from each of the neighboring cells of the second base stations, and

establishing, at the network element, the list of cell identifiers based on the obtained cell identifiers.

3. The method according to claim 2, further comprising

requesting, by the network element,, the cell identifiers from each of the neighboring cells of the plurality of second base stations.

4. The method according to any one of claims 1 to 3, further comprising

obtaining, at the network element, information on a cell type of the plurality of neighboring cells.

5. The method according to claim 4, wherein

deriving values of unallocated cell identifiers additionally takes into account the obtained information on a cell type of the plurality of neighboring cells.

6. The method according to claim 4, wherein

establishing the list of cell identifiers takes into account the obtained information on a cell type of the plurality of neighboring cells.

7. The method according to any one of claims 1 to 6, wherein

cell identifiers in the established list of cell identifiers that cause mod3/mod6/mod30 collision are not considered when deriving unallocated cell identifiers.

8. The method according to any one of claims 1 to 7, further comprising

informing the first base station of the selected one of the values of cell identifiers.

9. The method according to anyone of claims 1 to 7, wherein

the network element is located in the first base station.

10. The method according to any one of claims 1 to 9, wherein

the first base station is a small cell base station and the second base stations are macro base stations and/or small base stations.

11. An apparatus, comprising:

at least one processor,

at least one interface to at least one other network element, and

at least one memory for storing instructions to be executed by the processor, wherein

the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least to perform:

establishing, for a cell of a first base station, a list of cell identifiers of neighboring cells of a plurality of second base stations,

deriving values of unallocated cell identifiers based on the established list of cell identifiers, and

selecting one of the values of unallocated cell identifiers as the cell identifier of the first base station.

12. The apparatus according to claim 11, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus to perform

obtaining a cell identifier of each of cells of the plurality of second base station from each of the neighboring cells of the second base stations, and
establishing the list of cell identifiers based on the obtained cell identifiers.

13. The apparatus according to claim 12, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus to perform

requesting the cell identifiers from each of the neighboring cells of the plurality of second base stations.

14. The apparatus according to any one of claims 11 to 13, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus to perform

obtaining information on a cell type of the plurality of neighboring cells.

15. The apparatus according to claim 14, wherein

deriving values of unallocated cell identifiers additionally takes into account the obtained information on a cell type of the plurality of neighboring cells.

16. The apparatus according to claim 14, wherein

establishing the list of cell identifiers takes into account the obtained information on a cell type of the plurality of neighboring cells.

17. The apparatus according to any one of claims 11 to 16, wherein

cell identifiers in the established list of cell identifiers that cause mod3/mod6/mod30 collision are not considered when deriving unallocated cell identifiers.

18. The apparatus according to any one of claims 11 to 17, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus to perform

informing the first base station of the selected one of the values of cell identifiers.

19. The apparatus according to anyone of claims 11 to 17, wherein the apparatus is part of the first base station.

20. The apparatus according to any one of claims 11 to 19, wherein the first base station is a small cell base station and the second base stations are macro base stations and/or small base stations.

21. An apparatus, comprising:

means for establishing, for a cell of a first base station, a list of cell identifiers of neighboring cells of a plurality of second base stations,

means for deriving values of unallocated cell identifiers based on the established list of cell identifiers, and

means for selecting one of the values of unallocated cell identifiers as the cell identifier of the first base station.

22. A computer program product including a program for a processing device, comprising software code portions for performing the steps of any one of claims 1 to 10 when the program is run on the processing device.

23. The computer program product according to claim 22, wherein the computer program product comprises a computer-readable medium on which the software code portions are stored.

24. The computer program product according to claim 22, wherein the program is directly loadable into an internal memory of the processing device.

Fig. 1

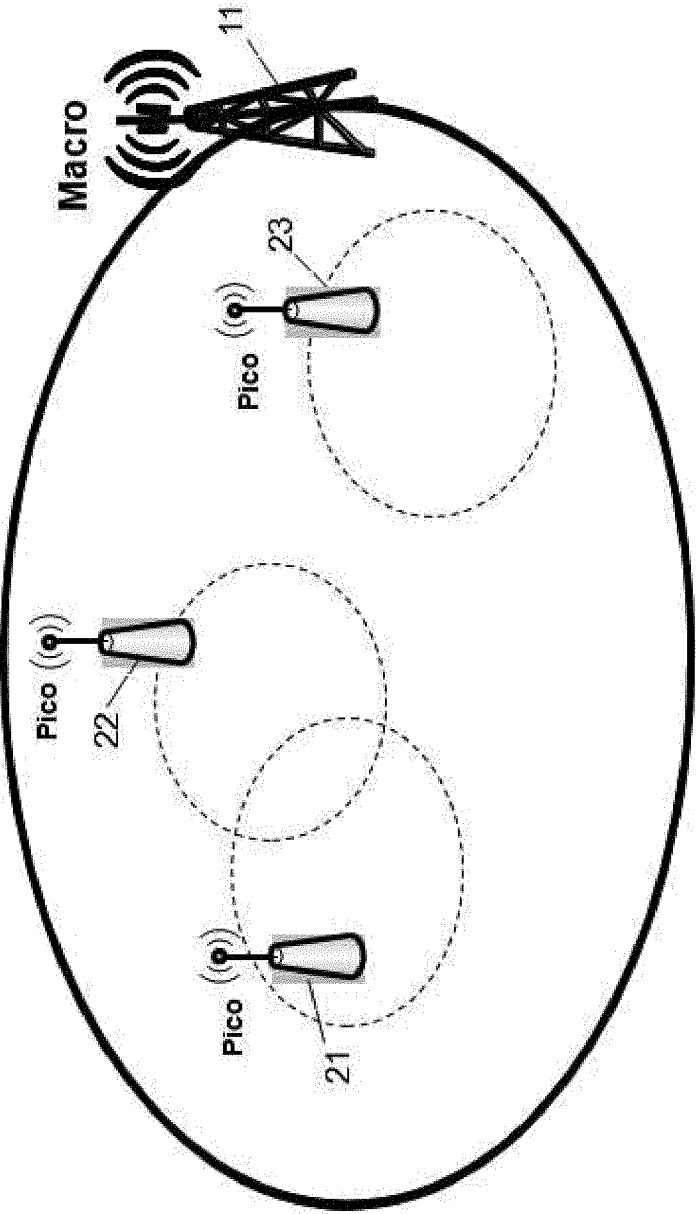


Fig. 2

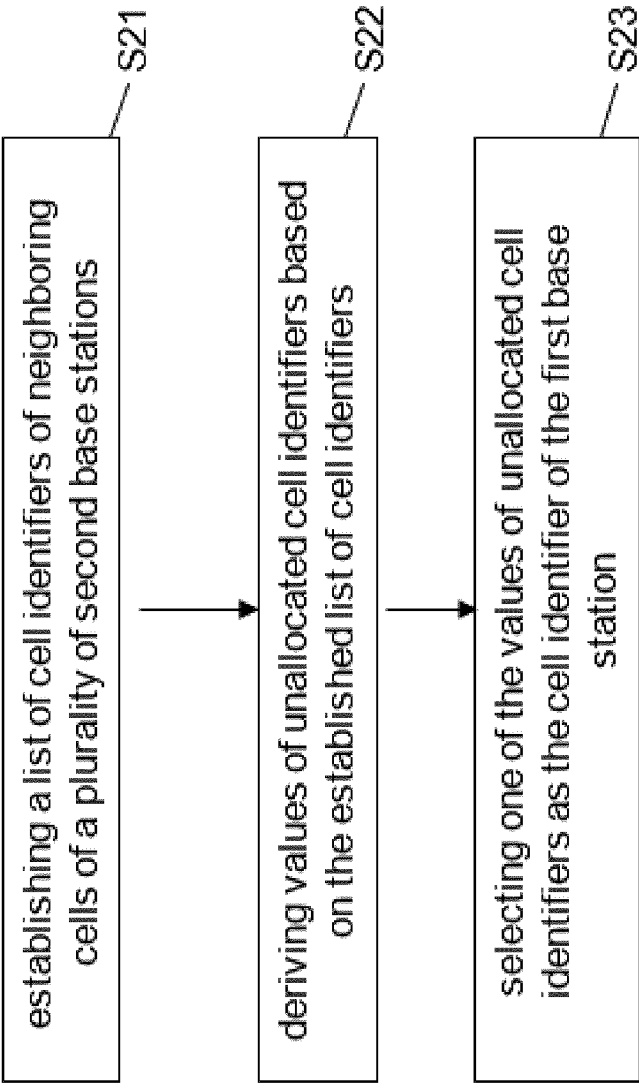
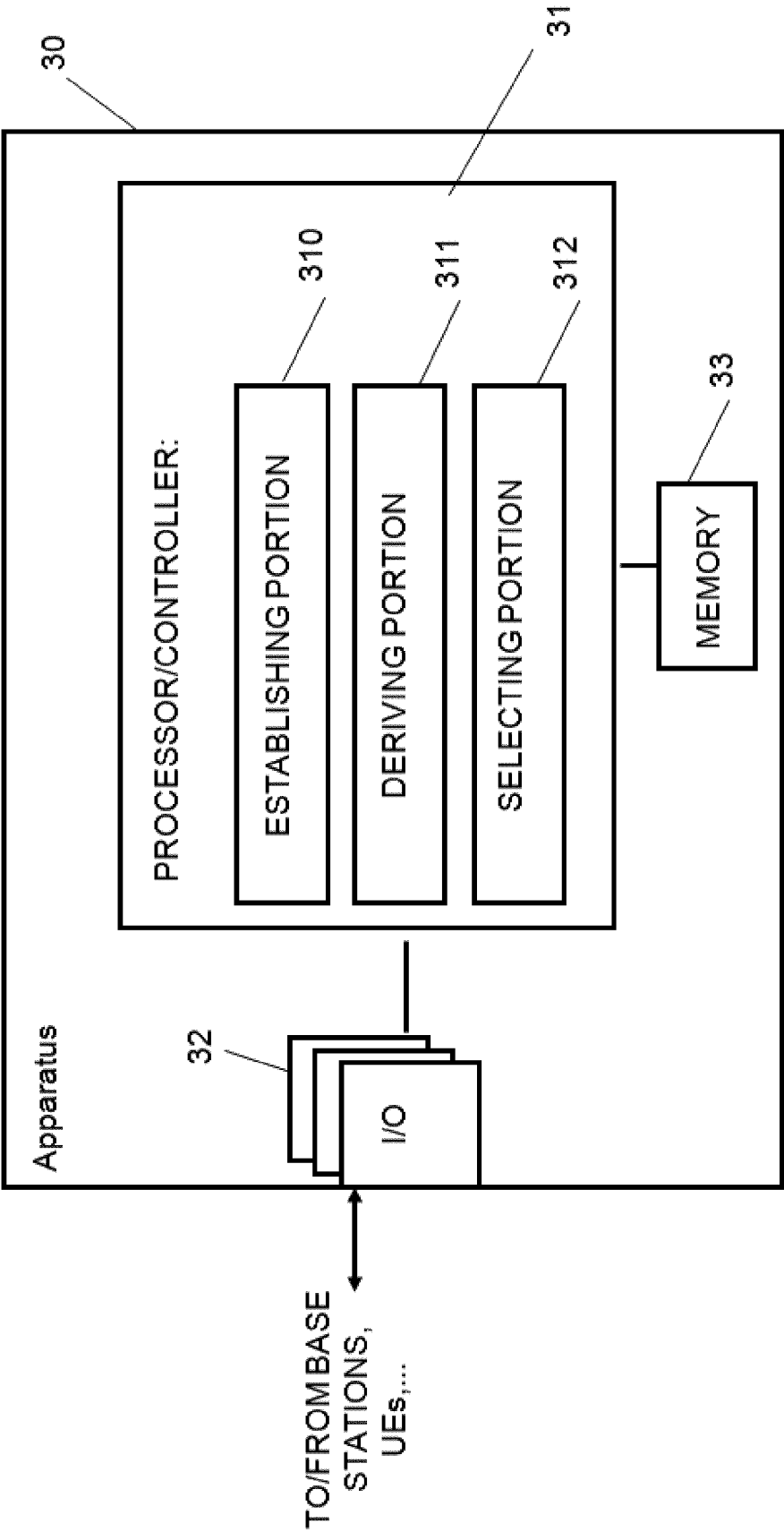


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W24/02

ADD. H04W36/00 H04W92/20

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 practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/291934 A1 (LOPES LUIS [GB]) 18 November 2010 (2010-11-18)	1-3, 8-13, 18-24
Y	abstract figures 2,5 paragraph [0023] paragraph [0026] paragraph [0028] paragraph [0031] - paragraph [0035] ----- -/--	4-7, 14-17



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

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Date of the actual completion of the international search

11 February 2014

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/057825

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	QUALCOMM EUROPE ET AL: "3GPP TSG RAN WG3 #61; R3-082228; Framework for distributed PCI selection", 3GPP DRAFT; R3-082228, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG3, no. Jeju Island; 20080825, 25 August 2008 (2008-08-25), pages 1-5, XP050165269, [retrieved on 2008-08-25]	1-3, 8-13, 18-24
Y	pages 2-3, par. 2.2; 2.2.1; 2.2.2 and 2.2.3	4-7, 14-17
Y	----- US 2011/201339 A1 (KUNINGAS TARMO [SE]) 18 August 2011 (2011-08-18)	4-6, 14-16
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