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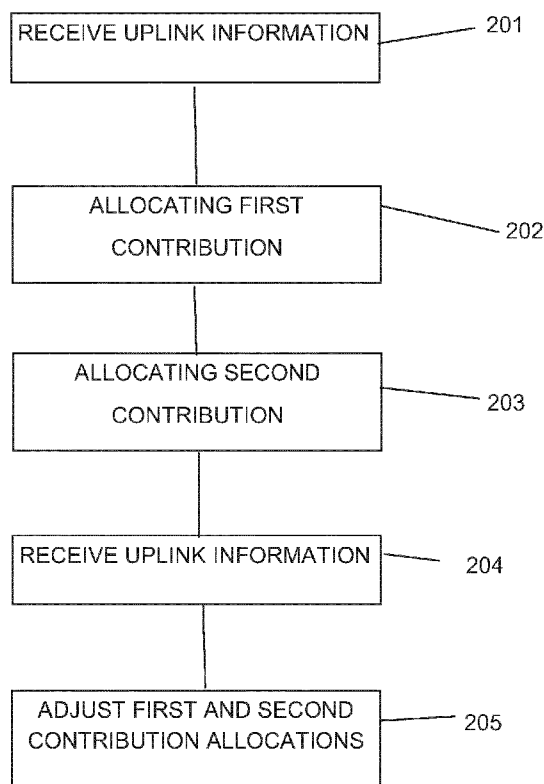


Figure 2A

(57) Abstract: A method is provided in which an allowable total noise for a first cell is determined. A first contribution to the allowable total noise by user equipment served by the first cell is allocated. A second contribution to the total allowable noise of the first cell by user equipment served by a second cell is allocated.



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DESCRIPTION

Title5 **Heterogeneous Network**

This application relates to a method and apparatus, and in particular but not exclusively to noise in heterogeneous networks.

10 A communication system can be seen as a facility that enables communications between two or more entities such as a communication device, e.g. mobile stations (MS) or user equipment (UE), and/or other network elements or nodes, e.g. Node B or base transceiver station (BTS), associated with the communication system. A communication system typically operates in accordance with a given standard or specification which sets out what
15 the various entities associated with the communication system are permitted to do and how that should be achieved.

Wireless communication systems include various cellular or otherwise mobile communication systems using radio frequencies for sending voice or data between stations, for example between a communication device and a transceiver network element. Examples of
20 wireless communication systems may comprise public land mobile network (PLMN), such as global system for mobile communication (GSM), the general packet radio service (GPRS) and the universal mobile telecommunications system (UMTS).

25 A mobile communication network may logically be divided into a radio access network (RAN) and a core network (CN). The core network entities typically include various control entities and gateways for enabling communication via a number of radio access networks and also for interfacing a single communication system with one or more communication systems, such as with other wireless systems, such as a wireless Internet Protocol (IP)
30 network, and/or fixed line communication systems, such as a public switched telephone network (PSTN).

The radio access network may provide a connection between the core network (CN) and a device such as a user equipment (UE) and implements a radio access technology. Examples of radio access networks may comprise the UMTS terrestrial radio access network (UTRAN) and the GSM/EDGE radio access network (GERAN). The radio access network
5 may include entities such as a base station or node B and a radio network controller (RNC).

A geographical area covered by a radio access network is divided into cells defining a radio coverage provided by a transceiver network element, such as a base station, base
10 transceiver station, Node B and/or eNodeB. A single transceiver network element may serve a number of cells. Some radio access networks may be homogeneous networks – having cells of similar size and power, for example macrocells. Other radio access networks may be heterogeneous – including cells of different sizes and power levels, for example macrocells, microcells and picocells. Heterogeneous networks may also include
15 Femtocells, which are typically small, low powered base stations.

The employment of such micro and picocells may affect the performance of the wider network. In particular, some micro and picocells may introduce interference into the surrounding wider network.

20 According to a first aspect, there is provided a method comprising: allocating to a first cell a contribution to an allowable noise of a second cell by user equipment served by the first cell.

25 According to a second or further aspect, there is provided a method comprising: determining an allowable total noise for a first cell; allocating a first contribution to the allowable total noise by user equipment served by the first cell; and allocating a second contribution to the total allowable noise of the first cell by user equipment served by a second cell.

30 The first contribution may further comprise: determining a required contribution to the total allowable noise by user equipment served by the first cell; and allocating the first contribution based on the required contribution.

Determining the required contribution may comprise determining the required contribution based on uplink parameters of the first cell.

- 5 Allocating the second contribution may further comprise: determining a remaining allowable total noise after the first contribution has been allocated; and allocating the second contribution based on the remaining allowable total noise.

10 The method may further comprise: receiving uplink information from the first cell and from the second cell; and adjusting the first and second contributions in response to the received uplink information.

The total allowable noise for the first cell may be the total amount of noise rise that the first cell can contribute to a system.

15

The total allowable noise may be the total amount of interference over thermal noise that the first cell can contribute to the system.

20 The method may further comprise: allocating respective contributions to further interfering cells.

The method may further comprise: allocating contributions to the allowable total noise to the further interfering cells.

25 The method may further comprise: allocating contributions to the first, second and further cells in order of priority.

The priority may further corresponds to one of: cell size; and a quality of service of users served by a cell.

5 Uplink information from a cell may comprises at least one of: information relating to the usage of an allocated noise contribution of the cell; a request for an increase in the allocated noise contribution for the cell; and a request for a decrease in the allocated noise contribution for the cell.

10 Allocating the first contribution may further comprise informing the first cell of the first contribution and allocating the second contribution further comprising informing the second cell of the second contribution.

The method may further comprise informing the first cell of the second contribution.

15 According to a second aspect, there may be provided an apparatus comprising: determining means for determining an allowable total noise for a first cell; allocating means for allocating a first contribution to the allowable total noise by user equipment served by the first cell, and allocating a second contribution to the total allowable noise of the first cell by user equipment served by a second cell.

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The determining means may further determine a required contribution to the total allowable noise by user equipment served by the first cell; and the allocating means may allocate the first contribution based on the required contribution.

25 The determining means may further be configured to determine the required contribution based on uplink parameters of the first cell.

The allocating means may further allocate the second contribution by: determining a remaining allowable total noise after the first contribution has been allocated; and allocating the second contribution based on the remaining allowable total noise.

- 5 The apparatus may be configured to: receive uplink information from the first cell and from the second cell; and further comprise adjusting means for adjusting the first and second contributions in response to the received uplink information.

10 The total allowable noise for the first cell may be the total amount of noise rise that the first cell can contribute to a system.

The total allowable noise may be the total amount of interference over thermal noise that the first cell can contribute to the system.

- 15 The allocating means may further be configured to allocate respective contributions to further interfering cells.

The allocating means may be further configured to allocate contributions to the allowable total noise to the further interfering cells.

20

The allocating means may further be configured to allocate contributions to the first, second and further cells in order of priority.

- 25 The priority may further correspond to one of: cell size; and a quality of service of users served by a cell.

Uplink information from a cell may comprises at least one of: information relating to the usage of an allocated noise contribution of the cell; a request for an increase in the allocated noise contribution for the cell; and a request for a decrease in the allocated noise contribution for the cell.

5

The apparatus may further be configured to allocate the first contribution by informing the first cell of the first contribution and allocate the second contribution by informing the second cell of the second contribution.

10 The apparatus may be further configured to informing the first cell of the second contribution.

According to a third aspect, there is provided, an apparatus comprising: a processor and a memory, the processor configured to determine an allowable total noise for a first cell;
15 allocate a first contribution to the allowable total noise by user equipment served by the first cell, and allocate a second contribution to the total allowable noise of the first cell by user equipment served by a second cell.

According to a fourth aspect, there is provided an apparatus comprising a processor and
20 at least one memory, wherein the processor is configured to carry out computer readable instructions to carry out the steps of: determining an allowable total noise for a first cell; allocating a first contribution to the allowable total noise by user equipment served by the first cell; and allocating a second contribution to the total allowable noise of the first cell by user equipment served by a second cell.

25

According to a fifth aspect, there is provided a method comprising: receiving an indication of an allocated contribution to an allowable noise of a first cell by user equipment served by a second cell; monitoring an actual contribution to the allowable noise made by the user equipment; and controlling the actual contribution in dependence on
30 the allocated contribution.

Controlling the actual contribution may comprise adjusting parameters of the second cell.

The parameters may be uplink parameters.

- 5 According to a sixth aspect, there is provided an apparatus comprising: receiving means for receiving an indication of an allocated contribution to an allowable noise of a first cell by user equipment served by a second cell; monitoring means for monitoring an actual contribution to the allowable noise made by the user equipment; and controlling means for controlling the actual contribution in dependence on the allocated contribution.

10

- According to a seventh aspect, there is provided an apparatus comprising a processor and a memory, the processor configured to receive an indication of an allocated contribution to an allowable noise of a first cell by user equipment served by a second cell, monitor an actual contribution to the allowable noise made by the user equipment, and control the
15 actual contribution in dependence on the allocated contribution.

20

According to an eighth aspect, there is provided an apparatus comprising a processor and at least one memory, wherein the processor is configured to carry out computer readable instructions to carry out the steps of: receiving an indication of an allocated contribution to
an allowable noise of a first cell by user equipment served by a second cell; monitoring an actual contribution to the allowable noise made by the user equipment; and controlling the actual contribution in dependence on the allocated contribution.

25

It will be appreciated that various of the features of the second or further aspects may be used in conjunction with the first aspect.

Embodiments will now be described with reference to the following figures in which:

Figure 1 shows an example of a network which may incorporate embodiments;

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Figure 2A shows the method steps carried out by a central controller of an embodiment;

Figure 2B shows the method steps carried out by a base station of an embodiment;

Figure 3 shows an example of a network incorporating a further embodiment;

Figure 4 shows method steps in accordance with a further embodiment;

5 Figure 5 shows a block diagram of a central controller; and

Figure 6 shows a block diagram of a base station.

The interference caused by the uplink channels of a cell may be limited by assigning a total noise budget to a cell. The total noise budget for a cell may indicate an allowable
10 amount of noise present in the cell. However, even with a total noise budget, a cell may have no control over the uplink power of a neighbouring cell. This may be of particular concern in heterogeneous networks where an overlap of coverage between cells may be common. While a cell can control the contribution to the total noise budget of its own uplink channels, it cannot control the contribution to the total noise budget from interference
15 from uplink transmissions of neighbouring cells.

Some embodiments provide a co-ordinated control of uplink parameters of neighbouring cells in order to address such interference. In some embodiments, the uplink parameters of a cell are controlled with respect to an allocated contribution that the cell can make to a
20 total noise budget. In some embodiments, an allocated noise contribution may be dynamically updated to reflect changing loads in a cell.

Figure 1 shows an example of a heterogeneous network in which embodiments may be implemented.

25

Figure 1 comprises a first cell defined by a first base station 100 and a second cell defined by a second base station 101. The first base station 100 may be in active communication with one or more user equipment, for example the first user equipment 102. The second base station 101 may be in active communication with one or more user equipment, for
30 example, the second user equipment 103.

The heterogeneous network of figure 1 may further comprise a network entity 105 and central controller 104. In some embodiments, the central controller 104 may be responsible for allocating noise contributions for one or more cells.

5

The network entity 105 may receive and transmit information between the first base station 100, second base station 101 and a core network 106. In some embodiments, the network entity 105 may be, for example, a radio network controller.

10 It will be appreciated that while the network entity 105 has been depicted as a separate entity, it may be incorporated into another network entity such as one of the base stations, or in some embodiments be omitted. Similarly, while the central controller 104 has been depicted as a separate network entity, it may be incorporated into another network entity, for example a base station, radio network controller and/or radio resource controller.

15

As shown in figure 1, the first user equipment 102 may be in communication with the first base station 100. The first user equipment 102 may receive data from the first base station 100 via a downlink channel and provide data to the first base station 100 via an uplink channel 107. Similarly, the second use equipment 103 may be in communication with the
20 second base station 101. The second user equipment 101 may receive data from the second base station 101 via a downlink channel and may transmit data to the second base station 101 via an uplink channel 108. Transmissions on an uplink channel of a cell may add to uplink noise of the cell.

25 Transmissions from the first user equipment 102 to the first base station 100 may additionally be received by the second base station 101 in the form of interference 107a. Similarly transmissions from the second user equipment 103 to the second base station 101 may additionally be received at first base station 100 in the form of interference 108a. The interference 108a from uplink channels of the second cell may add to the uplink noise present in the first cell and the interference 107a from uplink channels of the first cell may add
30 to uplink noise present in the second cell.

In some embodiments, a base station may have a total noise budget for noise on the uplink. The total noise budget may correspond to an acceptable amount of uplink noise for a cell. For example, the first cell may have a total noise budget that indicates an acceptable amount of uplink noise in the first cell. In some embodiments, the total noise budget may correspond to a noise rise budget for the cell, in other embodiments the total noise budget may correspond to an interference over thermal noise. In some embodiments, the noise rise of a cell may be calculated as a ratio of the total received wideband power to the noise power of the cell. In other or additional embodiments, the noise rise may correspond to the total received power of thermal noise at a cell.

The uplink noise in the first cell may in some embodiments be generated by i) one or more user equipment served by the first cell; and ii) interference from one or more user equipment served by neighbouring cell. For example, the uplink noise in the first cell comprises uplink noise generated by the first user equipment 102 and uplink noise generated from interference from the second user equipment 103.

While a base station of a cell may adapt uplink parameters in order to control the uplink noise generated by user equipment served by that cell, the base station may not be able to control uplink noise generated from interference by user equipment served by neighbouring cells. This may result in an inefficient use of uplink resources as a cell may reduce its own uplink transmissions to take into account interference from other cells that may not be aware of the interference.

In embodiments, the central controller 104 is used to allocate to a cell, an amount of noise that user equipment served by that cell may contribute to a total noise budget of a neighbouring cell. For example, the central controller 104 of figure 1 may allocate to the second cell 101, an amount of noise that user equipment 103 served by the second cell 101 may contribute to the total noise budget of the first cell 100. The central controller 104 may base this allocation on the uplink requirements of the first cell such that uplink resources of the first and second cells are used efficiently.

In some embodiments, the central controller 104 may determine the allocations based on information regarding uplink conditions and requirements of the first and second cells and/or requests to allocate more or less noise contribution to a cell. In some embodiments, the central controller 104 may adjust an allocated noise contribution in response to changing conditions of a cell.

In embodiments, the central controller may first allocate to a first cell, a noise contribution that user equipment served by the first cell can make to the total noise budget of the first cell, based on the requirements of the first cell. The central controller may then allocate contributions to the total noise budget of the first cell to any interfering cells. In some embodiments, this allocation of noise contributions may be carried out in order according to a priority of the cells, for example a size of the cells and/or a quality of service required to be provided by the cells.

In other embodiments, the central controller may allocate contributions to the total noise budget for a first cell to the first cell and neighbouring cells based on the uplink requirements of the cells.

A base station of a cell may then monitor a noise contribution of the cell and set the uplink parameters of that cell so that the allocated noise contribution is not exceeded.

In some embodiments, the base station may monitor noise contributions of the cell. The base station may monitor the noise contributions made by user equipment it is serving to the total noise budget of another cell by estimating the noise contributions based on measurements. In some embodiments, the base station may include network listening mode NLM functionality in which a receiver is incorporated into the base station that can receive transmissions from other cells. The measurements made from transmissions from another cell can be used to estimate a distance between the two cells. Alternatively, measurements made by user equipment may be transmitted to the base station from which a distance from the user equipment to the base station may be estimated and a distance from the user equipment to the other base station.

Figure 2A shows an example of the method steps carried out by central controller when allocating noise contribution to cells in a heterogeneous system.

At step 201, the central controller 104 may receive uplink information from one or more
5 cells. The uplink information may relate to the uplink conditions for example an indication of the amount of a current noise budget being used by the cell, an indication of a noise rise budget that may fulfil user quality of service requirements for a cell, quality of service information relating to users served by a cell and/or an importance or priority of users being served by the cell. In additional embodiments, background measurements may be
10 made to estimate a current background noise contribution from surrounding cells. In some embodiments information relating to measurements made during the night to find thermal noise may also be provided to the central controller.

The central controller 104 may select a cell to first allocate a contribution to. The selection
15 of the cell may be based on a priority of the cells, for example a size, hierarchy or level of quality of service to be provided by the cell. Alternatively or additionally, the selection of the cell may be based on the received uplink information. For example, the central controller 104 may select the first cell of figure 1 to allocate to first. The central controller 104 may be aware of a total noise budget for that cell and of uplink conditions and information
20 of the first cell.

Based on the uplink information of the first cell, the central controller may allocate a first contribution to the first cell at step 202. The first contribution may indicate the contribution of uplink noise to the total noise budget of the first cell that may be made by user equipment being served by the first cell.
25

The central controller may then allocate a second contribution to the second cell at step 203. The second contribution may indicate the contribution that user equipment served by the second cell may make to the total noise budget of the first cell. This allocation may, in
30 some embodiments, be based on the uplink information, the total noise budget and the first noise contribution.

At step 204, the central controller may receive further uplink information. This information may for example include a request from a cell to increase or decrease the noise contribution for the cell. The central controller 104 may then adjust the allocations of the first and second contributions in response to the request. In some embodiments, the central controller may provide a response to the requesting cell with an increase or decrease indication. In other embodiments centralised controller may explicitly signal a new noise contribution to the base station.

Figure 2B depicts a corresponding method carried out a base station of a cell, for example the second cell of figure 1. Once the central controller 104 has allocated the second contribution at step 203, the second contribution is transmitted to the second base station 101.

At step 211, the second base station 101 receives the allocated second contribution. The method then progresses step 212 where the second base station 101 monitors the contribution of the user equipment served by the second base station to the noise rise in first cell. The second base station 101 may set uplink parameters for the user equipment served by the second base station 101 so that the resultant contribution to the total noise budget of the first cell is in line with the allocated second contribution.

The second base station 101 may monitor its contribution to the total noise budget of the first cell. In some embodiments, the second base station 101 may include NLM functionality and may make measurements regarding a received signal code power RSCP from the first base station. This may indicate the attenuation with which a pilot signal from the first base station is received at the second base station. This may be used to predict a what transmit power user equipment served by the second base station may transmit at while remaining within the second allocated noise contribution. In some embodiments, margins may be introduced into this prediction.

Alternatively, if NLM functionality is not incorporated in the second base station, the second base station can calculate past loss estimates to the first base station of the uplink transmissions of user equipment being served by the second base station, based on received signal code power measurements made by the user equipment served by the second base station. In other embodiments, both these methods may be combined in order to provide a fast and accurate indication of the noise contribution made by the user equipment served by the second base station.

In other or additional embodiments, path losses between the base stations may be pre-measured and stored. For example, path losses may be planned and registered for example at a path loss database or stored at each base station. In this case, a base station may access the registered path loss information to monitor a contribution to the total noise budget. In some embodiments, the path loss may be calculated by planning tools taking into account a distance between base stations of cells and/or other conditions. It will be appreciated that the registered or calculated path losses may be used in conjunction with the other methods of determining the actual or estimated contribution to the noise rise budget.

The method may then proceed to step 213. The second base station 101 may determine that the conditions of the second cell has changed, for example, the cell loading has changed and/or uplink conditions have changed and may determine that a higher or lower allocated noise contribution may be required. In this case, the second base station 101 may transmit a request for an increase in the second noise contribution allocation to the central controller at step 213.

At step 214, the second base station 101 may receive a response from the central controller and adjust the allocated second noise contributions accordingly. For example, the central controller 104 may provide an indication back to increase, decrease, or not change the allocated second noise contribution. Alternatively, the central controller may explicitly signal a new noise contribution. The second base station 101 may adjust the uplink parameters accordingly and the method may return to step 212 where the contribution of the user equipment served by the second base station 101 to the total noise budget is monitored.

As mentioned above, the cell on which to base the allocations may be selected based on a priority of the cell. In the example embodiment of figure 3, noise contributions are allocated to the cells based on cell hierarchy.

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Figure 3 shows a first cell 305 and a second cell 306 of a heterogeneous network. The first cell 305 is a macro cell having a first base station 300 and the second cell 306 is a microcell having a second base station 301. The first base station may be in active communication with one or more user equipment, for example first user equipment 302, while
10 the second base station may be in active communication with one or more user equipment, for example user equipment 303.

In the embodiment of figure 3, a central controller 304 may be incorporated in the first base station 300. It will be appreciated that this is by way of example only and the central
15 controller 304 may be incorporated in another network entity such as a radio network controller or another controller such as a radio resource management controller.

In figure 3 it can be seen that the area of the first cell 305 and second cell 306 may at least partly overlap. The microcell 306 may cause interference and contribute to the uplink
20 noise of the macro cell 305.

In this embodiment, the noise contributions may be allocated in accordance with the hierarchy of the cells. A larger cell, or a cell higher in the hierarchy may, in some embodiments, have more stable uplink noise. This may be, for example, because the load of the
25 cell is more constant due to its size.

The centralised controller 304 may therefore allocate a contribution to the total noise budget of the first cell to the first cell based on the uplink requirements of the first cell. The central controller 304 may then allocation a noise contribution to the total noise budget of
30 the first cell for the user equipment served by the second cell. The allocated noise contri-

bution to the second cell may be based on the remaining unallocated total noise budget after the first noise allocation has been made.

5 In some embodiments, the central controller 304 may distribute part the total noise budget of the first cell between the first and the second cell based on the requirements of the cells. In some embodiments, the total noise budget may be distributed based on a priority of the cells.

10 Figure 4 shows an example of the method steps that may carried out in the embodiment of figure 3.

At step 401, the central controller 304 may determine the total noise budget of the macrocell. The total noise budget may be stored at the macrocell, may be received from another network entity or may be determined in any suitable fashion.

15

At step 402, the central controller may determine the uplink requirements of the macrocell 305 and determine a required noise contribution of the macrocell 305. For example, the central controller 304 may receive information corresponding to channel conditions and a load of the macrocell 305 and determine the noise that may be generated by the
20 macrocell 305 in serving the user equipment.

At step 403, the central controller 304 may receive uplink information from the microcell 306. The uplink information may relate to the uplink requirements of the microcell 306. It will be appreciated that the uplink information from the microcell 306 may be received at
25 any suitable time.

The central controller 304 may then allocate a contribution to the total noise budget of the macrocell 305 that can be made by user equipment served by the macrocell 305 and a contribution to the total noise budget of the macrocell 305 that may be made by the user

equipment served by the microcell 306. In some embodiments, the central controller 304 may do this by allocating a noise contribution to the macrocell 305 corresponding to the noise contribution required by the macrocell 305 and determined at step 402. The central controller 304 may allocate the remaining unallocated total noise budget to the microcell 305.

It will be appreciated that embodiments may be implemented in different networks and in accordance with that specific network implementation. Additionally it will be appreciated that the central controller 104, 304 may be implemented individually or as part of another network entity.

Figure 5 shows an example of a central controller 104, 304 of some embodiments. The central controller 500 comprises receiving means 501, allocating means 502, determining means 503 and a memory 504. The receiving means 501 may be configured to receive uplink information from one or more base stations 100, 101. The determining means 503 may be configured to determine a total noise budget for a base station 100. The determining means 503 may for example determine the total noise budget based on information received through the receiving means 501, and/or stored in memory 504. The allocating means 502 may be coupled to the receiving means 501, the determining means 503 and may use the information received by the receiving means 501 and the total noise budget determined by the determining means 503 to allocate the first noise contribution and the second noise contribution to the first 100 and second 101 base stations. The allocating means 580 may further be coupled to the memory 504.

Figure 6 shows an example of a base station according to some embodiments. The base station 600 of figure 6 comprises receiving means 601, monitoring mean 602, requesting means 603, determining means 604 and a memory 605. The receiving means 601 may be configured to receive an allocated noise contribution from a central controller 104, 304. The monitoring means 602 may be configured to monitor the actual noise contribution of one or more user equipment being served by the base station 600 and set uplink parameters so that the noise contributed by the served user equipment does not exceed the allocated noise contribution.

The determining mean 604 may be configured to monitor uplink conditions, for examples cell load, and determine whether a request should be sent to increase or decrease the allocated noise contribution. The requesting means 603 may be configured to transmit
5 such a request. The receiving means 601 may be further configured to receive a response to a request for an increase or decrease in the noise contribution and monitoring means 602 may monitor the adjusted allocated noise contribution. The receiving means 601, monitoring means 602, requesting means 603, and determining means 604 may be coupled to the memory 605.

10

It is also noted herein that while the above describes exemplifying embodiments, there are several variations and modifications which may be made to the disclosed solution without departing from the scope of the present invention.

15 It will be appreciated that embodiments may be implemented in different networks and in accordance with that specific network implementation. For example, embodiments may be implemented in accordance with the 3G 3PP or LTE 3PP and in accordance with a variety of air interfaces, for example WCDMA, WCDMA HSPA, OFDMA and/or E-UTRAN.

20 It will be appreciated that in some embodiments, cells may be operating in accordance with different protocols. For example, macrocells may operate in accordance with one or more first protocols and pico or microcells may operate in accordance with one or more second protocols. In these embodiments, the central controller may be able to operate in the plurality of protocols and/or may generate messages to a relevant base station in accordance with a relevant protocol. In other embodiments, a micro or second cell may include an interface that may receive messages in accordance with protocol of the central
25 controller and translate the message to a relevant format for the second cell.

It will be appreciated that while the foregoing refers to a base station, the base station may
30 include a variety of access points in different networks, for example, a base station may include a base transceiver station, a NodeB and/or an eNodeB.

It will also be appreciated that the central controller may be incorporated in any suitable network element, for example, a base station, radio network controller, radio resource management controller. Alternatively, the central controller may be a stand alone entity or have functionality shared between more than one entity. In other embodiments, the central controller may be implemented as part of a self organising network SON solution.

It will be appreciated that in the foregoing information relating to the uplink information, requests and allocated noise contributions may be transmitted using the relevant interfaces. For example, in a 3G HSPA 3PP network, information may be transmitted for example, over the lub, lur and luh interfaces. In LTE 3PP, such information may be transmitted over, for example, the X2 interface. The information may in other embodiments be transmitted using an air communication scheme for example in conjunction with LTE-A. In other embodiments, information may be communicated to femtocells using management systems and/or broadband forum protocols.

In general, the various embodiments may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects of the embodiments may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the invention is not limited thereto. While various aspects of the invention may be illustrated and described as block diagrams, flow charts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

Some embodiments may be implemented by computer software executable by a data processor of a network entity, such as in the processor entity, or by hardware, or by a combination of software and hardware.

Further in this regard it should be noted that any blocks of the logic flow as in the Figures may represent program steps, or interconnected logic circuits, blocks and functions, or a combination of program steps and logic circuits, blocks and functions. The software may be stored on such physical media as memory chips, or memory blocks implemented within

the processor, magnetic media such as hard disk or floppy disks, and optical media such as for example DVD and the data variants thereof, CD.

5 The memory may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor-based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory.

10 Furthermore while some embodiments may have been described with entities associated with specific network implementation, for example in accordance with a 3G 3PP network or an LTE network, it will be appreciated that embodiments may be implemented in other networks and by network entities not restricted by a specific network implementation.

15 The foregoing description has provided by way of exemplary and non-limiting examples a full and informative description of the exemplary embodiment of this invention. However, various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings and the appended claims. However, all such and similar modifications of the teachings of this invention will still fall within the scope of this invention as defined in
20 the appended claims. Indeed, there is a further embodiment comprising a combination of one or more of any of the other embodiments previously discussed.

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CLAIMS:

1. A method comprising:

5 allocating to a first cell a contribution to an allowable noise of a second cell by user equipment served by the first cell.

2. A method comprising:

determining an allowable total noise for a first cell;

10 allocating a first contribution to the allowable total noise by user equipment served by the first cell; and

allocating a second contribution to the total allowable noise of the first cell by user equipment served by a second cell.

15 3. The method of claim 1, wherein allocation the first contribution further comprises:

determining a required contribution to the total allowable noise by user equipment served by the first cell; and

allocating the first contribution based on the required contribution.

20 4. The method of claim 3, wherein determining the required contribution comprises determining the required contribution based on uplink parameters of the first cell.

5. The method of any of claims 3 and 4 wherein allocating the second contribution further comprises:

25 determining a remaining allowable total noise after the first contribution has been allocated; and

allocating the second contribution based on the remaining allowable total noise.

6. The method of any preceding claim, further comprising:

receiving uplink information from the first cell and from the second cell; and

5 adjusting the first and second contributions in response to the received uplink information.

7. The method of claim 1, wherein the total allowable noise for the first cell is the total amount of noise rise that the first cell can contribute to a system.

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8. The method of any preceding claim, wherein the total allowable noise is the total amount of interference over thermal noise that the first cell can contribute to the system.

9. The method of any preceding claim, further comprising:

15 allocating respective contributions to further interfering cells.

10. The method of claim 9 comprising:

allocating contributions to the allowable total noise to the further interfering cells.

20 11. The method of any preceding claim, further comprising:

allocating contributions to the first, second and further cells in order of priority.

12. The method of claim 10, wherein the priority corresponds to one of:

cell size; and

25 a quality of service of users served by a cell.

13. The method of claim 6 wherein uplink information from a node comprises at least one of:

Information relating to the usage of an allocated noise contribution of the node;

5 a request for an increase in the allocated noise contribution for the node; and

a request for a decrease in the allocated noise contribution for the node.

14. The method of any preceding claim wherein allocating the first contribution further comprising informing the first cell of the first contribution and allocating the second contribution further comprising informing the second cell of the second contribution.

15. The method of claim 1 further comprising informing the first cell of the second contribution.

15 16. An apparatus comprising:

determining means for determining an allowable total noise for a first cell;

allocating means for allocating a first contribution to the allowable total noise by user equipment served by the first cell, and allocating a second contribution to the total allowable noise of the first cell by user equipment served by a second cell.

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17. An apparatus comprising a processor and at least one memory, wherein the processor is configured to carry out computer readable instructions to carry out the steps of:

determining an allowable total noise for a first cell;

25 allocating a first contribution to the allowable total noise by user equipment served by the first cell; and

allocating a second contribution to the total allowable noise of the first cell by user equipment served by a second cell.

18. A method comprising:

receiving an indication of an allocated contribution to an allowable noise of a first cell by user equipment served by a second cell;

5 monitoring an actual contribution to the allowable noise made by the user equipment; and

controlling the actual contribution in dependence on the allocated contribution.

19. An apparatus comprising:

10 receiving means for receiving an indication of an allocated contribution to an allowable noise of a first cell by user equipment served by a second cell;

monitoring means for monitoring an actual contribution to the allowable noise made by the user equipment; and

15 controlling means for controlling the actual contribution in dependence on the allocated contribution.

20. An apparatus comprising a processor and at least one memory, wherein the processor is configured to carry out computer readable instructions to carry out the steps of:

20 receiving an indication of an allocated contribution to an allowable noise of a first cell by user equipment served by a second cell;

monitoring an actual contribution to the allowable noise made by the user equipment; and

controlling the actual contribution in dependence on the allocated contribution.

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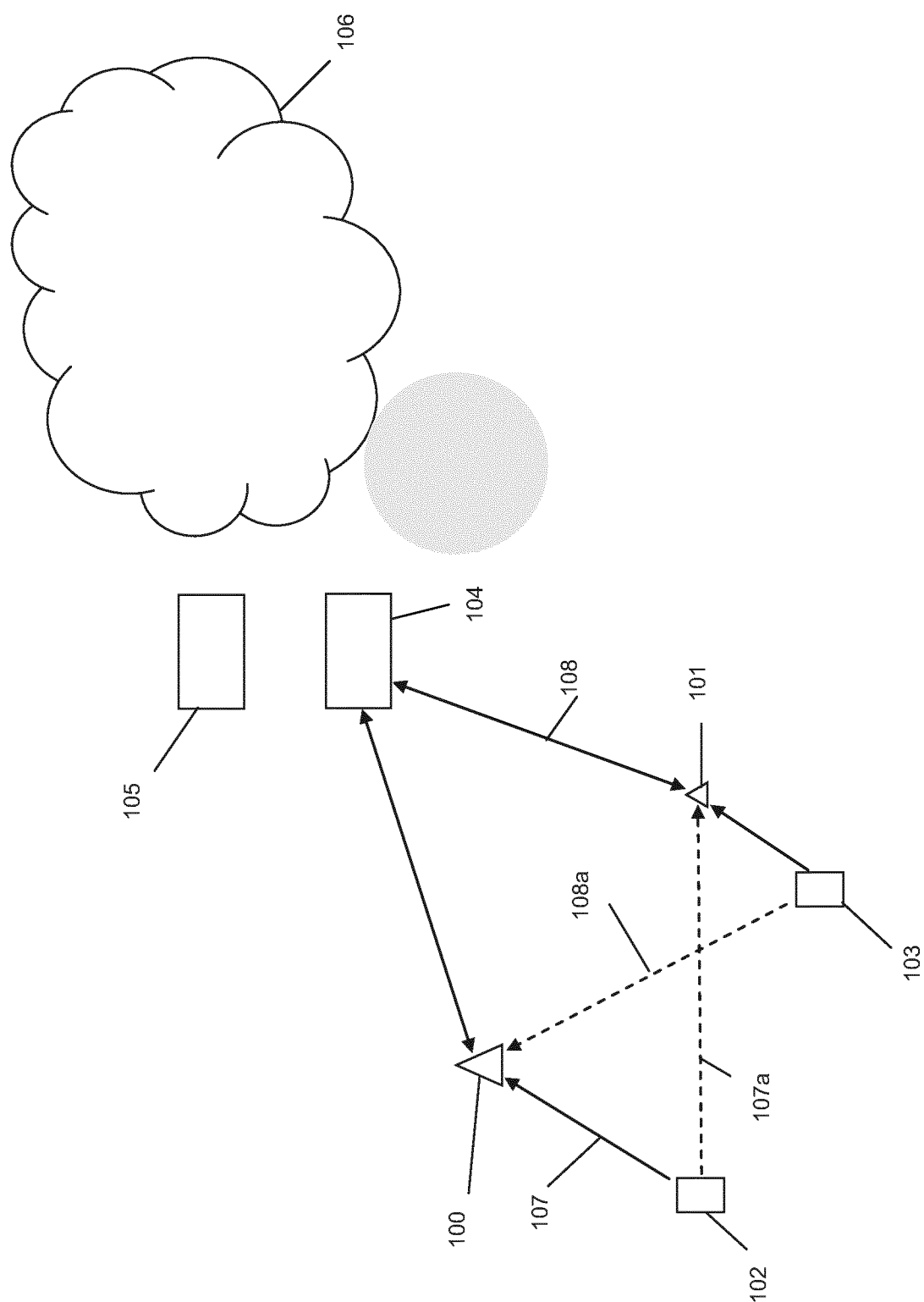


Figure 1

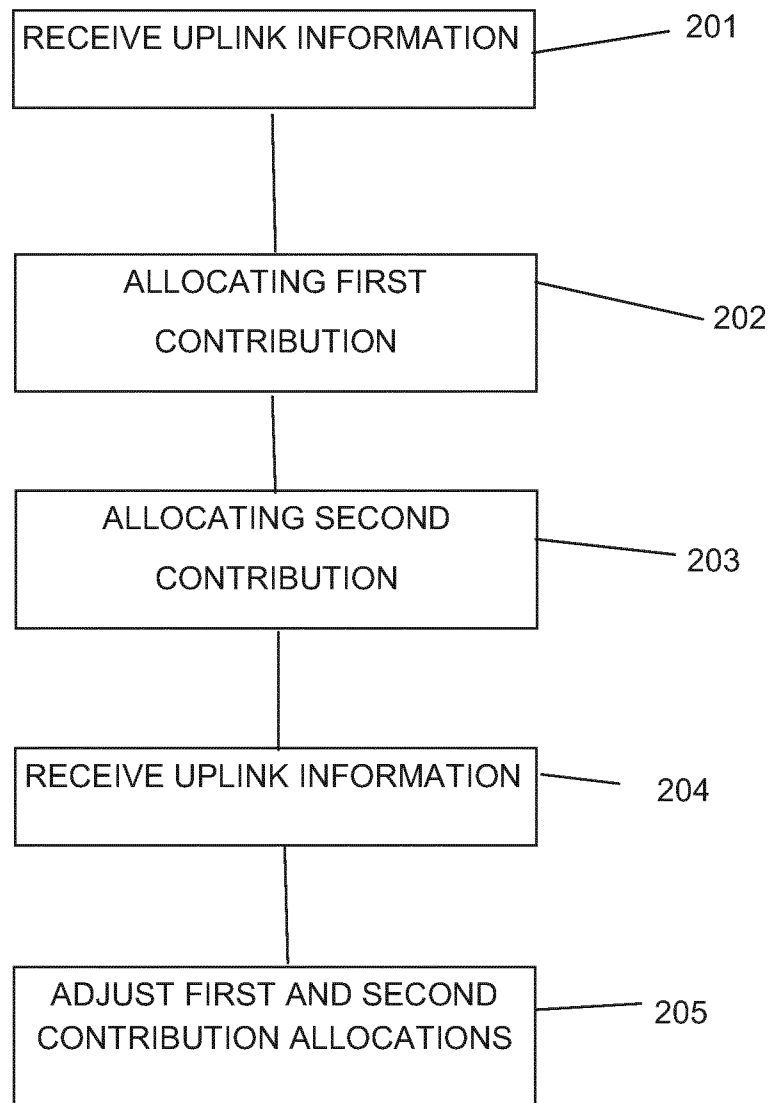


Figure 2A

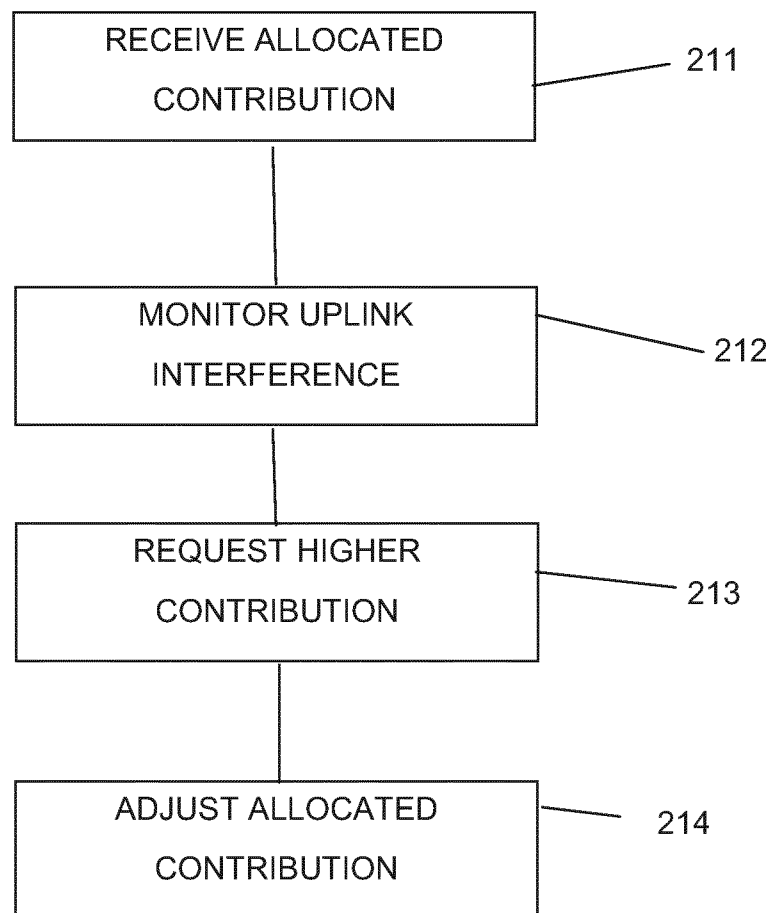


Figure 2B

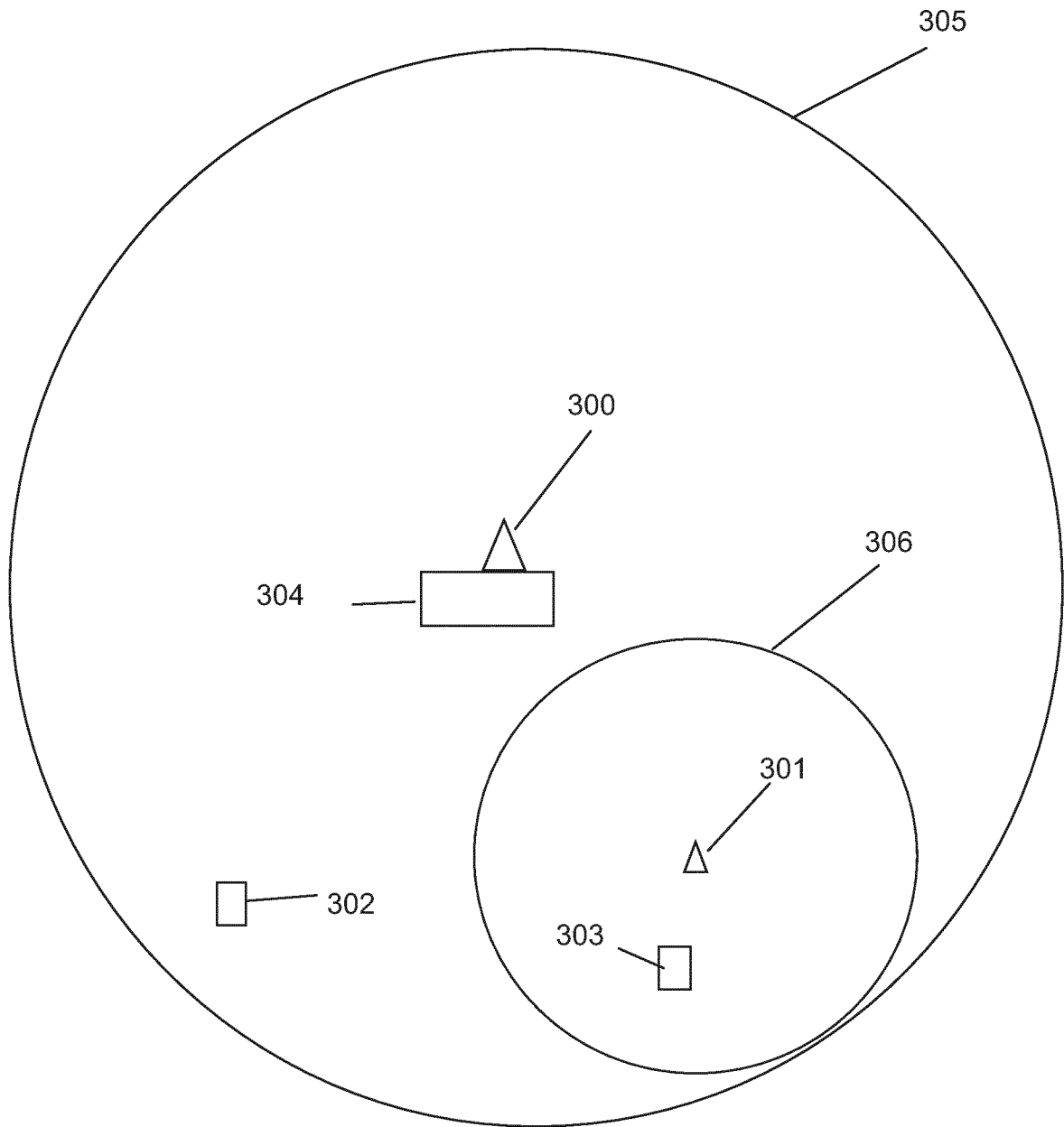


Figure 3

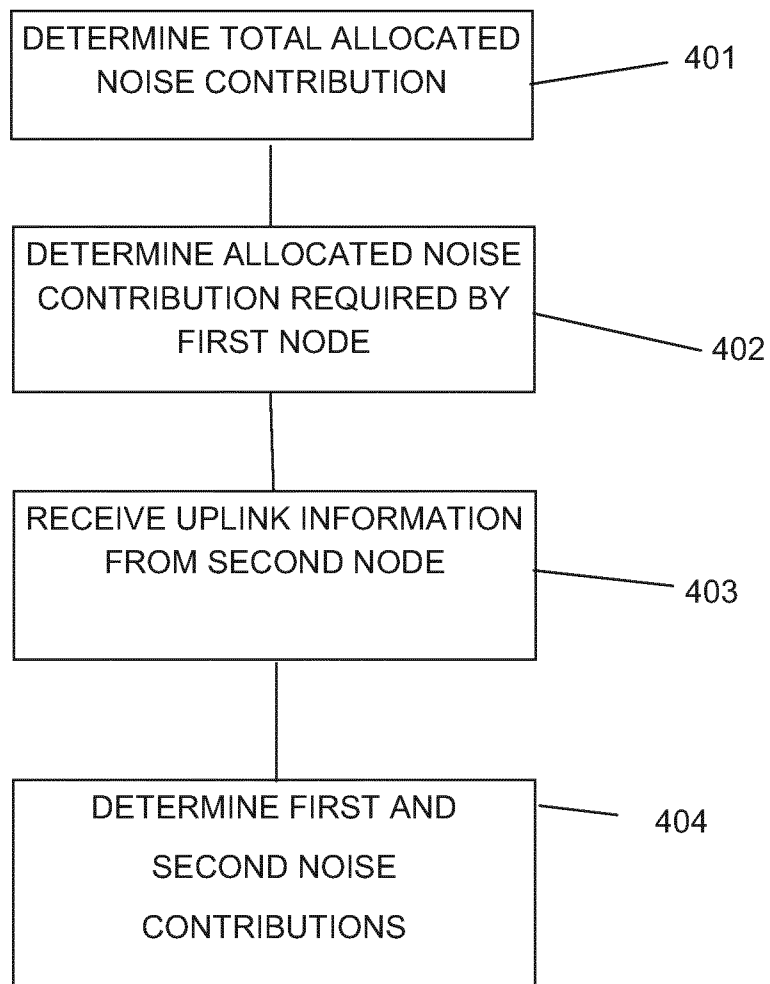


Figure 4

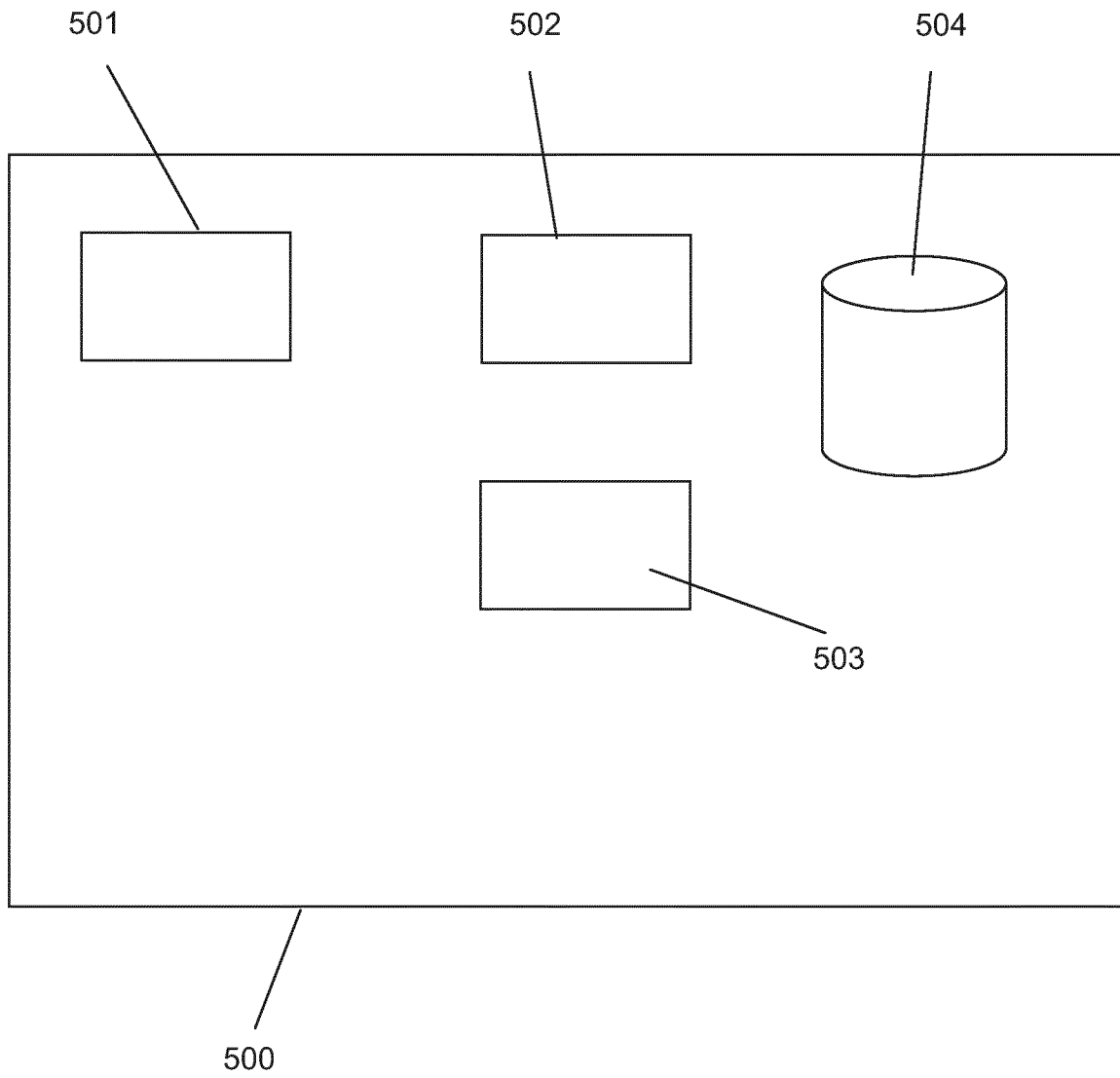


Figure 5

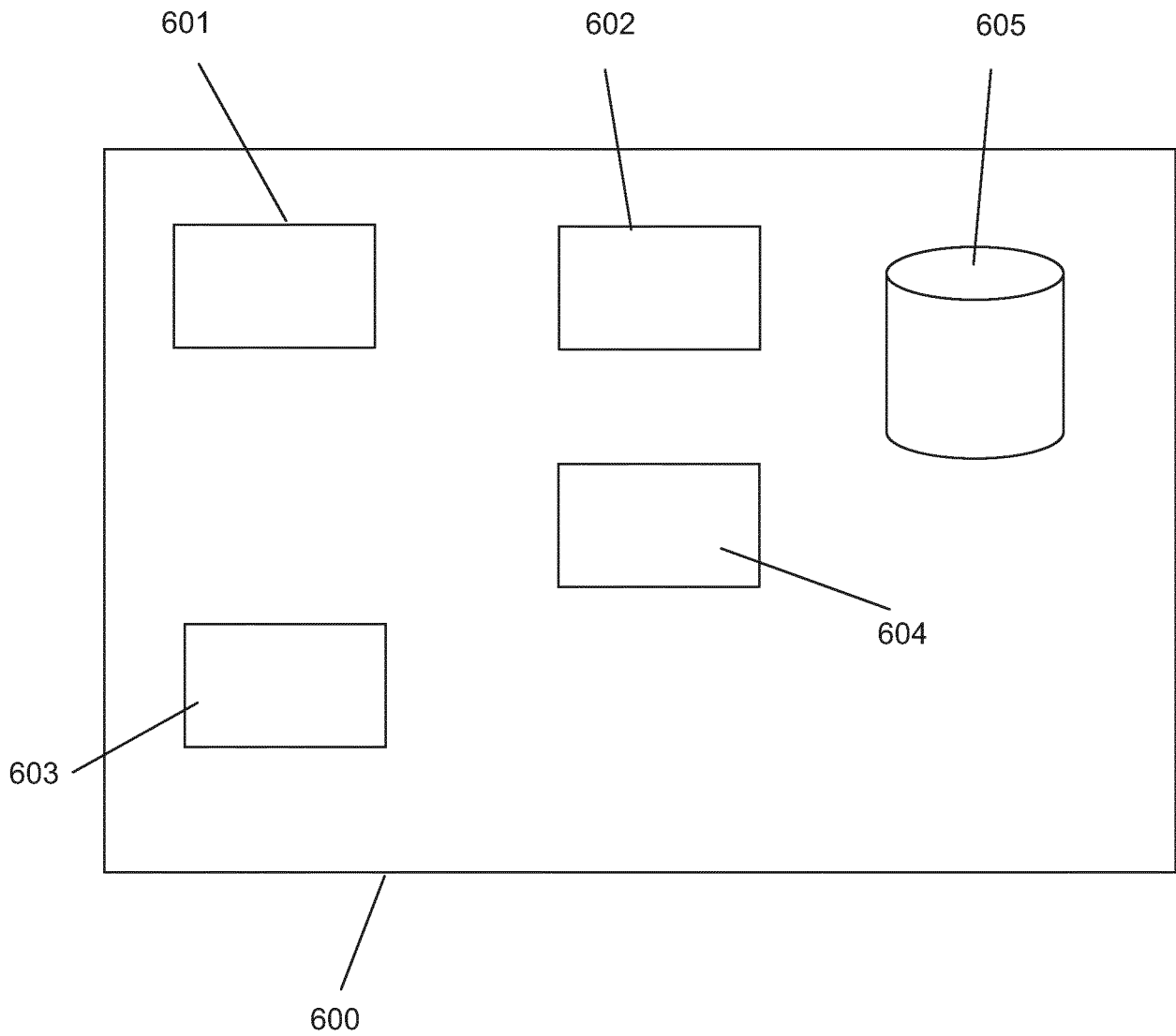


Figure 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/060265

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W52/24
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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	WO 2008/156417 A2 (ERICSSON TELEFON AB L M [SE]; SIMONSSON ARNE [SE]; RACZ ANDRAS [HU]; P) 24 December 2008 (2008-12-24) the whole document -----	1-20
X	WO 2008/130297 A1 (ERICSSON TELEFON AB L M [SE]; SIMONSSON ARNE [SE]; FURUSKAER ANDERS [S]) 30 October 2008 (2008-10-30) the whole document -----	1-20
X	EP 1 887 709 A1 (ALCATEL LUCENT [FR]) 13 February 2008 (2008-02-13) paragraph [0018] - paragraph [0025] -----	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

12 April 2013

Date of mailing of the international search report

18/04/2013

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Authorized officer

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2012/060265

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