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(54) **Title:** INTERFERENCE AVOIDANCE IN A WCDMA SYSTEM

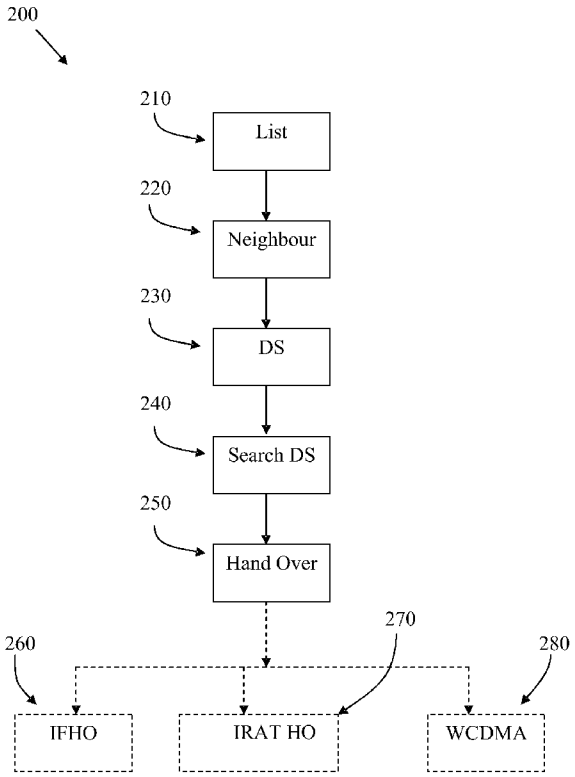

Fig. 2

(57) **Abstract:** A method (200) for a cellular system (100) comprising base stations (111, 125-127) of a first and a second kind, which control cells of a first (110) and second (120-122) kinds, and a control function (140) for the base station of the first kind (111). The control function (140) maintains a list of cells in the vicinity of the first cell, a Neighbour Cell list, and a UE (112) in the first cell measures tra nsmissions from Neighbour Cells and reports them, and said UE (112) makes Detected Set, DS, measurements, and reports them to the control function. The control function (140) searches DS measurement reports for cells of the second kind (120-122), and if (2 50) a cell of the second kind is found, a hand over of the UE is initiated, to prevent transmissions from the UE to cause interference in the base station of the second kind.

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TITLE

Interference avoidance in a WCDMA system.

TECHNICAL FIELD

The present invention discloses a method and a device for avoiding inter cell interference in a cellular system such as the WCDMA system, in which system there are both small cells, so called Femto cells, and "ordinary" cells, so called Macro cells.

BACKGROUND

In a wireless cellular telephony system of the WCDMA kind, only one or a few frequencies are used by the system, which is made possible by the fact that the transmissions in the different cells of the system are made using different so called scrambling codes.

The fact that only one or a few frequencies are used in a WCDMA system may cause a problem when deploying so called Femto Base Stations, which are at present being developed in order to provide wireless cellular telephony coverage for end users in limited coverage areas, so called Femto cells, such as, for example, private homes or offices.

A Femto Base Station will more or less be designed as an "ordinary" base station of the system within which it is intended for deployment, i.e. in this case a WCDMA system. However, a major difference between Femto Base Stations and the "ordinary" or "Macro" base stations of the WCDMA system in which the Femto Base Station is deployed is the output power of the Femto Base Station, and thus the area which can be covered by means of the cell which is served by the Femto Base Station, the Femto cell. The output power of the Femto Base Station will be significantly much smaller than the output power of the Macro base stations, and will thus limit the size of a Femto cell compared to the area of the Macro cells.

The problem referred to above which may arise when using Femto cells interspersed with the larger Macro cells in a WCDMA system is caused by the fact that both the Macro cells and the Femto cells may be deployed on one and the same frequency. Thus, user terminals, UEs, in the Macro cells may interfere with the Femto cells when transmitting to the Macro base stations, i.e. so called Up Link, UL, transmissions.

If a Macro UE is close to a Femto base station, its UL transmissions, which may be made using a high output power level, may cause interference in the Femto base station.

A WCDMA system comprises a control function for Base Stations, known as the Radio Network Controller, the RNC. There is a function in the RNC in a WCDMA system by means of which the RNC keeps track of cells in the vicinity of a cell which it controls, the so called Neighbour list. The RNC also controls certain functions of the UEs in a cell, which is done via the Base Station of the cell.

Potentially, the Neighbour list could be used by an RNC in order to minimize UL interference from UEs to nearby Femto Base Stations. However, it is envisioned that large amounts of Femto cells may be deployed in a WCDMA network. If many Femto cells are deployed, it will not be possible to define all of them as neighbours to surrounding Macro cells, since the number of cells in a Neighbour list may be limited and, in addition, even if that were possible, the work involved in keeping such lists updated would be prohibitive.

Also, the problem described above is underlined by the fact that Femto base stations may be equipped with some kind of access control, since they are intended for use in private home or small offices. This means that it will not be possible for UEs of WCDMA cells in their vicinity to connect to them by means of functions in WCDMA known as soft or softer Hand Over, functions

which otherwise might control transmissions of Macro UEs in the vicinity of Femto base stations so that interference problems would not arise.

SUMMARY

Hence, as shown above, there is a need to reduce or eliminate the risk of UL transmissions from Macro Cell UEs causing interference in Femto Base Stations.

This need is addressed by the present invention in that it discloses a method for use in a wireless cellular telephony system which comprises a first base station of a first kind, such as a Macro Base Station, and a second base station of a second kind, such as a Femto Base Station.

The two base stations mentioned above control a cell of a first and a second kind respectively, each cell being able to accommodate a number of user terminals, UEs. The cells of the first and second kinds have a respective coverage which at least partially coincide with each other, and the system also comprises a control function for the base station of the first kind.

The method of the invention comprises:

- letting the control function maintain a list of cells which are in the vicinity of the first cell, a Neighbour Cell list,
- letting a UE in the first cell measure transmissions from Neighbour Cells and report them to the control function,
- letting the UE also detect transmissions from cells which are not Neighbour cells of the first cell, so called Detected Set, DS, measurements, and report them to the control function.

In addition, the method of the invention comprises:

- letting the control function search DS measurement reports to identify cells of the second kind,

- if a cell of the second kind is found in a DS measurement report, the control function initiates a hand over of the reporting UE, in order to prevent transmissions from the reporting UE to cause interference in the base station of the second kind.

Thus, by means of the present invention, interference in Femto cells caused by UL transmissions from Macro UEs can be reduced or eliminated, since a Macro UE which is detected to be within the coverage of a Femto Base Station can be subjected to a Hand Over.

This and other advantages of the present invention will become more apparent from the following detailed description.

The invention also discloses a node for use as a control function for a Macro Base Station in a WCDMA system.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in more detail in the following, with reference to the appended drawings, in which

Fig 1 shows an overview of a system in which the invention may be applied, and

Fig 2 shows a flow chart of a method of the invention, and

Fig 3 shows a block diagram of a control function of the invention.

DETAILED DESCRIPTION

Fig 1 shows an example of a part of a system 100 in which the invention may be used. Before the invention and in particular fig 1 are explained further, it should be pointed out that although the invention is primarily intended for a WCDMA system, the invention it is not limited to such an application. Thus, in the text below, some terms which are generic to cellular telephony will sometimes be used instead of WCDMA specific terms.

One example of such a generic term is the term" base station", a term which is used to denote a function which controls the traffic to and from a cell in the system. In some systems, the function is known as Radio Base Station, RBS, and in WCDMA systems, the term used is usually Node B. In other systems, the term Base Transceiver stations, BTS, or eNodeB is used. Hence, the term "base station" is intended as a generic term intended to cover all such functions or nodes in cellular systems.

The system 100 comprises a number of base stations 125-127 of a second kind, so called Femto Base Stations, which are base stations with essentially the same functions as "normal" or Macro base stations, but with a significantly much smaller cell, i.e. the Femto cell, than a Macro cell.

As an example, a Femto cell could have an area which is 1000 times smaller than a Macro cell, or even less. The cells which are controlled by the Femto Base Stations 125-127, i.e. the Femto cells, are shown as 120-122 in fig 1. As shown in fig 1, the system 100 may also comprise a function 140 for controlling the Femto Base Stations, a so called Radio Network Controller, RNC 140. The role of the RNC as such is well known to those skilled in the art, and will thus not be described in more detail here.

In each of the Femto cells of the Femto Bases 120-122 in fig 1, there can be a first number of users with user terminals, UEs, one of which is shown as 123 in the cell 120.

Also shown in fig 1 is a Macro cell 110, inside which the Femto Bases 125 - 127 with their cells 120-122 are located. This is merely an example, it is possible for a Femto cell to have a coverage which only has a partial overlap with a Macro Cell. The Macro cell 110 can comprise a number of users with user terminals, UEs, one of which is shown as 112 in fig 1. The traffic to and from UEs in the Macro Cell 110 is controlled by a Macro Radio Base Station,

RBS, shown as 111 in fig 1. The Macro Base Station will also be referred to as the "NodeB" below.

The NodeB 111 is in turn controlled by an RNC, which can be the same RNC 140 as the one controlling the Femto Base Stations, which is indicated in fig 1, or the RNC of the NodeB 111 can be another RNC.

As explained previously in this text, one of the problems intended to be addressed by the present invention is the fact that Up Link, UL, transmission from the UEs 112 in the Macro cell 110 may cause interference in the Femto Base Stations 125-127, since these transmission may be made with a high level of output power, particularly when compared to the output power levels used in a Femto cell.

As will be explained in more detail below, the invention comprises the concept of letting the RNC of the Macro cell 110 detect if a UE in the Macro cell 110 has come within "hearing range" (radio detection) of one of the Femto base stations 125-127, and if so, the RNC of the NodeB initiates a Hand Over of the UE in question, so that the UL transmissions of the UE will not be received by the Femto cell in question.

The Hand Over can be of different kinds: since the reason for the Hand Over is to avoid interference by UE UL transmissions, the Hand Over can be a so called Inter Frequency Hand Over, IFHO.

In the case of an IFHO, the UE is handed over to another operating frequency, but may still be handled by the same NodeB, or by another NodeB on the new frequency. Thus, in the case of an IFHO, the UE still operates in a WCDMA system, but on another frequency.

The Hand Over may also be a so called Inter Radio Access Technology Hand Over, IRAT HO. In the case of an IRAT HO, the UE is handed over to

another system, i.e. it will operate in a wireless cellular telephony system of another standard, such as, for example, the GSM system or an LTE system. The Base Station to which the Hand Over is made can still be the same Base Station, if it is equipped to operate according to the new standard, or it can be another Base Station which has the proper equipment.

It can be mentioned that IRAT HO may be used in systems which only comprise Macro cells, if a UE of a WCDMA system moves into an area where there is little or no WCDMA coverage, but where there is, for example, GSM coverage.

In the following, reference may be made to a UE which listens for "other cells", or which is "in communication with other cells", or "detects transmissions from other cells", etc. These phrases may be used as alternatives to saying that the UE listens to transmissions from a NodeB of another cell, is in communication with a NodeB of another cell, or that it detects transmissions from NodeBs of other cells, etc.

An RNC of the system 100 has, for each cell of a NodeB that it controls, a list of cells which are in the vicinity of that cell, the Neighbour cell list. The Neighbour cell list includes a number of parameters for each cell in the list, such as, for example the cell ID and the cell's scrambling code. . In the WCDMA system, the Neighbour List, with the scrambling code and possibly also the output power level of the cells in the list, can be sent by the RNC to a UE, and a UE may be requested by its controlling RNC to listen for transmissions from cells in the Neighbour list, and to report detected transmissions from other cells to the RNC, which is done via the NodeB.

However, a problem arises if a UE reports that it has detected NodeB transmissions from a cell which is not in the Neighbour list which the UE has received from its RNC. If such a cell/NodeB is detected by a UE and reported to the RNC of the UE's cell, then the detected cell cannot be included in the

UE's AS. Such cells, i.e. cells which are not in the UE's neighbour cell lists can still be detected by the UE, for example by means of a function known in the 3GPP as detected set, DS, measurements. The DS function is a function by means of which a UE attempts to detect all transmissions on a certain frequency, suitably the one used by the NodeBs in the UE's AS, regardless of whether or not they are included in the UE's neighbour cell list. When a UE detects a transmission in a DS measurement, it will send a measurement report comprising the scrambling code or codes detected in the DS measurement to the RNC of the UE.

In brief, and as will be explained in more detail in the following, by means of the present invention, an RNC which receives a DS measurement report will be able to use the contents of the report to see if a cell which has been detected during a DS measurement is a Femto cell. The check to see if the detected cell is a Femto cell will, in a preferred embodiment, take place in real time, or as near real time as possible, and if the cell turns out to be Femto cell, the Hand Over mentioned previously will be initiated.

Turning now to how an RNC may, according to the invention, carry out its check of a DS measurement report in order to see if any of the cells in the report may be Femto cells, this may be done in the following manner: A number of scrambling codes can be reserved by the system for use by Femto cells only. The RNC maintains a list of these codes, and when the RNC receives a DS report, it can check to see if any of the scrambling codes in the DS report is a code which is one of those that are reserved for Femto cells.

If/when a DS report from a UE has been identified as comprising a scrambling code from a Femto cell, then a Hand Over, a HO, either an IFHO or an IRAT HO can be initiated for the UE in question.

As an alternative to the RNC maintaining a list of the reserved scrambling codes, various interactive scenarios are possible, such as the RNC

forwarding the DS reports to a node which carries out the search, in which case the RNC would simply receive a result of the search, such as "Femto"/"No Femto", or "Initiate HO"/"Don't initiate HO". As another alternative, the RNC can receive the list of reserved scrambling codes from a node which keeps the list. Other options are also possible, as will be apparent to those skilled in the art.

Fig 2 shows a schematic flow chart of a method 200 of the invention. Steps which are options or alternatives have been shown with dashed lines.

As has emerged from the description above, the method is intended for use in a wireless cellular telephony system such as a WCDMA system. The system in which the invention is applied will comprise base station of a first and a second kind, e.g. Macro Base Stations and Femto Base Stations, which controls respective cells of a first and a second kind, i.e. Macro and Femto cells in this example. The coverages of the two cells should at least partially coincide with each other, and the system will comprise a control function for the Base Stations of the first kind, e.g. an RNC if the invention is used in a WCDMA system

As indicated in step 210 of fig 2, the method 200 comprises letting the control function, e.g. the RNC, maintain a list of cells which are in the vicinity of the first cell, a Neighbour Cell list.

Step 220 shows that the method 200 comprises letting a UE in a cell of the first kind, i.e. in this case in a Macro cell, measure transmissions from Neighbour Cells and report them to the control function.

Also shown is step 230, which comprises letting the measuring UE detect transmissions from cells which are not Neighbour cells of its cell, so called Detected Set, DS, measurements, which are reported to the control function.

In addition, the method comprises, as shown in step 240, letting the control function search the DS measurement reports in order to identify cells of the second kind, and, step 250, if a cell of the second kind (e.g. Femto) is found in a DS measurement report, the control function will initiate a hand over of the reporting UE, so that transmissions from the reporting UE are prevented from causing interference in the base station or stations of the second kind, the Femto Base Stations.

As indicated in step 260, the Hand Over can be an IFHO, as an alternative to which it can be an IRAT HO, as indicated in step 270. Step 280 is used to indicate that the invention is suitably applied to a WCDMA system, although other systems, such as LTE systems, are also possible application areas for the present invention.

Fig 3 shows a schematic block diagram of a controlling node 300 of the invention, such as an RNC. As indicated in fig 3, the RNC 300 of the invention comprises an interface 310, which is used both for transmission and reception of traffic to/from the NodeBs, and via them the UEs. It is possible for the RNC 300 of the invention to be in contact with the NodeBs and/or UEs which it controls via, for example, the Internet or some other such network, in which case the interface 310 will serve as the interface towards that network.

The RNC of the invention will also comprise a transmit function 320 and a receive function 330, as well as a control and calculation function, suitably a microprocessor 340 as shown in fig 3, and the RNC 300 also comprises memory means, 350.

The Memory means 350 will serve to maintain the Neighbour Cell list, which has been explained above, in which it may be aided by the processor 340.

The interface 310 and the receive part 330 can be used to communicate with a UE via a NodeB, i.e. to receive reports from a UE regarding detected transmissions by UEs from Neighbour Cells, and also for receiving reports from said UE regarding transmissions from cells which are not Neighbour cells of the first cell, i.e. the Detected Set measurements. The processor 340, and possibly also the memory means 350, can serve to search DS reports in order to identify Femto cells.

The processor 340, together with the transmit part 320 and the interface 310 can be used for initiating a hand over of the reporting UE, if a Femto cell is found in a DS measurement report.

Finally, it should be mentioned that the measurements carried out by the UE, i.e. the measurements of Neighbour cells and Detected Set cells can be carried out independently by the UE, or they can be ordered from the RNC, as has been mentioned above. In the latter case, the processor 340 may keep track of when the measurements should be carried out, and the interface310 and the transmit part 320 are used to transmit the commands for measurements to the UE, suitably via the NodeB.

This proposed functionality can improve system performance and reduce the UL interference in the small cells, thus making it more attractive to mix small and large WCDMA cells on the same frequency. However, the invention can be used in other systems where the same problems are encountered, and should thud not be seen as being restricted o WCDMA systems.

The invention is not limited to the examples of embodiments described above and shown in the drawings, but may be freely varied within the scope of the appended claims.

CLAIMS

1. A method (200) for use in a wireless cellular telephony system (100), said system comprising a first base station (111) of a first kind and a second base station (125-127) of a second kind, which control a cell of a first (110) and a second (120-122) kind respectively, each cell being able to accommodate a number of user terminals, UEs, the cells of the first and second kinds having respective coverages which at least partially coincide with each other, the system (100) additionally comprising a control function (140) for the base station of the first kind (111), the method comprising the following:

- letting (210) said control function (140) maintain a first list of cells which are in the vicinity of the first cell, a Neighbour Cell list,
- letting (220) a first UE (112) in the first cell measure transmissions from Neighbour Cells and report them to said control function,
- letting (230) said first UE (112) detect transmissions from cells which are not Neighbour cells of the first cell, so called Detected Set, DS, measurements, and report them to said control function,

the method being characterized in that it additionally comprises:

- letting (240) said control function (140) search DS measurement reports to identify cells of the second kind (120-122),
- if (250) a cell of the second kind is found in a DS measurement report, the control function initiates a hand over of the reporting UE, in order to prevent transmissions from the reporting UE to cause interference in the base station of the second kind.

2. The method (200, 260) of claim 1, according to which said hand over is a hand over to another operating frequency.

3. The method (200, 270) of claim 1, according to which said hand over is a hand over to a wireless cellular telephony system of another standard.

4. The method (200, 280) of any of the previous claims, applied to a WCDMA system.

5. The method (200, 280) of claim 4, according to which the control function (140) maintains a list of scrambling codes used by the base stations of the second kind (125-127), by means of which cells of the second kind can be identified in the DS reports.

6. The method (200, 280) of claim 4 or 5, according to which the controlling function (140) is a Radio Network Controller, an RNC.

7. A node (300) for use in a wireless cellular telephony system (100), said system comprising a first base station (110) of a first kind and a second base station (125-127) of a second kind, which control a cell of a first (110) and a second (120-122) kind respectively, each cell being able to accommodate a number of user terminals, UEs, the cells of the first and second kinds having respective coverages which at least partially coincide with each other, the node (300) being intended to serve as a control function (140) for the base station of the first kind, and comprising the following:

- means (350) for maintaining a first list of cells which are in the vicinity of the first cell, a Neighbour Cell list,
- means (310, 330) for receiving from a first UE in the first cell reports regarding measured transmissions from Neighbour Cells,
- means (310, 330) for receiving from said first UE reports regarding detected transmissions from cells which are not Neighbour cells of the first cell, so called Detected Set, DS, measurements,

the node (300) being characterized in that it additionally comprises:

- means (340, 350) for searching DS measurement reports to identify cells of the second kind,
- means (340, 320, 310) for initiating a hand over of the reporting UE, if a cell of the second kind is found in a DS measurement report, in

order to prevent transmissions from the reporting UE to cause interference in the base station of the second kind.

8. The node (300) of claim 7, in which said means (340, 320, 310) for hand over initiate a hand over to another operating frequency.

9. The node of claim 7, in which said means (340, 320, 310) for hand over initiate a hand over to a wireless cellular telephony system of another standard.

10. The node (300) of any of claims 7-9, being a Radio Network Controller in a WCDMA system.

11. The node (300) of claim 10, which maintains a list of scrambling codes used by the base stations (125-127) of the second kind, by means of which cells (120-122) of the second kind can be identified in the DS reports.

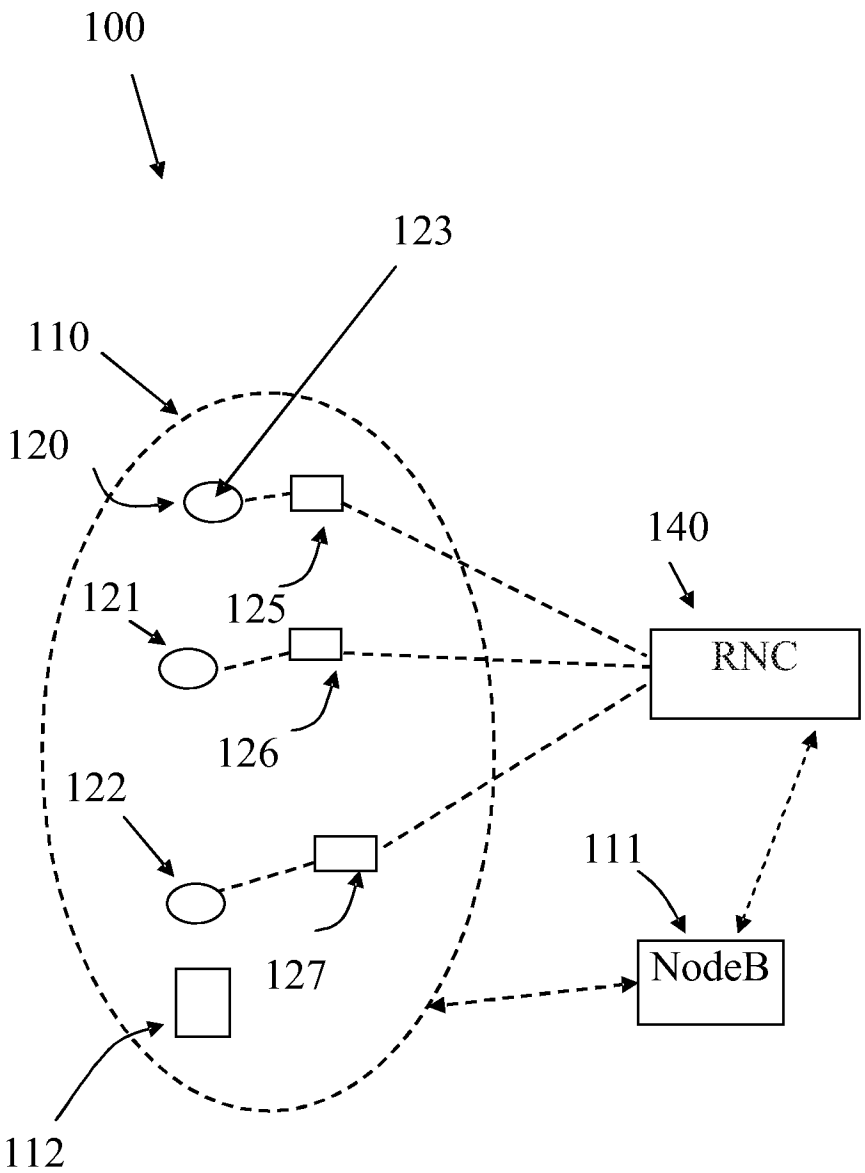

Fig. 1

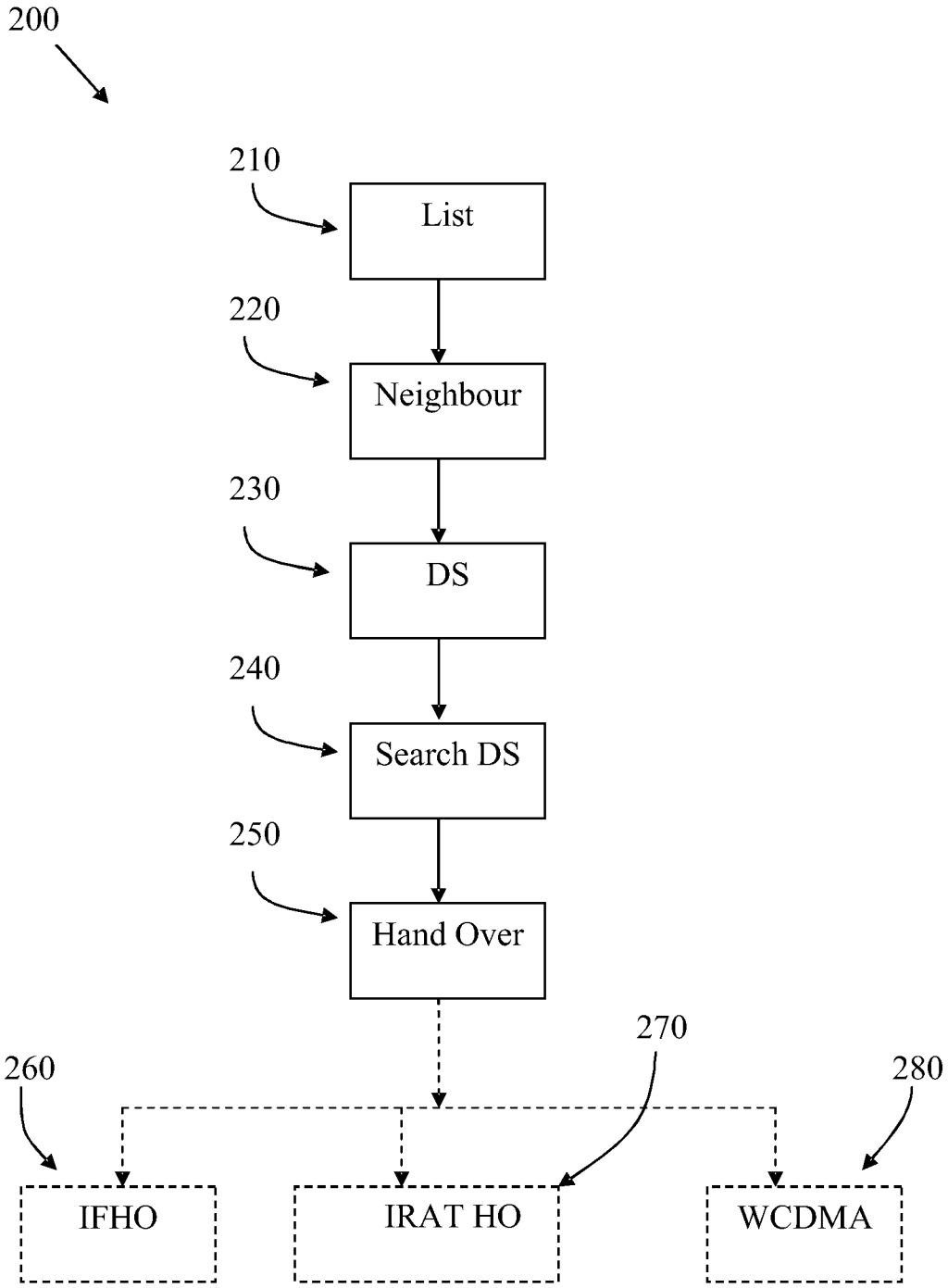
200
210
List
220
Neighbour
230
DS
240
Search DS
250
Hand Over
260
270
280
IFHO
IRAT HO
WCDMA

Fig. 2

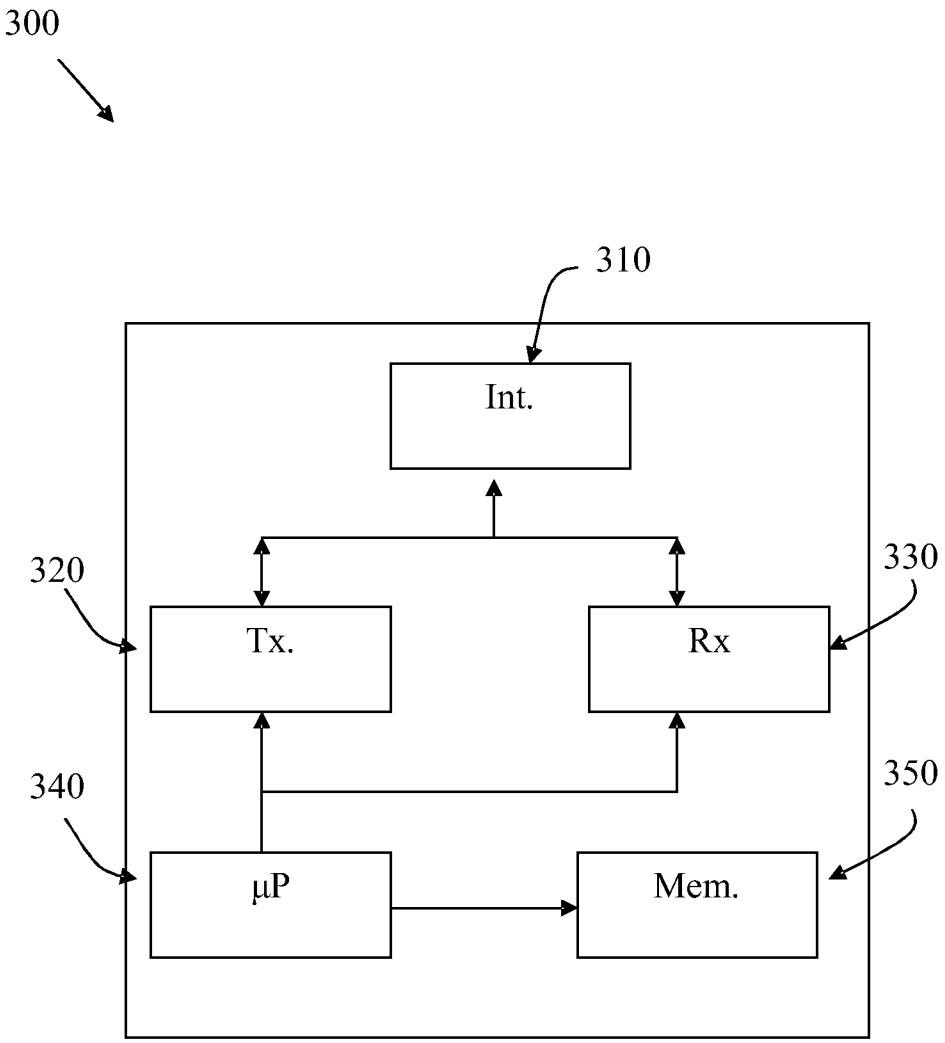

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2007/050389

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04B, H04Q, H04L, H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2005101890 A1 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)), 27 October 2005 (27.10.2005), claim 1, abstract, page 5, line 22 - line 24, page 6 (step 4) --	1-4,6-10
Y	WO 03094544 A1 (NOKIA CORPORATION), 13 November 2003 (13.11.2003), page 2, line 9 - line 25; page 21, line 3 - line 19, abstract --	1-4,6-10
A	US 20070105527 A1 (NYLANDER, T ET AL), 10 May 2007 (10.05.2007), abstract --	1-11

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
16 April 2008	17 -04- 2008
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Predrag Pajovic/CC Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 0070897 A1 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)), 23 November 2000 (23.11.2000), abstract --	1-11
A	WO 2006010958 A2 (RICHARDSON, A), 2 February 2006 (02.02.2006), abstract -- --------	1-11

International patent classification (IPC)
H04B 1/10 (2006.01)
H04Q 7/36 (2006.01)

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Use the application number as username.
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Cited literature, if any, will be enclosed in paper form.

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