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GB 2456126 A **WO 1998/038806 A3**
US 20100157845 A1
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R1-103563, 3GPP TSG-RAN WGI #61 bis, DRESDEN, June 28th-July 2nd 2010. "Increasing footprint of low power nodes for improved performance".

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(54) Title of the Invention: **Cell selection**
Abstract Title: **Biased RSRP cell selection for use with overlapping cell operating ranges.**

(57) A communication system is described in which a first base station controls a cell selection bias value based on signal measurements received from user devices within a cell operating range of the first base station. The signal measurement may be physical cell identifier, a reference signal received power (RSRP), geographic location of a user device or path loss measurement. The base station obtains data identifying the further base station having a different cell operating range that overlaps with the operating range of the first base station and determines the cell selection bias for at least one of the base stations based on the received signal measurement reports. The determined cell selection bias value is then transmitted to a user device within the cell operating range of the first base station. The bias is used to ensure user devices preferentially choose one cell over another, i.e. a pico/ femto/low power cell over an umbrella/macro cell.

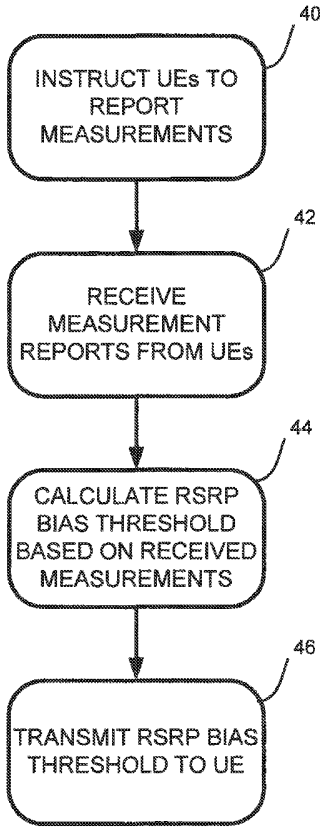

Figure 4

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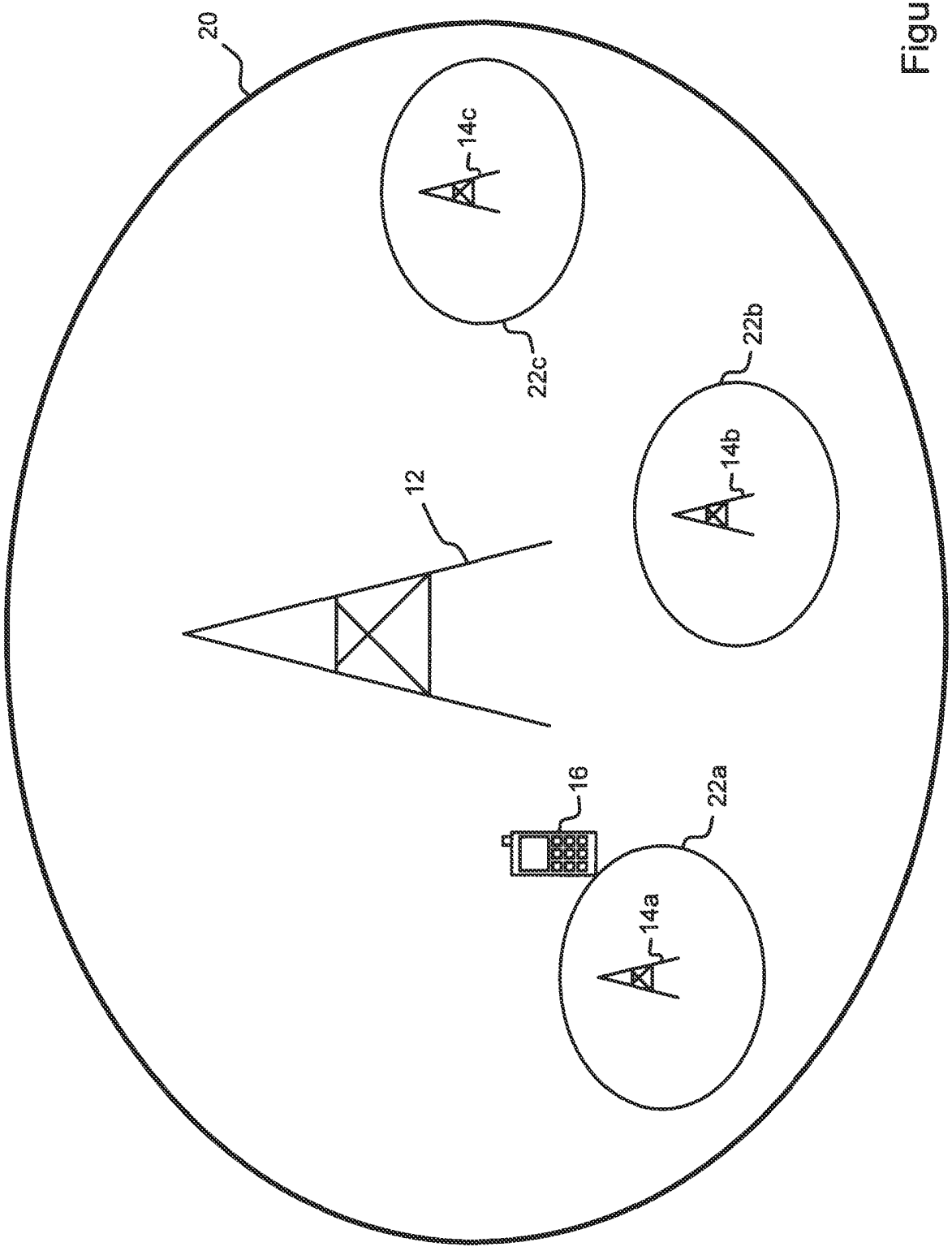

Figure 1

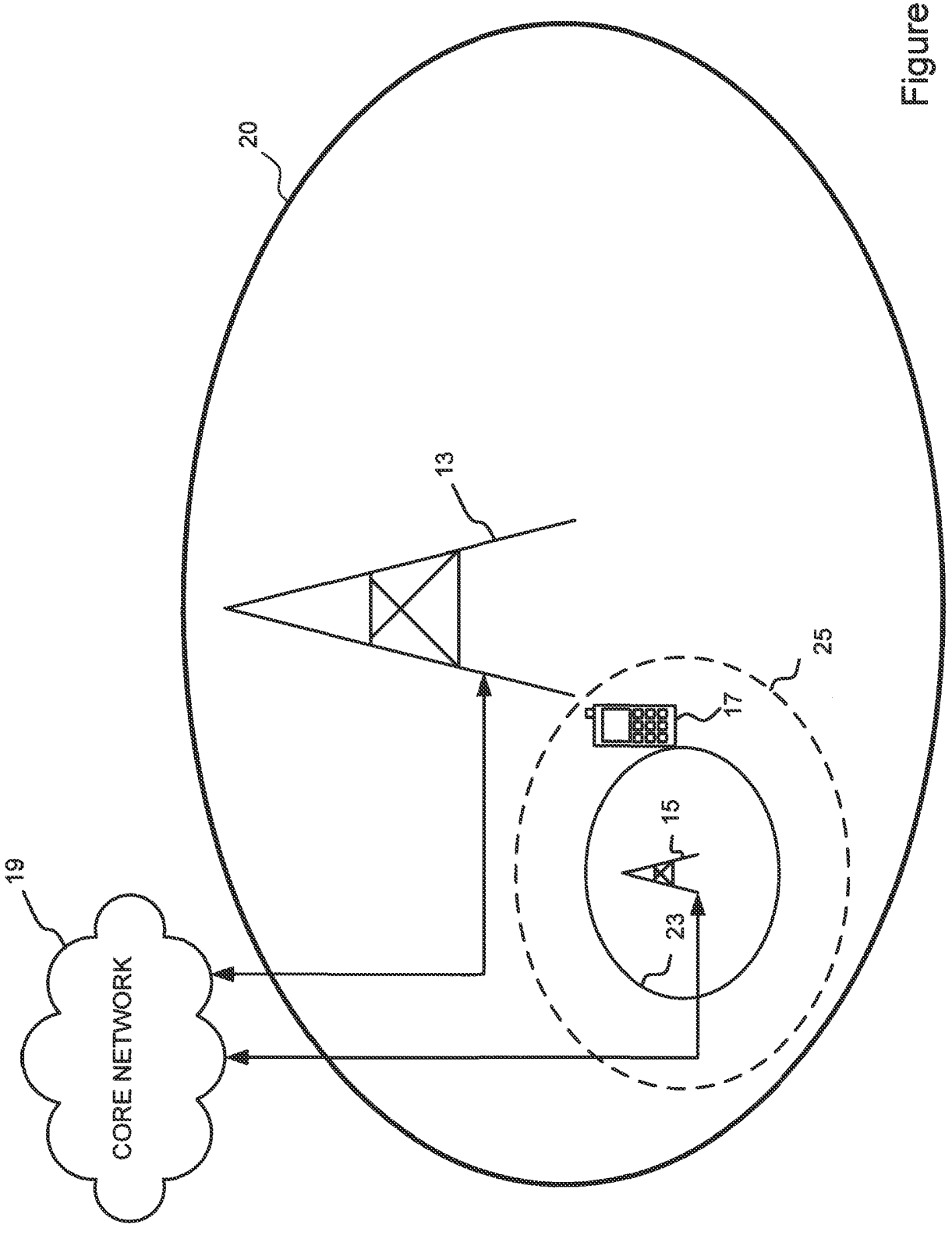

Figure 2

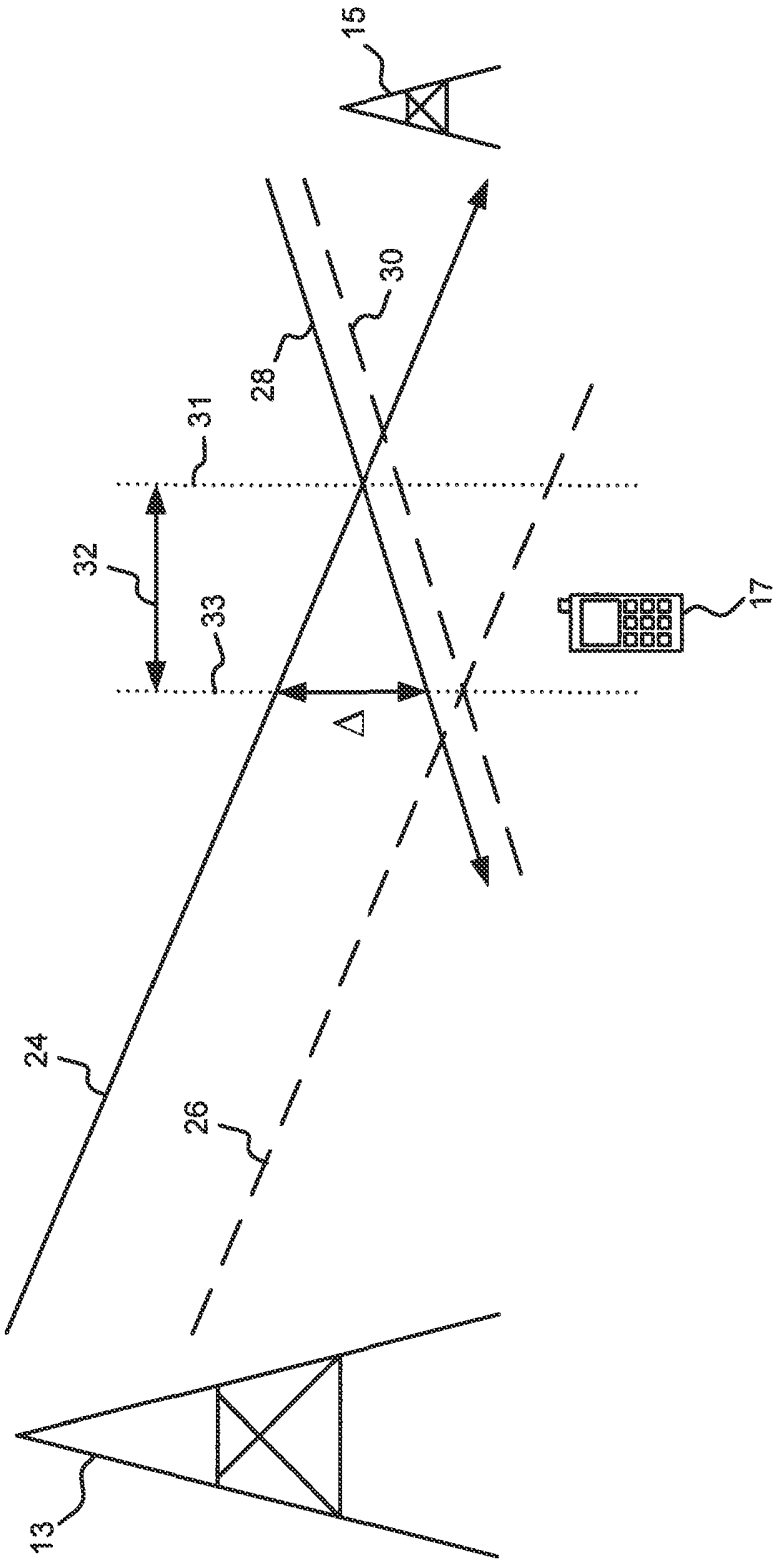

Figure 3

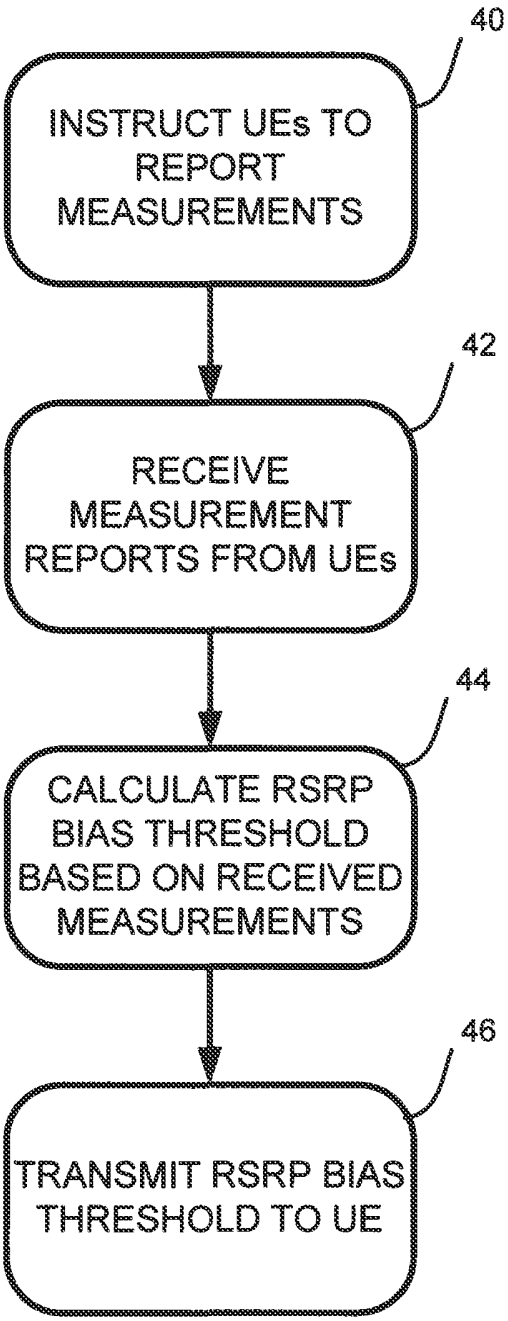
40
INSTRUCT UEs TO REPORT MEASUREMENTS
42
RECEIVE MEASUREMENT REPORTS FROM UEs
44
CALCULATE RSRP BIAS THRESHOLD BASED ON RECEIVED MEASUREMENTS
46
TRANSMIT RSRP BIAS THRESHOLD TO UE

Figure 4

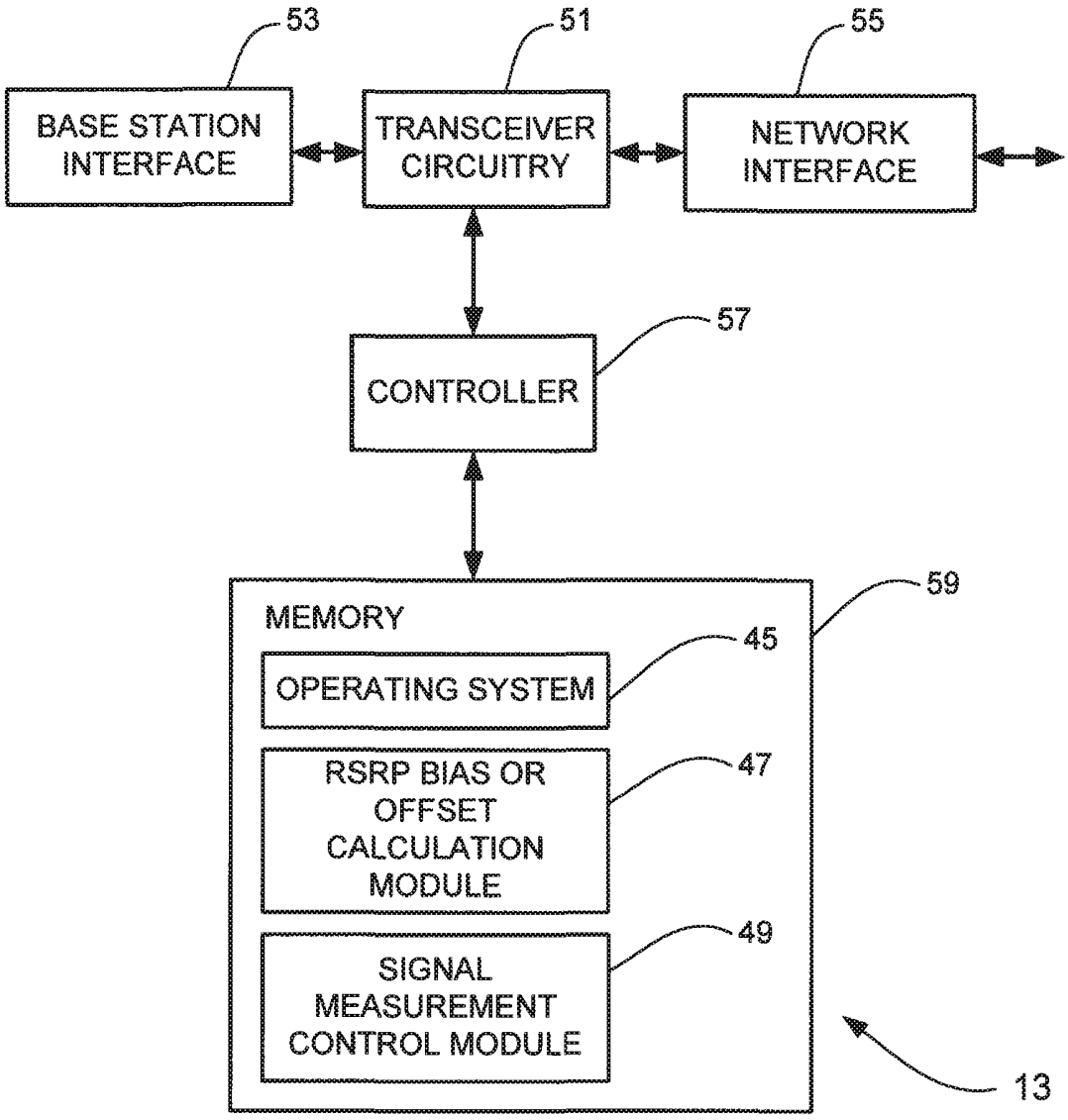
53
51
55
BASE STATION INTERFACE
TRANSCEIVER CIRCUITRY
NETWORK INTERFACE
57
CONTROLLER
59
MEMORY
45
OPERATING SYSTEM
47
RSRP BIAS OR OFFSET CALCULATION MODULE
49
SIGNAL MEASUREMENT CONTROL MODULE
13

Figure 5

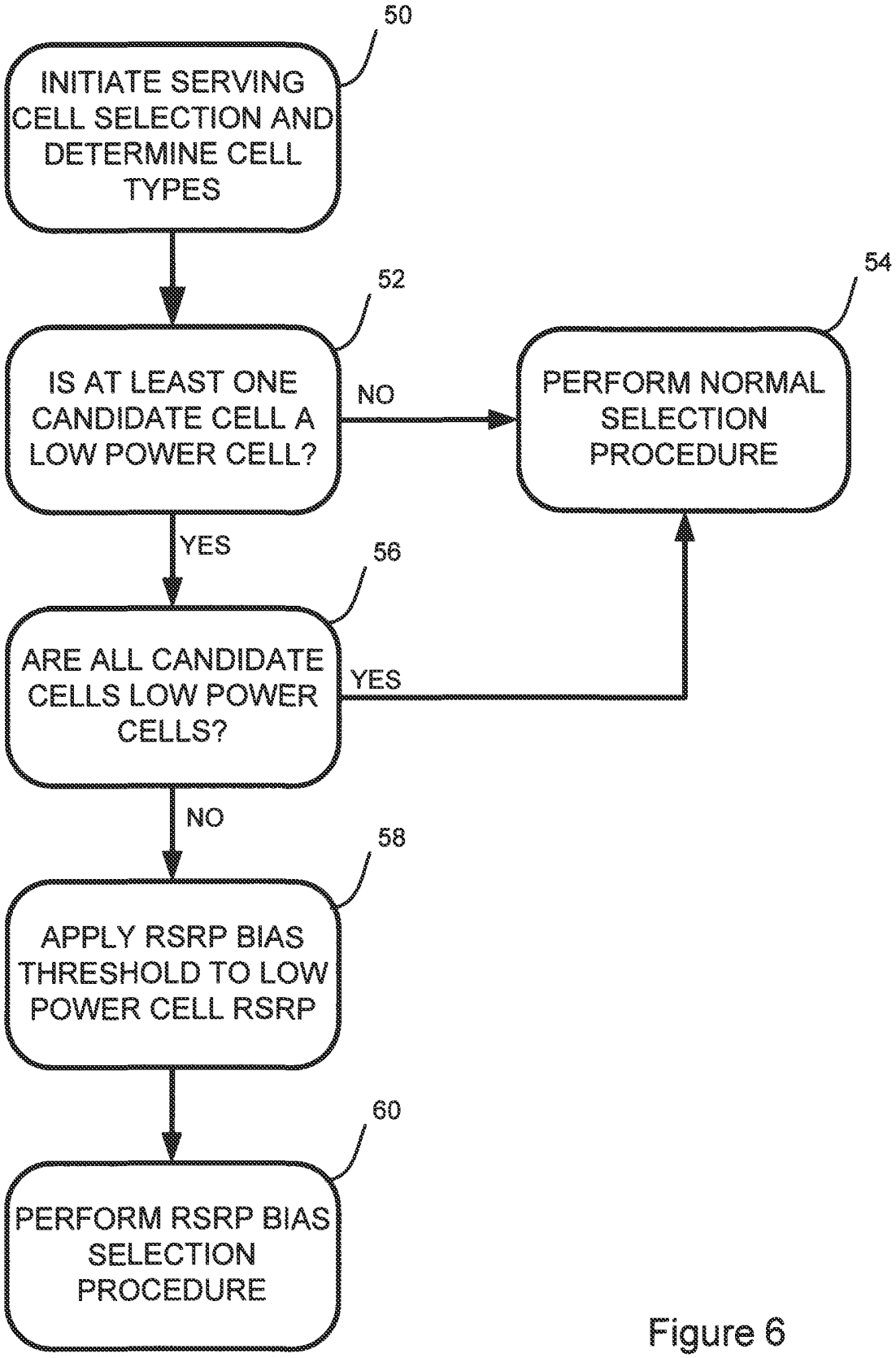
50
INITIATE SERVING CELL SELECTION AND DETERMINE CELL TYPES
52
IS AT LEAST ONE CANDIDATE CELL A LOW POWER CELL?
NO
54
PERFORM NORMAL SELECTION PROCEDURE
YES
56
ARE ALL CANDIDATE CELLS LOW POWER CELLS?
YES
NO
58
APPLY RSRP BIAS THRESHOLD TO LOW POWER CELL RSRP
60
PERFORM RSRP BIAS SELECTION PROCEDURE

Figure 6

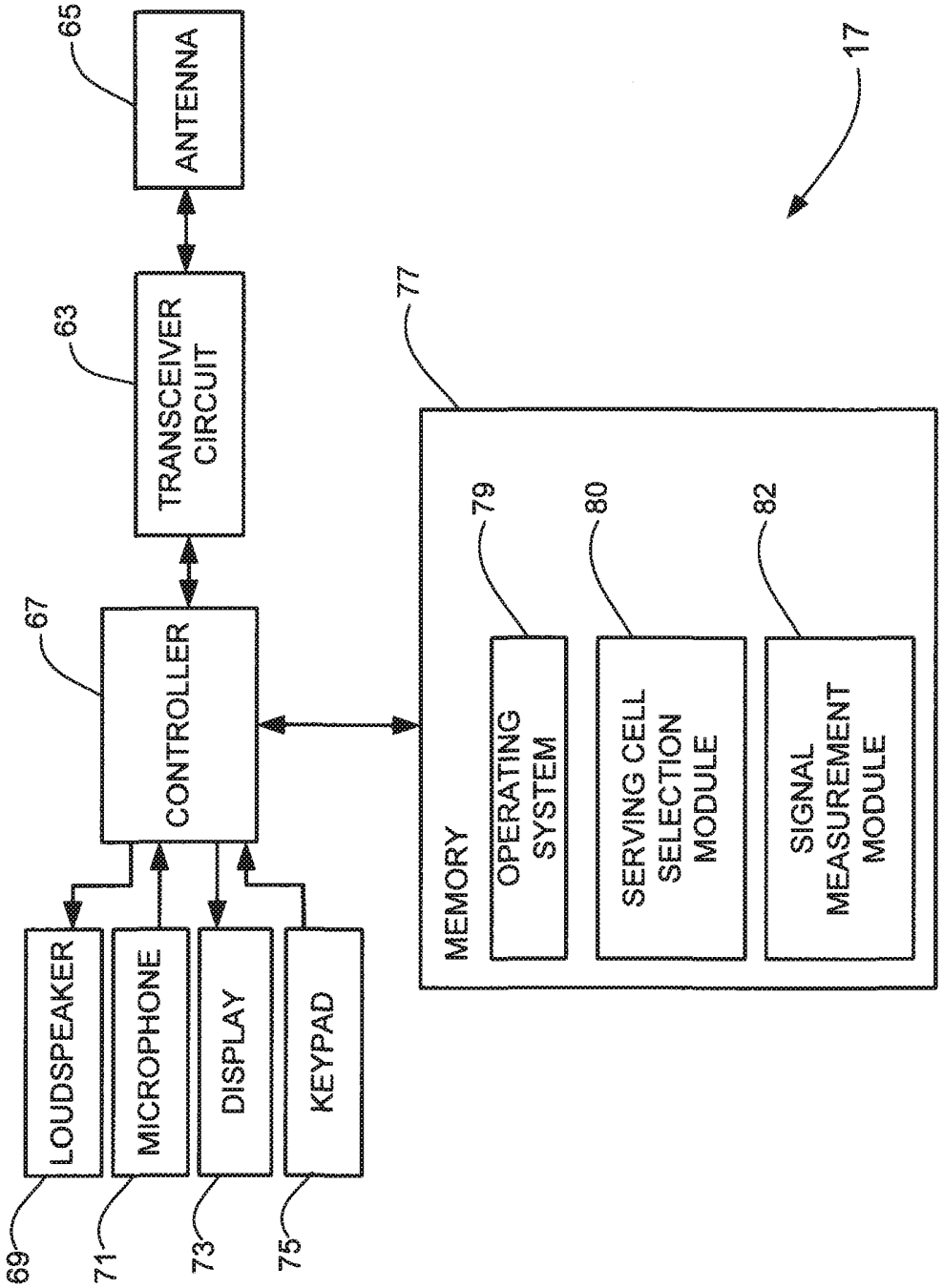
65
ANTENNA
63
TRANSCEIVER CIRCUIT
67
CONTROLLER
77
MEMORY
79
OPERATING SYSTEM
80
SERVING CELL SELECTION MODULE
82
SIGNAL MEASUREMENT MODULE
17
LOUDSPEAKER
MICROPHONE
DISPLAY
KEYPAD
69
71
73
75

Figure 7

CELL SELECTION

The present invention relates to mobile telecommunication networks and, particularly but not exclusively, networks operating according to the 3GPP standards or equivalents or derivatives thereof. The invention has particular although not exclusive relevance to the Long Term Evolution (LTE) of UTRAN (called Evolved Universal Radio Access Network (E-UTRAN)).

In a mobile telephone network, a user equipment may be in a region in which it is able to receive signals relating to more than one cell of the network. In order to determine which cell to connect to, measurements of received signal power of a signal from a base station (also known as an eNB in LTE standard) associated with each cell can be made and the cell corresponding to the base station having the highest or strongest Reference signal Received Power (RSRP) is chosen.

Figure 1 shows a wireless communication network in which an eNB 12 of a macro cell, having a relatively high transmitted signal power and therefore covering a relatively large area 20, may be supplemented with one or more low power eNBs 14a, 14b, 14c corresponding to pico cells located within the area 20 covered by the macro cell. For example the low power eNBs may be used to provide extra capacity at a hotspot or to improve coverage in a low signal area within the area of a macro cell. This leads to user equipment 16 located near to the edge of a pico cell 14a receiving signals from both the macro eNB 12 and pico eNB 14a. In the RAN1#61Bis meeting in Dresden 28 June to 2 July 2010, it was proposed that an RSRP bias mechanism should be implemented such that user equipments should preferentially connect to the pico cell under certain circumstances.

This RSRP bias mechanism allows user equipments 16 being served by a macro cell 12 but near to a pico cell 14a, for example as determined by pathloss criteria, to camp on the pico cell 14a even if handover/cell reselection criteria based on

RSRP are not met. According to the proposed biasing mechanism, an offset or threshold value is added to the RSRP of the low power cell before comparing it with the RSRP of the macro cell. Thus, the lower power cell will be selected even if the reference signal received power for that cell is lower than the RSRP for the macro cell by up to the threshold amount.

Without RSRP biasing, cell selection between the pico cell and the macro cell is based on the strongest signal, i.e. highest RSRP value. This leads to the footprint of the pico cell being limited by interference from the macro cell, and limits the number of user equipment devices that are able to benefit from the hotspot provided by the pico cell.

Using the RSRP bias mechanism, user equipment can be controlled to preferentially connect to the pico cell, even when the pico cell has a lower measured RSRP than the macro cell. In effect, this provides a range expansion for the low powered pico cell, increasing the size of the area served by the pico cell, and allowing more traffic to be offloaded from the macro cell to the pico cell. The RSRP biasing mechanism is applicable to heterogeneous networks comprising a mix of high power, macro, cells and lower power cells such as pico or hybrid cells.

However, while the use of RSRP bias has been proposed, details of how such a mechanism could be implemented have not yet been considered.

Embodiments of the present invention aim to provide a method of implementing a RSRP bias mechanism in a mobile communication network to allow user equipment devices to preferentially connect to a pico cell in a heterogeneous wireless network comprising overlapping macro and pico cells.

According to one aspect of the invention, there is provided a first base station for use in a communications network, the first base station comprising: means for

receiving signal measurement reports from user devices within a first cell operating range of the first base station; means for obtaining data identifying a second base station having a second cell operating range which is different from and overlaps with the first cell operating range of the first base station; and means for determining a cell selection bias value (which may be an offset or gain value) for the first or second base station using the received signal measurement reports. The base station may then transmit the determined cell selection bias value to a user device within the first cell operating range of the first base station.

The signal measurement reports may comprise one or more of: a physical cell identifier, a reference signal received power, geographical location of a user device, and a pathloss measurement. Furthermore, the signal measurement reports may relate to signals transmitted by a plurality of base stations and/or may relate to signals transmitted by the first base station or the second base station. The measurement reports will typically be obtained from many different user devices, and the cell selection bias value is preferably updated to reflect the changing path characteristics within the cell.

The first base station may further comprise means for instructing user devices within the first operating cell range of the first base station to generate the signal measurement reports. The instructions may instruct the user devices may comprise means for instructing the user devices using an automatic neighbour relation management function, or a minimization of drive testing mechanism.

The first base station will typically be a macro base station and the second base station will typically be a pico, home base station or hybrid or a relay node. However, the invention is also applicable where the first base station is a pico/home base station / hybrid / relay node and the second base station is a macro base station.

According to another aspect of the invention, there is provided a method of controlling serving cell selection in a wireless communication network, the method comprising: receiving signal measurement reports from user devices within a first cell operating range of a first base station; obtaining data identifying a second base station having a second cell operating range which is different from and overlaps with the first cell operating range of the first base station; determining a cell selection bias value for the first or second base station using the received signal measurement reports. The method may also comprise transmitting the determined cell selection bias value to a user device within the first cell operating range of the first base station.

The received signal measurement reports may comprise one or more of: a physical cell identifier; a reference signal received power; geographical location of a user device, and a pathloss measurement. The received signal measurement reports may relate to signals transmitted by a plurality of base stations, and/or the received signal measurement reports may relate to signals transmitted by the first base station or the second base station.

The method may further comprise instructing the user devices within the first operating cell range of the first base station to generate the signal measurement reports, and instructing the user devices may comprise instructing the user devices using one of automatic neighbour relation management, and minimization of drive testing.

According to another aspect of the invention, there is provided a user device for use in a communications network, the user device comprising: means for obtaining signal measurements for signals communicated between the user device and a plurality of base stations within communication range of the user device, the base stations having different and overlapping cell operating ranges; means for obtaining a cell selection bias value for a base station, which cell selection bias value is determined using the signal measurements; and means

for selecting a base station on which to camp in dependence upon signal measurements obtained for the plurality of base stations and the cell selection bias value.

The means for obtaining a cell selection bias value may comprises one of: means for receiving a cell selection bias value from a first base station of the plurality of base stations; and means for calculating a cell selection bias value in dependence on the obtained signal measurements.

The user device may further comprise means for determining a cell type for each of the plurality of base stations.

According to another aspect of the invention, there is provided a method of selecting a base station in a wireless communication network, the method comprising: obtaining signal measurements for signals communicated between a user device and a plurality of base stations within communication range of the user device, the base stations having different and overlapping cell operating ranges; obtaining a cell selection bias value for a base station, which cell selection bias value is determined using the signal measurements; and selecting a base station on which to camp in dependence upon signal measurements obtained for the plurality of base stations and the cell selection bias value.

Obtaining a cell selection bias value may further comprise one of: receiving a cell selection bias value from a first base station of the plurality of base stations; and calculating a cell selection bias value in dependence on the obtained signal measurements.

The method may further comprise determining a cell type for each of the plurality of base stations.

According to another aspect of the invention there is provide a computer program product comprising computer program code adapted when executed on a processor to perform the steps of any of the above methods

The invention also provides corresponding base stations and UEs for performing the above methods.

The invention provides, for all methods disclosed, corresponding computer programs or computer program products for execution on corresponding equipment, the equipment itself (user equipment, nodes or components thereof) and methods of updating the equipment.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 schematically illustrates a heterogeneous wireless telecommunication system including low power cells;

Figure 2 schematically illustrates a heterogeneous wireless telecommunications system including low power cells having range extension in accordance with the invention;

Figure 3 illustrates signal levels received by a user equipment located between two transmitters in the wireless telecommunications system of Figure 2;

Figure 4 illustrates a method of providing a RSRP bias threshold values in the network;

Figure 5 is a block diagram of an eNB forming part of the wireless telecommunication system of Figure 2.

Figure 6 illustrates a method of selecting a serving cell using RSRP bias; and

Figure 7 is a block diagram of a user equipment forming part of the system shown in Figure 2.

Figure 2 schematically illustrates a cell of a wireless (cellular) telecommunication system 11 in which the user of a user equipment 17 can communicate with other users (not shown), and with the core network via a macro cell associated with eNB 13 of the wireless communication network , or via one of a number of low power cells provided by low power eNBs 15 for example pico cells. In the wireless telecommunication system, a macro cell 21 is provided by the base station 13 (or eNB). Within the area covered by the macro cell, a number of low-power cells provided by low power eNBs 15 are provided to increase capacity in specific areas within the macro cell. Alternatively, the low power cells may comprise open access Home eNB, hybrid or relay cells.

At any one time, a user equipment 17 may be able to receive signals relating to a number of different cells. For example, a user equipment located near the edge of one cell may receive signals relating to a serving cell and also a neighbouring cell, or as in the system shown in Figure 2, a user equipment 17 located in or near the pico cell 15 will receive signals from both the low power eNB 15 and the eNB 13 of the macro cell. In order to implement RSRP biasing at the user equipment, the user equipment needs to understand the type of cell the received signals relate to.

In this present embodiment, RSRP bias is controlled by a macro cell serving the user equipment. The macro cell has knowledge of the local configuration of eNBs, and in particular of the presence of any low power eNBs 15 within the area of the macro cell 21, and therefore knows the type of each cell from which a user equipment 15 located within the area of the macro cell 21 may receive signals. When the user equipment 15 reports that it is able to receive signals from

multiple eNB 13, 15, the macro node determines whether any of the eNBs are a low power eNBs 15 and if so, instructs the user equipment 17 to implement RSRP biasing for a serving cell selection procedure including those low power eNBs. Furthermore, the macro cell calculates an RSRP biasing threshold based on ongoing measurements of signal characteristics within the area of the macro cell to allow the biasing threshold to be optimized according to measured signal properties from the multiple eNBs. This may allow the serving eNB to optimize the biasing threshold according to operation of the network. The calculated threshold can then be provided to one or more user equipments within the area of the macro cell for use in the serving cell selection procedure.

The macro eNB 13 collects measurements from multiple user equipments operating in the area of the macro cell 21 relating to signals received from multiple eNBs by the user equipment. The macro eNB 13 can then use these measurements to determine an appropriate value for the RSRP bias threshold. Each user equipment can be instructed to measure and report received signal strength, for example RSRP, and information relating to pathloss characteristics for signals received from each eNB by the user equipment along with a Physical Cell Identifier (PCI) that allows each cell to be identified. In some arrangements, the user equipments may be arranged to report a geographical location along with the signal measurements.

According to one embodiment, the signal measurements from multiple UEs are statistically collected at the macro eNB 13 to determine average values for the RSRP and pathloss for each cell identified by a unique PCI value to allow the appropriate value for the RSRP bias threshold to be calculated. Furthermore, the UEs may also report a current speed of the UE which may be used by the macro eNB to further refine the calculated bias value.

One way in which the macro eNB 13 could collect the required measurements is via the Automatic Neighbour Relation (ANR) management mechanism. This

mechanism allows an eNB to instruct each user equipment to perform measurements on neighbour cells, as part of the normal call procedure. The ANR protocol may be extended to include the received signal strengths and pathloss data in the measured values, along with the PCI of the neighbouring cells. The use of the PCI values may provide sufficient localization of the measurement (if macro eNB is aware that a specific PCI belongs to a pico cell) to allow the threshold values to be calculated. However, accuracy may be increased by inclusion of geographical reporting. If geographical reporting is required, it may be necessary to extend the current ANR mechanism to include this information.

Alternatively, the minimization of drive tests mechanism MDT could be enhanced to report received signal strength and pathloss data, alongside geographic location at which the measurements were taken.

The macro cell 13 can use the reported measurement to determine the threshold value by comparing the RSRP and pathloss values for signals from different eNBs measured by UEs within the area of the macro cell 21. Figure 3 illustrates the situation in the network of Figure 2 in which a user equipment 17 is located between the macro cell 13 and one of the pico cells 15. Solid lines 24 and 28 illustrate the reference signal received power received at a UE for the macro eNB 13 and pico eNB 15 respectively against distance from the respective cell, and dashed lines 26 and 30 illustrate 1/pathloss experienced by signals transmitted by the macro and pico eNB. As the pico eNB 15 transmits at much lower power than the macro eNB 13, the reference signal received power 28 for signals from the pico cell 15 drops below the level of the RSRP 24 for the macro cell 12 within a short distance (represented by line 31) from the pico cell transmitter. However, due to the smaller distance to the pico eNB 15 often the pathloss 30 for the signal from the pico eNB may be much less than the pathloss 26 for the signal from the macro eNB 13 as shown in Figure 3. This leads to a region 32 in which the measured RSRP for signals from the pico eNB 15 is lower than that from the macro eNB 13, however taking into account the pathloss for the two signals

improved performance may be realized by connecting to the pico cell rather than the macro cell. At the distance between the macro and pico eNBs shown by line 33 in Figure 3, the pathloss will be approximately the same for signals transmitted from both the macro and pico eNBs. The difference in RSRP for the signals from the two eNBs at which pathloss is approximately equal, is shown in Figure 3 as Δ, and indicates an optimal threshold value for the RSRP biasing mechanism.

Once the threshold value has been determined at the macro cell, this value is indicated to the user equipment 17 by the macro cell, for example in Radio Resource Control (RRC) signaling. The threshold value provided to the user equipment 17 may be associated with a specific PCI value, thereby associating the threshold with the low power eNB 15. Applying the RSRP bias threshold during serving cell selection between the low power eNB 15 and the eNB 13 of the macro node leads to a range extension of the area covered by the low power cell, as shown by the dashed area 25 in Figure 2.

Thus, the threshold value can be determined based on a plurality of measurements taken by a one or more user equipments located throughout the area 21 of the macro cell, allowing the macro cell to optimize the cell selection bias threshold based on pathloss and RSRP measurements.

Figure 4 illustrates a method of controlling selection of a serving cell according to embodiments of the invention. In the first step 40, a serving eNB instructs user equipments within the cell served by the eNB to perform measurements of RSRP and pathloss values for signals being received from other eNBs as well as from the serving eNB. These values are received at the serving eNB at step 42 which then uses these values, along with knowledge of any low power cells within the macro cell area to calculate RSRP bias threshold values for the low power cells based on the measurements provided by the UEs in step 44. These RSRP bias threshold values can then be transmitted to a UE which is within range of a pico cell for use in performing the serving cell selection procedure.

In some embodiments, the UEs may also report the type of each cell for which measurements have been performed. The macro eNB may then use this data to generate the knowledge of low power cells within the macro cell area.

Figure 5 is a block diagram illustrating the main components of the macro eNB 13 shown in Figure 2. As shown, the eNB 13 includes transceiver circuitry 51 which is operable to transmit signals to, and to receive signals from, the mobile telephone 17 via one or more antennae 53 and which is operable to transmit signals to and to receive signals from the network 19 via interface 55. The operation of the transceiver circuitry 51 is controlled by a controller 57 in accordance with software stored in memory 59. The software includes, among other things, an operating system 45, an RSRP bias or offset calculation module 47, and a signal measurement control module 49.

The signal measurement control module 49 provides functionality to instruct user equipment within the area of the macro cell to measure the required signal properties and report these measurements back to the macro eNB 13. The received measurements are then supplied to the RSRP bias calculation module 47 which calculates cell selection bias values for any pico cells within the area of the macro cell based on the measured signal properties. The calculated values are then supplied to user equipment for use in cell selection procedures via transceiver circuitry 51 and antennae 53.

While in the above embodiment, control of the RSRP bias has been described as being performed by the macro cell, in other embodiments control of the RSRP bias mechanism may be performed by a pico cell based on measurements received from UEs within the coverage area of the pico cell, or by another network entity in communication with the macro or pico cells. According to some embodiments, the pico cell may inform neighbouring macro cells of the appropriate bias or offset values based on the measurements reported to the

pico cell. As all measurements reported to the pico cell eNB 15 relate to signal measurements made within the small area of the pico cell, calculating the bias or offset values at the pico eNB based on the local signal measurements may allow for the bias value to be set optimally for the local pico cell.

In the above embodiment the RSRP bias was calculated by the serving cell. In an alternative embodiment the RSRP bias may be controlled by the user equipment itself. In order to determine when to apply an RSRP bias value in a cell selection, the user equipment must determine whether any of the local cells is a low power (pico) cell. This information may be provided by the serving cell in a message to the user equipment identifying the cell types of local cells.

Alternatively, the user equipment may be provided with a range of physical cell identifier (PCI) values that are reserved for pico and hybrid (i.e. low power) cells to which RSRP bias should be applied.

The user equipment may then apply a fixed threshold to the RSRP associated with the low power cell during the cell selection procedure, for example a fixed value of up to 6dB may be chosen. Alternatively, the user equipment may calculate a threshold value based on some agreed guidelines negotiated between the network and the user equipment and using signal properties measured by the user equipment, or the calculation may be performed in some other implementation dependent manner.

The above example embodiments have been described in the context of a serving cell selection, or as a handover from a macro cell to a pico cell. However, embodiments of the present invention can also be used during handover of a pico cell to a macro cell. A user equipment connected to a pico cell moving into the region 32 would measure an RSRP 24 for the macro cell greater than the RSRP 28 for the pico cell. If the RSRP bias mechanism was not implemented for handovers from a pico cell to a macro cell, this would fulfill the normal handover

criteria and the user equipment would handover to the macro cell. However, it may be preferable to maintain the connection to the pico cell while the user equipment is in the range extended area 25.

In order to avoid the user equipment handing over to the macro cell within the range extended area 25, a user equipment connected to a low power cell, such as a pico cell, must be aware that the serving cell is a low power cell so that the user equipment knows to apply the RSRP bias mechanism. This can be achieved by the low power cell informing the user equipment, or by the user equipment knowing a range of PCI values reserved for low power cells. As with the macro to pico handover case, the RSRP biasing threshold must be applied to the RSRP of the low power cell before the cell selection procedure is performed. The biasing threshold may be provided by the network or calculated in the user equipment as described above.

Embodiments of the present invention are also applicable to networks including relay nodes. In particular, a mobile relay node located near the edge of a macro cell may apply an RSRP bias to mitigate interference from an adjacent cell. Also, providing 'cell type' information to user equipment to identify a node as a mobile relay node enables the user equipment to make connection decisions based on the status of the relay node.

In the case where a user equipment performs a handover from a pico cell to another pico cell, it may be preferable for the user equipment not to implement any RSRP biasing and to simply perform a normal handover procedure. Thus, the user equipment should be able to determine both whether the serving node is low power node and whether the neighbour is a low power node to ensure that RSRP biasing is correctly applied.

Figure 6 illustrates a method according to an embodiment of the invention for performing serving cell selection in a user equipment. When the serving cell

selection procedure is initiated, for example during handover, the user equipment determines the type of each candidate cell in the selection procedure in step 50. If none of the candidate cells are determined to be a low power cell, such as a pico or hybrid cell, a normal selection procedure can be performed at step 54. However, if it is determined that at least one candidate cell is a low power cell, the RSRP bias selection procedure may be required. Optionally, if it is determined that all/both the candidate cells are low power cells, as shown at step 56, the normal selection procedure may be applied. In the next step 58 of the illustrated method, the RSRP bias threshold is added to the measured RSRP value for the low power cell, and then the selection procedure is performed using the adjusted RSRP values in step 60. If the RSRP of the low power cell added to the threshold value is greater than the RSRP of the macro cell then the low power cell is selected, else the macro cell will be selected by the user equipment.

The RSRP bias threshold value used by the user equipment in step 58 of the method illustrated in Figure 6 may be supplied by the network via the serving eNB, for example having been determined using the method shown in Figure 4, or may be determined within the user equipment as described above. Similarly, the determination of cell types may be based on information provided by the network, such as PCI ranges of low power cells provided in broadcast messages as described above. Alternatively, the determination of cell types may be based on data stored within the user device.

Figure 7 schematically illustrates the main components of the user equipment 17 suitable for implementing embodiments of the invention shown in Figure 2. As shown, the user equipment 17 includes transceiver circuitry 63 which is operable to transmit signals to and to receive signals from the macro eNB 13 or the low power eNB 15 via one or more antennae 65. As shown, the user equipment 17 also includes a controller 67 which controls the operation of the mobile telephone 17 and which is connected to the transceiver circuit 63 and to a loudspeaker 69, a microphone 71, a display 73, and a keypad 75. The controller 67 operates in

accordance with software instructions stored within memory 77. As shown, these software instructions include, among other things, an operating system 79, a serving cell selection module 80, and a signal measurement module 82.

In embodiments of the invention in which the RSRP bias is controlled by the macro eNB 15, the signal measurement module 82 is operable to receive a instruction from the eNB to measure signal properties for eNBs within range and provide the measurement results to the eNB. Serving cell selection module 80 allows the user equipment 17 to perform the serving cell selection procedure. This module allows the user equipment to obtain a RSRP bias value to be used in cell selection procedures involving a low power node. The RSRP bias value may be obtained from the macro eNB, or alternatively may be determined by the serving cell selection module 80.

In all embodiments of the invention, the threshold value is preferably less than or equal to 6dB. Simulation results show that values lower than this provide a range extension to the pico cell that helps to mitigate interferences by offloading UEs from the macro cell to the pico cell. However, values greater than 6dB could lead to issues with receiving the control channel, and may require further modifications to the operation of the network.

According to a further alternative embodiment, UEs may be provided with a list of PCI values and associated RSRP bias values by the network 19. Thus, a user equipment within range of multiple eNBs will receive the PCI value for each eNB and apply a bias value based on an associated RSRP bias value in the received list.

A detailed embodiment has been described above. As those skilled in the art will appreciate, a number of modifications and alternatives can be made to the above embodiment whilst still benefiting from the inventions embodied therein.

The above embodiments have been described with reference to user equipment. As those skilled in the art will appreciate, user equipment may comprise mobile telephones, personal digital assistants, laptop computers, or any other user device capable of interfacing with the wireless communication network.

While the embodiments have been described as applying adding a bias value to an RSRP for signals from a low power transmitter, the skilled man will appreciate that the same effect can be realized by subtracting the bias value from an RSRP for a macro cell.

In the above embodiments, a number of software modules were described. As those skilled will appreciate, the software modules may be provided in compiled or un-compiled form and may be supplied to the base station or to the user equipment as a signal over a computer network, or on a recording medium. Further, the functionality performed by part or all of this software may be performed using one or more dedicated hardware circuits. However, the use of software modules is preferred as it facilitates the updating of eNBs 13, 15 and the user equipment 17 in order to update their functionalities.

Various other modifications will be apparent to those skilled in the art and will not be described in further detail here.

Claims:

1. A first base station for use in a communications network, the first base station comprising:

means for receiving signal measurement reports from user devices within a first cell operating range of the first base station;

means for obtaining data identifying a second base station having a second cell operating range which is different from and overlaps with the first cell operating range of the first base station;

means for determining a cell selection bias value for the first or second base station using the received signal measurement reports; and

means for transmitting the determined cell selection bias value to a user device within the first cell operating range of the first base station.

2. The first base station of claim 1, wherein the signal measurement reports comprise one or more of: a physical cell identifier, a reference signal received power, geographical location of a user device, and a pathloss measurement.

3. The first base station of claim 1 or claim 2, wherein the signal measurement reports relate to signals transmitted by a plurality of base stations.

4. The first base station of claim 3, wherein the signal measurement reports relate to signals transmitted by the first base station and the second base station.

5. The first base station of any preceding claim, further comprising means for instructing the user devices within the first operating cell range of the first base station to generate the signal measurement reports.

6. The first base station of claim 5, wherein the means for instructing the user devices further comprises means for instructing the user devices using one

of an automatic neighbour relation management, and a minimization of drive testing mechanism.

7. A method of controlling serving cell selection in a wireless communication network, the method comprising:

receiving signal measurement reports from user devices within a first cell operating range of a first base station;

obtaining data identifying a second base station having a second cell operating range which is different from and overlaps with the first cell operating range of the first base station;

determining a cell selection bias value for the first or second base station using the received signal measurement reports; and

transmitting the determined cell selection bias value to a user device within the first cell operating range of the first base station.

8. The method of claim 7 wherein the received signal measurement reports comprise one or more of: a physical cell identifier; a reference signal received power; geographical location of a user device, and a pathloss measurement.

9. The method of claim 7 or claim 8 wherein the received signal measurement reports relate to signals transmitted by a plurality of base stations.

10. The method of claim 9, wherein the received signal measurement reports relate to signals transmitted by the first base station and the second base station.

11. The method of any of claims 7 to 10 further comprising instructing the user devices within the first operating cell range of the first base station to generate the signal measurement reports.

12. The method of any of claim 11 wherein instructing the user devices comprises instructing the user devices using one of automatic neighbour relation management, and minimization of drive testing.

13. A user device for use in a communications network, the user device comprising:

means for obtaining signal measurements for signals communicated between the user device and a plurality of base stations within communication range of the user device, the base stations having different and overlapping cell operating ranges;

means for obtaining a cell selection bias value for a base station, which cell selection bias value is determined using the signal measurements; and

means for selecting a base station on which to camp in dependence upon signal measurements obtained for the plurality of base stations and the cell selection bias value.

14. The user device of claim 13, wherein the means for obtaining a cell selection bias value further comprises one of: means for receiving a cell selection bias value from a first base station of the plurality of base stations; and means for calculating a cell selection bias value in dependence on the obtained signal measurements.

15. The user device of claim 13 or claim 14, further comprising means for determining a cell type for each of the plurality of base stations.

16. A method of selecting a base station in a wireless communication network, the method comprising:

obtaining signal measurements for signals communicated between a user device and a plurality of base stations within communication range of the user device, the base stations having different and overlapping cell operating ranges;

obtaining a cell selection bias value for a base station, which cell selection bias value is determined using the signal measurements; and

selecting a base station on which to camp in dependence upon signal measurements obtained for the plurality of base stations and the cell selection bias value.

17. The method of claim 16 wherein obtaining a cell selection bias value further comprises one of: receiving a cell selection bias value from a first base station of the plurality of base stations; and calculating a cell selection bias value in dependence on the obtained signal measurements.

18. The method of claim 16 or claim 17, further comprising determining a cell type for each of the plurality of base stations.

19. A computer program product comprising computer program code adapted when executed on a processor to perform the steps of any of claims 7 to 12 or 16 to 18.

Application No: GB1013639.8 **Examiner:** Mrs Emma Porter

Claims searched: 1-19 (all) **Date of search:** 22 November 2010

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19	US2010/0157845 A1 (RESEARCH IN MOTION) see whole document, especially paragraphs 21-25 and 28.
X	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13. 14, 15, 16, 17, 18, 19	GB2456126 A (MOTOROLA) see whole document, page 5 line 4-page 7 line2, Page9 line 22 - page 10 line 17 and page 15 line 24-page 16 line 13.
X	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19	WO98/38806 A3 (NOKIA) see whole document, page 2 line 22 - line 31.
X	1, 2, 3, 4, 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19	R1-103563, 3GPP TSG-RAN WGI #61 bis, DRESDEN, June 28th-July 2nd 2010. "Increasing footprint of low power nodes for improved performance". see whole document, especially references to increasing the footprint of lower power nodes denoted as "Biased RSRP".

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

H04L; H04W

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, TXTUS1, TXTUS2, TXTUS3, TXTUS4, TXTEP1, TXTGB1, TXTWO1

International Classification:

Subclass	Subgroup	Valid From
H04W	0036/08	01/01/2009
H04W	0036/00	01/01/2009