(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 August 2013 (29.08.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/123637 A1

(51) International Patent Classification:
H04W 48/16 (2009.01) *H04W 16/00* (2009.01)

(21) International Application Number:
PCT/CN2012/071354

(22) International Filing Date:
20 February 2012 (20.02.2012)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **RENESAS MOBILE CORPORATION** [JP/JP]; 6-2, Otemachi 2-Chome, Chiyoda-ku, Tokyo 100-0004 (JP).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **BAI, Wei** [CN/CN]; Room 1201, Building 14, Xi Ba He Zhong Li, Chaoyang District, Beijing 100028 (CN). **WEI, Na** [CN/CN]; #609-2-303 Jing Ao Jia Yuan, Chaoyang District, Beijing 100018 (CN). **WANG, Haiming** [CN/CN]; Room 1403, Unit 5, Building 101, Jiang Fu Jia Yuan, Jiang Tai Road, Chaoyang District, Beijing 100015 (CN). **ZENG, Erlin** [CN/CN]; Room 1605, Building A-12, Xi San Qi Jian Cai Cheng Fu Li Tao Yuan, Haidian District, Beijing 100096 (CN). **HONG, Wei** [CN/CN]; Room 606, Haidian North second street, Haidian District, Beijing 100080 (CN). **SUN, Pengfei** [CN/CN]; 4#1907 Tonghuinan Road 8#, Tongzhou District, Beijing 100010 (CN).

(74) Agent: **KING & WOOD PRC LAWYERS**; 20th Floor, East Tower, World Financial Centre, No. 1 Dongsanhuan Zhonglu, Chaoyang District, Beijing 100020 (CN).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: ENHANCED MEASUREMENT FOR NEW CARRIER TYPE

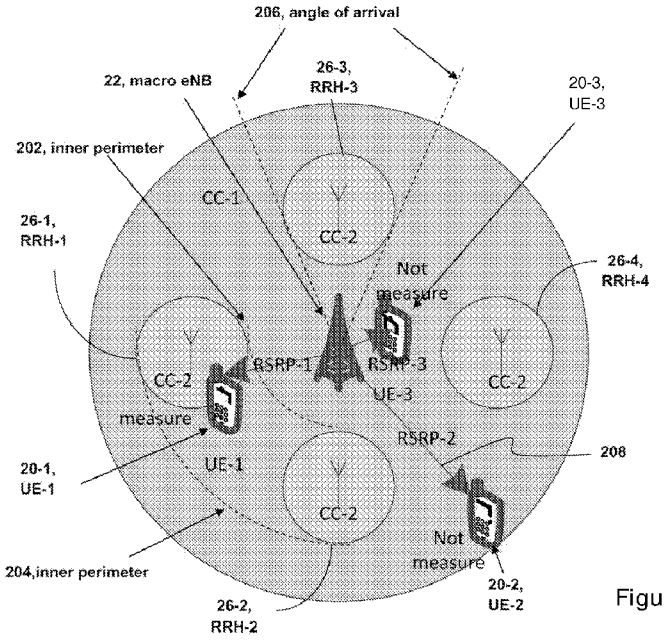


Figure 2

(57) Abstract: In specific example embodiments a serving cell (macro cell/eNB) sends to a user equipment UE a special measurement object that identifies a neighbor cell (pica cell) and gives a finite range for measuring the serving cell. Whether the U measures and reports on that neighbor cell is conditional on the whether the UE's measurement of the serving cell falls within that finite range. In the examples the range gives low and high thresholds for reference signal received power or quality. In one embodiment the network needs to confirm prior to the UE using a next measurement gap for measuring that neighbor cell; in another the UE enters the gap autonomously if the network previously configured the UE for autonomous operation.

WO 2013/123637 A1

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

ENHANCED MEASUREMENT FOR NEW CARRIER TYPE

TECHNICAL FIELD:

[0001] The exemplary and non-limiting embodiments of this invention relate generally to wireless communication systems, methods, devices and computer programs, and more specifically relate to user equipment UE measurements of neighbour cells.

BACKGROUND:

[0002] Abbreviations used in this description and/or in the referenced drawings are defined below following the Detailed Description section.

[0003] Carrier Aggregation (CA) in LTE-Advanced extends the maximum bandwidth in the uplink (UL) and/or downlink (DL) directions by aggregating multiple component carriers within a frequency band (intra-band CA) or across different frequency bands (inter-band CA). Figure 1 shows a CA arrangement that is sometimes referred to as a heterogeneous network or hetnet.

[0004] The hetnet scenario of Figure 1 is scenario 4 for carrier aggregation detailed at 3GPP TS 36.300v11.0.0 informative annex J.1. The eNB 101 provides macro coverage on frequency f1 110 and a number of remote radio heads (RRH) 102a, 102b are deployed on frequency f2 120 in areas of high traffic such as railway stations, airports, shopping malls, etc. Alternatively, dedicated pico eNBs may be deployed in place of the remote radio heads. While Figure 1 depicts inter-band CA, these teachings are applicable also for inter-band CA.

[0005] The user equipment (UE) in an environment with other cells neighboring its serving cells will typically take and report measurements of those neighbor cells for various purposes; so its serving cell can know which is the best handover candidate for that UE or know whether there is a candidate hotspot for offloading the UE's traffic to name just two. Generally the network configures the UE to perform neighbor cell measurements, but extending the conventional practice to the hetnet deployment of

Figure 1 with macro cells 101 and RRHs 102a, 102b may result in the UE performing many unnecessary measurements even if it is out of the RRH coverage area 120.

[0006] Further, if the macro eNB 101 serving cell wants to avoid the UE missing its measurement for the carrier 110 which is operated by some RRH 102a, it can configure a lower value for S-measure or even not configure S-measure to UE. The network provides to the UE in the MeasConfig information element a parameter s-Measure which is a threshold for the macro cell 101 to control whether or not the UE is required to perform neighbour cell measurements. If the serving cell reference signal received power RSRP measured by the UE is greater than the s-Measure parameter, the UE does not measure other cells. The network can disable this by setting the value "0" for the s-Measure parameter. But a UE in the Figure 1 environment and configured with a low or zero value for the s-Measure parameter may waste power by taking measurements which may not be useful.

[0007] Specifically, 3GPP TS 36.331 details the s-Measure parameter as follows:

> 4> if *s-Measure* is not configured; or
>
> 4> if *s-Measure* is configured and the PCell RSRP, after layer 3 filtering, is lower than this value:
>
> 5> perform the corresponding measurements of neighbouring cells on the frequencies and RATs indicated in the concerned *measObject,* applying for neighbouring cells on the primary frequency the time domain measurement resource restriction in accordance with *measSubframePatternConfigNeigh,* if configured in the concerned *measObject*;

[0008] Some relevant description may be seen at document R2-114951 by ZTE entitled DISCUSSION ON ENHANCEMENT OF SMALL CELL DISCOVERY; and document R2-115139 entitled ENHANCEMENT OF PROXIMITY INDICATION IN HETEROGENEOUS NETWORKS

[both from 3GPP TSG-RAN WG2 Meeting #75bis; Zhuhai, China; 10-14 October 2011].

[0009] For Release 11 of LTE there is proposed a new type of component carrier, agreed in the work item document RP-110451 by Nokia and Nokia Siemens Networks entitled WI PROPOSAL: LTE CA ENHANCEMENTS [3GPP TSG RAN Meeting #51; Kansas City, USA; 15-18 March 2011]. There are ongoing discussions on such a new carrier type focusing on the need for a certain kind of reference signals and their design.

[0010] In related discussions documents R1-114071 by NTT and DoCoMo entitled ISSUES REGARDING ADDITIONAL CARRIER TYPE IN REL-11 CA [3GPP TSG RAN WG1 Meeting #67; San Francisco, USA; 14-18 November 2011], and R2-115745 by NTT and DoCoMo entitled INTER-FREQUENCY PICO CELL MEASUREMENTS FOR HETNET DEPLOYMENTS [3GPP TSG RAN WG2 #76; San Francisco, USA; 14-18 November 2011], propose that operators are also interested in a quick cell identification for the RRH scenario of the new carrier type.

[0011] What is needed in the art is a more effective way to conduct UE measurements of neighbor cells in the hetnet type of scenario shown by example at Figure 1, preferably that is also consistent with how the new LTE Release 11 carrier is to be designed.

SUMMARY:

[0012] In a first exemplary embodiment of the invention there is a method comprising: determining a finite range for measuring a serving cell; and conditioning measurements of a neighbor cell on measurements of the serving cell falling within the finite range.

[0013] In a second exemplary embodiment of the invention there is an apparatus for communicating comprising at least one processor and at least one memory including computer program code. In this embodiment the at least one processor is arranged with the memory storing the computer program code to cause the apparatus to perform:

determining a finite range for measuring a serving cell; and conditioning measurements of a neighbor cell on measurements of the serving cell falling within the finite range.

[0014] In a third exemplary embodiment of the invention there is a computer readable memory tangibly storing a set of instructions which, when executed on a communicating apparatus such as a user equipment or network access node causes the apparatus to perform at least: determining a finite range for measuring a serving cell; and conditioning measurements of a neighbor cell on measurements of the serving cell falling within the finite range.

[0015] In a fourth exemplary embodiment of the invention there is an apparatus for communicating, comprising means for determining a finite range for measuring a serving cell; and means for conditioning measurements of a neighbor cell on measurements of the serving cell falling within the finite range. For the case in which this apparatus is a user equipment, in one embodiment the means for the determining comprises circuitry for determining the finite range from a special measurement object received at a radio receiver of the user equipment; and the means for conditioning measurements of the neighbor cell comprises circuitry which controls whether or not the user equipment is to measure the neighbor cell based on whether or not measurements of the serving cell fall within the finite range. For the case in which this apparatus is a network access node that is the serving cell, in one embodiment the means for the determining comprises circuitry for selecting the finite range from a local memory (suitable for the neighbor cell or cells); and the means for conditioning measurements of the neighbor cell comprises circuitry configured to send to a user equipment a special measurement object which indicates low and high thresholds to define the finite range which instructs the user equipment of a condition for measuring the neighbor cell.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0016] Figure 1 is a prior art schematic diagram illustrating scenario 4 for carrier aggregation from 3GPP TS 36.300 v11.0.0 showing remote radio heads/pico cells

within larger macro cells, and illustrates an example environment in which some embodiments of these teachings may be practiced.

[0017] Figure 2 illustrates a hetnet scenario similar to Figure 1 but showing how the RSRP range according to some example embodiments of these teachings operate for three different UEs at different positions relative to the macro cell.

[0018] Figure 3 is a logic flow diagram that illustrates, from the perspective of the UE and the network access node, the operation of a method, and a result of execution of computer program instructions embodied on a computer readable memory, in accordance with the exemplary embodiments of this invention.

[0019] Figure 4 is a non-limiting example of a simplified block diagram of the UE in communication with a wireless network illustrated as an eNB and a MME/S-GW, which are exemplary electronic devices suitable for use in practicing some example embodiments of this invention.

DETAILED DESCRIPTION:

[0020] While the examples below are in the context of the LTE system with a UE operating in a carrier aggregation deployment of a hetnet, these are non-limiting examples only. The specific examples used in these teachings are readily extendable for other RATs (radio access technologies) such as UTRAN (universal terrestrial radio access network) and UMTS (universal mobile telecommunications system), whether or not those other RATs are deployed with carrier aggregation. In that regard the eNB in the below examples is exemplary for a generic wireless network access node.

[0021] Exemplary embodiments according to the teachings detailed below provide an enhanced measurement procedure from the UE point of view which provides a more efficient power consumption and a faster cell identification for the RRH scenario such as that shown at Figure 1. In addition to the enhanced measurement procedure, these teachings also detail some special forward compatible designs to suit the possible new

LTE carrier type noted in the background section above.

[0022] According to an exemplary embodiment of these teachings, the eNB configures a finite range of measurement quantity, for example RSRP, for a macro carrier which is used as mobility measurement, and a special measurement object for the CA capable UE. If the UE's measured results of the macro carrier falls into the given range, the UE should start the measurement procedure on the configured special measurement object.

[0023] In more general terms if we consider the macro eNB as the UE's serving cell and the pico cell operated by the RRH or by a home eNB as a neighbor cell, then in effect the UE's measurements of the neighbor cell/pico cell/RRH are conditioned on the UE's measurements of the serving cell/macro eNB falling within the finite range for measuring the serving cell/macro eNB. The eNB which configures the UE with the finite range conditions the UE's measurement of the neighbor cell/pico cell/RRH by sending the UE the limits of that range. Similarly the UE conditions its own measurements of the neighbor cell/RRH using the finite range that it received in signaling from the macro cell/eNB. In an exemplary embodiment the special measurement object defines for the UE which neighbor cell(s)/pico cell(s)/RRH(s) is/are subject to the above conditional measuring, and also gives the high and low limits of the range.

[0024] From the UE's perspective, once it is configured by the network the UE should not measure the special measurement object unless the RSRP, or RSRQ, or other measurement of the macro cell falls into the configured range. In one specific embodiment, if the RSRP/RSRQ of the macro cell falls into the configured range, the UE shall: a) do RRM measurement on the configured special measurement object; and b) report to the eNB with UL signaling that the corresponding measurement will be performed.

[0025] Further, if it happens that the UE will need a measurement gap to do that corresponding measurement, the UE in one instance must wait for the eNB's confirmation to use the measurement gap. In another instance the UE may

autonomously enter the measurement gap, so long as the UE is already configured to do so by the network. While each special measurement object should have two thresholds to set the finite quantity range, nothing precludes the thresholds for different special measurement objects from being identical.

[0026] So for example a given UE may be configured with two special measurement objects, each identifying different RRHs but each having identical high and low thresholds to set the range. Or the network can more efficiently list both those RRHs in the same special measurement object which has only one pair of thresholds to set the single range that the UE will apply for both RRHs. If the range changes for one but not both of those RRHs, the network can then replace that previous special measurement object by configuring the UE with two new special measurement objects, each identifying a different RRH and giving a different range for measuring them.

[0027] More generally, the eNB should configure one or more special measurement object(s) to the UE, and with two RSRP or RSRQ thresholds which we refer to as *th-1* and *th-2*. In practical systems these two thresholds should be pre-tested by the network operator, or configured by network operations and maintenance. Regardless, these two thresholds will define a range where the RRH might be deployed.

[0028] Assuming the UE's measured RSRP/RSRQ falls within the range, the following summarizes the above two options for actually using a gap to measure the neighbor cell/RRH:

If a measurement gap is needed

i. The eNB could confirm the UE's request to enter the measurement gap to do the measurement.
ii. The eNB could configure the UE to autonomously enter the measurement gap, and then just assume there was a gap used for that purpose once the eNB receives the UE's measurement reporting of the RRH. In this case the UE need not specifically send a request to the eNB to enter the measurement gap.

Note that such a special measurement object should not be counted in N_{freq}, which is defined at section 8.2.1.1 of 3GPP TS 36.133 v10.5.0 (2011-12) as the effective total number of frequencies excluding the serving frequency being monitored using gaps.

[0029] Now consider several examples in view of Figure 2. Like Figure 1, at Figure 2 there is a macro eNB 22 and multiple RRHs designated RRH-1 (26-1), RRH-2 (26-2), RRH-3 (26-3) and RRH-4 (26-4). The RRHs are spaced sufficiently that they are each operating on the same frequency band, component carrier 2 (CC-2 in the figure, assumed to be a secondary cell/secondary component carrier for the respective UEs 20-1, 20-2, 20-3) and their respective coverage areas are shown by shading. The macro eNB 22 is operating on a different band, component carrier 1 (assumed to be the primary cell/primary component carrier for the respective UEs). In an embodiment component carrier 2 is consistent with the new LTE carrier noted in the background section above.

[0030] There are three UEs in Figure 2, designated as UE-1 (20-1), UE-2 (20-2) and UE-3 (20-3), and each are at different positions relative to the macro eNB 22. For simplicity of this example assume RSRP/RSRQ is linearly correlated with distance such that the UE-3 (20-3) nearest the macro eNB 22 sees the highest RSRP/RSRQ and the furthest UE-2 (20-3) sees the lowest. Assume further that each of these three UEs are configured by the macro eNB 22 with four special measurement objects, each identifying a different one of the four RRHs and each having identical high and low thresholds for the measurement range.

[0031] In Figure 2 we see that the RSRP/RSRQ of the macro eNB 22 measured by UE-1 (20-1) lies within the range defined by the low threshold and the high threshold, so it may start to measure the potential RRH-1 (26-1). The RSRP/RSRQ of the macro eNB 22 measured by UE-2 (20-2) falls below the low threshold of the range and so UE-2 (20-2) has not met the conditions to measure RRH-2 (26-2) which it is near (though UE-2 may not be able to hear RRH-2 anyway given the illustrated coverage area), so UE-2 will not make any attempt to measure RRH-2, thus saving power. The RSRP/RSRQ of the macro eNB 22 measured by UE-3 (20-3) falls above the high

threshold of the range and so UE-3 also has not met the conditions to measure any of the four RRHs, which as illustrated in Figure 2 UE-3 cannot hear with sufficient signal strength anyway. This may save power at UE-3 (20-3).

[0032] Continuing with the simplification that RSRP/RSRQ is linearly related to distance from the macro eNB, the reason that measurements of each of the four RRHs in Figure 2 are conditioned on the same range is because each is equi-distant from the macro eNB. The high and low thresholds in effect define a two dimensional torus or donut about the macro eNB in which lie those four RRHs; those UEs beyond the donut's outer perimeter (partially shown by dashed line 204) will see too low RSRP/RSRQ, those UEs inside the donut's inner perimeter (partially shown by dashed line 202) will see too high RSRP/RSRQ, and those UEs within the confines of the donut will see their RSRP/RSRQ from the macro cell within the range. If for example RRH-4 were notably further from the macro eNB than is shown at Figure 2, the appropriate range for it would be a reduced low threshold and a reduced high threshold (assuming a linear relation of distance to signal strength).

[0033] With this in mind, consider the UE-2 (20-2) shown at Figure 2. If its mobility takes it in a direct line 208 towards the macro eNB 22, its RSRP/RSRQ from the macro eNB 22 will eventually fall within the range but in no case will it also be in a coverage area of either RRH-2 (26-2) or RRH-4 (26-4), so it may waste power searching for a cell to measure. Or if it can read something from either of those cells it is likely to be too weak to be of use to the macro eNB. The eNB 22 could have stored in its local memory some AoA information for the various RRHs. To illustrate this aspect Figure 2 shows two radial lines 206 extending from the macro eNB which give the AoA information for RRH-3 and component carrier 2. Continuing the above donut analogy, the AoA information serves to segment the donut so as to identify radially the coverage limits of the different RRHs. Then at least for low-mobility UEs in which the measurement efficiency gains would be the most pronounced, the eNB 22 could just configure the carrier which it estimates the UE might be located in as a special measurement object according to the angle information.

[0034] Below is one non-limiting example of the special measurement object according to these teachings. There is a high and a low threshold, and a physical cell identifier which identifies the cell or cells which are to be measured if the measured signal from the macro eNB falls between those high and low thresholds.

```
CellsToAddModSpecial ::=    SEQUENCE {
    cellIndex                       INTEGER (1..maxCellMeas),
    physCellId                      PhysCellId,
    ThresholdHigh                   RSRP-Range
    ThresholdLow                    RSRP-Range
    cellIndividualOffset            Q-OffsetRange
}
```

[0035] One technical advantage of these teachings is that the eNB could control the UE to do measurements at the correct time when its measurements of the RRH might provide useful information. This would result in savings to the UE's power consumption; would reduce the delay for the UE to identify the cell which is operated by a RRH, and would reduce the U-plane interruption by efficiently utilizing the measurement gap, for example.

[0036] Figure 3 is a logic flow diagram which summarizes some example embodiments of the invention. Figure 3 is worded to describe from the perspective of the UE and from the perspective of the macro eNB (or one or more components of either) that is operating as the serving cell to the UE. Figure 3 may be considered to illustrate the operation of a method for operating a wireless communications device, and a result of execution of a computer program stored in a computer readable memory, and a specific manner in which components of an electronic device are configured to cause that electronic device to operate, whether such an electronic device is the UE, the eNB or other network access node operating as the serving cell, or one or more components therefore such as a modem, chipset, or the like.

[0037] Such blocks and the functions they represent are non-limiting examples, and may be practiced in various components such as integrated circuit chips and modules, and that the exemplary embodiments of this invention may be realized in an apparatus that is embodied as an integrated circuit. The integrated circuit, or circuits, may comprise circuitry (as well as possibly firmware) for embodying at least one or more of

a data processor or data processors, a digital signal processor or processors, baseband circuitry and radio frequency circuitry that are configurable so as to operate in accordance with the exemplary embodiments of this invention.

[0038] Such circuit/circuitry embodiments include any of the following: (a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and (b) combinations of circuits and software (and/or firmware), such as: (i) a combination of processor(s) or (ii) portions of processor(s)/software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone/UE, to perform the various functions summarized at Figure 3) and (c) circuits, such as a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation, even if the software or firmware is not physically present. This definition of 'circuitry' applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term "circuitry" would also cover an implementation of merely a processor (or multiple processors) or portion of a processor and its (or their) accompanying software and/or firmware. The term "circuitry" also covers, for example, a baseband integrated circuit or applications processor integrated circuit for a mobile phone/UE or a similar integrated circuit in a server, a cellular network device, or other network device.

[0039] At block 302 the wireless communications device determines a finite range for measuring a serving cell. It is finite because it has both low and high limits. Then at block 304 measurements of a neighbor cell are conditioned on measurements of the serving cell falling within the finite range.

[0040] In the above specific but non-limiting examples the neighbor cell is a pico cell identified in a special measurement object that is configured by a wireless network for a UE, and the finite range for measuring the serving cell (macro eNB) comprises a low threshold and a high threshold for reference signal received power RSRP or reference signal received quality RSRQ. By example, the pico cell may be operated by a remote radio head such as those shown at Figure 1, or by a home eNB (sometimes referred to as

an HeNB) for example, or by other such small-cell access nodes.

[0041] The remainder of Figure 3 illustrates more specific implementations. Block 306 characterizes that the measurements of the neighbor cell are done within a measurement gap during which a UE taking the measurements may not be (that is, it may not be required by the network to be) in contact with the serving cell. For the particular embodiment that block 306 represents, for the case in which the UE will use a measurement gap for the neighbor cell measurement, there is a confirmation between the serving cell and the UE that the UE can enter the measurement gap to take at least one of the measurements of the neighbor cell.

[0042] Block 308 specifies that when Figure 3 is done by the serving cell (or one or more components therefore), then the determining at block 302 further comprises signaling the determined finite range to a UE to perform block 304. That is, the eNB signaling the range to the UE is how the eNB conditions the UE's measurements of the neighbor cell (which are taken by the UE) on measurements of the serving cell taken by the UE falling within the finite range.

[0043] Block 310 specifies that when Figure 3 is done by the UE (or one or more components therefore), then the finite range at block 302 is determined from signaling received at the UE from the serving cell, and then Figure 3 further includes the UE reporting the measurements of the neighbor cell to the serving cell. Block 312 follows from block 310 since it is autonomous by the UE. Specifically, the UE's measurements of the neighbor cell are at block 312 done within a measurement gap during which the UE taking the measurements is not required by the network to be in contact with the serving cell, and in this particular embodiment the UE enters the measurement gap autonomously so long as it has been configured to do so by the serving cell/network.

[0044] Reference is now made to Figure 4 for illustrating a simplified block diagram of various electronic devices and apparatus that are suitable for use in practicing some example embodiments of this invention. In Figure 4 a wireless network (macro eNB 22 and mobility management entity MME and/or serving gateway S-GW 24) is adapted

for communication over a wireless link 21A with an apparatus, such as a mobile terminal or UE 20, via a network access node such as a base station/macro eNB 22 or relay station. The network may include the MME/S-GW 24 which provides connectivity with further networks (e.g., a publicly switched telephone network PSTN and/or a data communications network/Internet).

[0045] The UE 20 includes processing means such as at least one data processor (DP) 20A, storing means such as at least one computer-readable memory (MEM) 20B storing at least one computer program (PROG) 20C, communicating means such as a transmitter TX 20D and a receiver RX 20E for bidirectional wireless communications with the network access node 22 via one or more antennas 20F. Also stored in the MEM 20B at reference number 20G is the UE's rules for handling the special measurement object and for applying the RSRP or RSRQ range for deciding if it should make a measurement of the RRH it identifies, as is detailed above with specificity.

[0046] The network access node/macro eNB 22 also includes processing means such as at least one data processor (DP) 22A, storing means such as at least one computer-readable memory (MEM) 22B storing at least one computer program (PROG) 22C, and communicating means such as a transmitter TX 22D and a receiver RX 22E for bidirectional wireless communications with the UE 20 via one or more antennas 22F. The access node 22 also includes at unit 22G the rules for creating the special measurement object and for setting the RSRP or RSRQ range for conditioning the UE's measurements of the RRH. There is also a data and/or control path 25 coupling the macro eNB 22 with the MME/S-GW 24, and another data and/or control path 23 coupling the macro eNB 22 to the RRH/pico eNB 26 or other base stations/eNBs/access nodes. The UE 20 has a wireless link 21B with the RRH/pico eNB 26 for taking measurements thereof.

[0047] For completeness the RRH/pico eNB 26 is also illustrated as having a data processor (DP) 26A, storing means / computer-readable memory (MEM) 26B storing at least one computer program (PROG) 26C, and communicating means such as a transmitter TX 26D and a receiver RX 26E for bidirectional wireless communications

with the UE 20 via one or more antennas.

[0048] Similarly, the MME/S-GW 24 includes processing means such as at least one data processor (DP) 24A, storing means such as at least one computer-readable memory (MEM) 24B storing at least one computer program (PROG) 24C, and communicating means such as a modem 24H for bidirectional wireless communications with the eNB 22 via the data/control path 25. While not particularly illustrated for the UE 20 or macro eNB 22 or RRH/pico eNB 26, those devices are also assumed to include as part of their wireless communicating means a modem which may be inbuilt on an RF front end chip within those devices 20, 22, 26 and which also carries the TX 20D/22D/26D and the RX 20E/22E/26E.

[0049] At least one of the PROGs 20C/20G in the UE 20 is assumed to include program instructions that, when executed by the associated DP 20A, enable the device to operate in accordance with the exemplary embodiments of this invention, as detailed above particularly with respect to Figure 3. The macro eNB 22 (and the RRH 26) also has software stored in its MEM 22B to implement certain aspects of these teachings as detailed above particularly with respect to Figure 3. In this regard the exemplary embodiments of this invention may be implemented at least in part by computer software stored on the MEM 20B, 22B which is executable by the DP 20A of the UE 20 and/or by the DP 22A/26A of the access node(s) 22, 26, or by hardware, or by a combination of tangibly stored software and hardware (and tangibly stored firmware). Electronic devices implementing these aspects of the invention may not be the entire UE 20 or macro eNB 22 (or 26), but exemplary embodiments may be implemented by one or more components of same such as the above described tangibly stored software, hardware, firmware and DP, modem, system on a chip SOC or an application specific integrated circuit ASIC.

[0050] In general, the various embodiments of the UE 20 can include, but are not limited to personal portable digital devices having wireless communication capabilities, including but not limited to cellular telephones, navigation devices, laptop/palmtop/tablet computers, digital cameras and Internet appliances.

[0051] Various embodiments of the computer readable MEMs 20B, 22B and 26B include any data storage technology type which is suitable to the local technical environment, including but not limited to semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory, removable memory, disc memory, flash memory, DRAM, SRAM, EEPROM and the like. Various embodiments of the DPs 20A, 22A and 26A include but are not limited to general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and multi-core processors.

[0052] Some of the various features of the above non-limiting embodiments may be used to advantage without the corresponding use of other described features. The foregoing description should therefore be considered as merely illustrative of the principles, teachings and exemplary embodiments of this invention, and not in limitation thereof.

[0053] The following abbreviations used in the above description and/or in the drawing figures are defined as follows:

3GPP	third generation partnership project
AoA	angle of arrival
CA	carrier aggregation
DL	downlink
E-UTRAN	evolved UTRAN (also known as LTE)
Hetnet	heterogeneous network
LTE	long term evolution (also known as E-UTRAN)
LTE-A	long term evolution-advanced
RRC	radio resource control
RRM	radio resource management
RF	radio-frequency
RSRP	reference signal received power
RSRQ	reference signal received quality
UE	user equipment
UL	uplink
UTRAN	universal terrestrial radio access network

What is claimed is:

1. A method for operating a wireless communications device, comprising:
determining a finite range for measuring a serving cell; and
conditioning measurements of a neighbor cell on measurements of the serving cell falling within the finite range.

2. The method according to claim 1, in which the neighbor cell is a pico cell identified in a special measurement object that is configured by a wireless network for a user equipment.

3. The method according to claim 2, in which the finite range for measuring the serving cell comprises a low threshold and a high threshold for reference signal received power RSRP or reference signal received quality RSRQ.

4. The method according to claim 1, in which the measurements of the neighbor cell are done within a measurement gap during which a user equipment taking the measurements need not be in contact with the serving cell, the method further comprising confirming between the serving cell and the user equipment that the user equipment can enter the measurement gap to take at least one of the measurements of the neighbor cell.

5. The method according to any of claims 1 through 5, in which the wireless communications device comprises a network access node operating as the serving cell or one or more components therefore,
in which determining the finite range further comprises signaling the determined finite range to a user equipment so as to condition the measurements of the neighbor cell which are taken by the user equipment on measurements of the serving cell taken by the user equipment falling within the finite range.

6. The method according to any of claims 1 through 5, in which the wireless communications device comprises a user equipment or one or more components

therefore,

in which the finite range is determined from signaling received from the serving cell, the method further comprising reporting the measurements of the neighbor cell to the serving cell.

7. The method according to claim 6, in which the measurements of the neighbor cell are done within a measurement gap during which the user equipment taking the measurements need not be in contact with the serving cell, the method further comprising the user equipment entering the measurement gap autonomously when configured to do so by the serving cell.

8. An apparatus for communicating comprising

at least one processor and at least one memory including computer program code,

the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to perform:

determining a finite range for measuring a serving cell; and

conditioning measurements of a neighbor cell on measurements of the serving cell falling within the finite range.

9. The apparatus according to claim 8, in which the neighbor cell is a pico cell identified in a special measurement object that is configured by a wireless network for a user equipment.

10. The apparatus according to claim 9, in which the finite range for measuring the serving cell comprises a low threshold and a high threshold for reference signal received power RSRP or reference signal received quality RSRQ.

11. The apparatus according to claim 8, in which the measurements of the neighbor cell are done within a measurement gap during which a user equipment taking the measurements need not be in contact with the serving cell,

and the at least one memory and the computer program code are configured with the at

least one processor to cause the apparatus to at least further perform:

confirming between the serving cell and the user equipment that the user equipment can enter the measurement gap to take at least one of the measurements of the neighbor cell.

12. The apparatus according to any of claims 8 through 11, in which the apparatus comprises a network access node operating as the serving cell or one or more components therefore,
in which determining the finite range further comprises signaling the determined finite range to a user equipment so as to condition the measurements of the neighbor cell which are taken by the user equipment on measurements of the serving cell taken by the user equipment falling within the finite range.

13. The apparatus according to any of claims 8 through 11, in which the apparatus comprises a user equipment or one or more components therefore,
in which the finite range is determined from signaling received from the serving cell,
and the at least one memory and the computer program code are configured with the at least one processor to cause the apparatus to at least further perform:

reporting the measurements of the neighbor cell to the serving cell.

14. The apparatus according to claim 13, in which the measurements of the neighbor cell are done within a measurement gap during which the user equipment taking the measurements need not be in contact with the serving cell,
and the at least one memory and the computer program code are configured with the at least one processor to cause the user equipment to enter the measurement gap autonomously when configured to do so by the serving cell.

15. A computer readable memory comprising a set of instructions which, when executed on a user equipment or network access node, causes the user equipment or network access node to perform the steps of:

determining a finite range for measuring a serving cell; and

conditioning measurements of a neighbor cell on measurements of the serving

cell falling within the finite range.

16. The computer readable memory according to claim 15, in which the neighbor cell is a pico cell identified in a special measurement object that is configured by a wireless network for a user equipment.

17. The computer readable memory according to claim 16, in which the finite range for measuring the serving cell comprises a low threshold and a high threshold for reference signal received power RSRP or reference signal received quality RSRQ.

18. The computer readable memory according to claim 15, in which the measurements of the neighbor cell are done within a measurement gap during which a user equipment taking the measurements need not be in contact with the serving cell, and the computer readable memory comprising the set of instructions further causes the user equipment or network access node to further confirm between the serving cell and the user equipment that the user equipment can enter the measurement gap to take at least one of the measurements of the neighbor cell.

19. The computer readable memory according to any of claims 15 through 18, in which the computer readable memory comprising the set of instructions are executed on the network access node which is operating as the serving cell,
in which determining the finite range further comprises signaling the determined finite range to a user equipment so as to condition the measurements of the neighbor cell which are taken by the user equipment on measurements of the serving cell taken by the user equipment falling within the finite range.

20. The computer readable memory according to any of claims 15 through 18, in which the computer readable memory comprising the set of instructions are executed on the user equipment,
in which the finite range is determined from signaling received from the serving cell, and the set of instructions, when executed, further cause the user equipment to report the measurements of the neighbor cell to the serving cell.

21. The computer readable memory according to claim 20, in which the measurements of the neighbor cell are done within a measurement gap during which the user equipment taking the measurements need not be in contact with the serving cell, and the set of instructions, when executed, further cause the user equipment to enter the measurement gap autonomously when configured to do so by the serving cell.

22. An apparatus for communicating, comprising:

means for determining a finite range for measuring a serving cell; and

means for conditioning measurements of a neighbor cell on measurements of the serving cell falling within the finite range.

23. The apparatus according to claim 22, in which the neighbor cell is a pico cell identified in a special measurement object that is configured by a wireless network for a user equipment.

24. The apparatus according to claim 23, in which the finite range for measuring the serving cell comprises a low threshold and a high threshold for reference signal received power RSRP or reference signal received quality RSRQ.

25. The apparatus according to any one of claims 22 through 24, in which:

the apparatus comprises a user equipment;

the means for the determining comprises circuitry for determining the finite range from a special measurement object received at a radio receiver of the user equipment; and

the means for conditioning measurements of the neighbor cell comprises circuitry which controls whether or not the user equipment is to measure the neighbor cell based on whether or not measurements of the serving cell fall within the finite range.

26. The apparatus according to any one of claims 22 through 24, in which:

the apparatus comprises a network access node that is operating as the serving cell;

the means for the determining comprises circuitry for selecting the finite range from a local memory; and

the means for conditioning measurements of the neighbor cell comprises circuitry configured to send to a user equipment a special measurement object which indicates low and high thresholds to define the finite range which instructs the user equipment of a condition for measuring the neighbor cell.

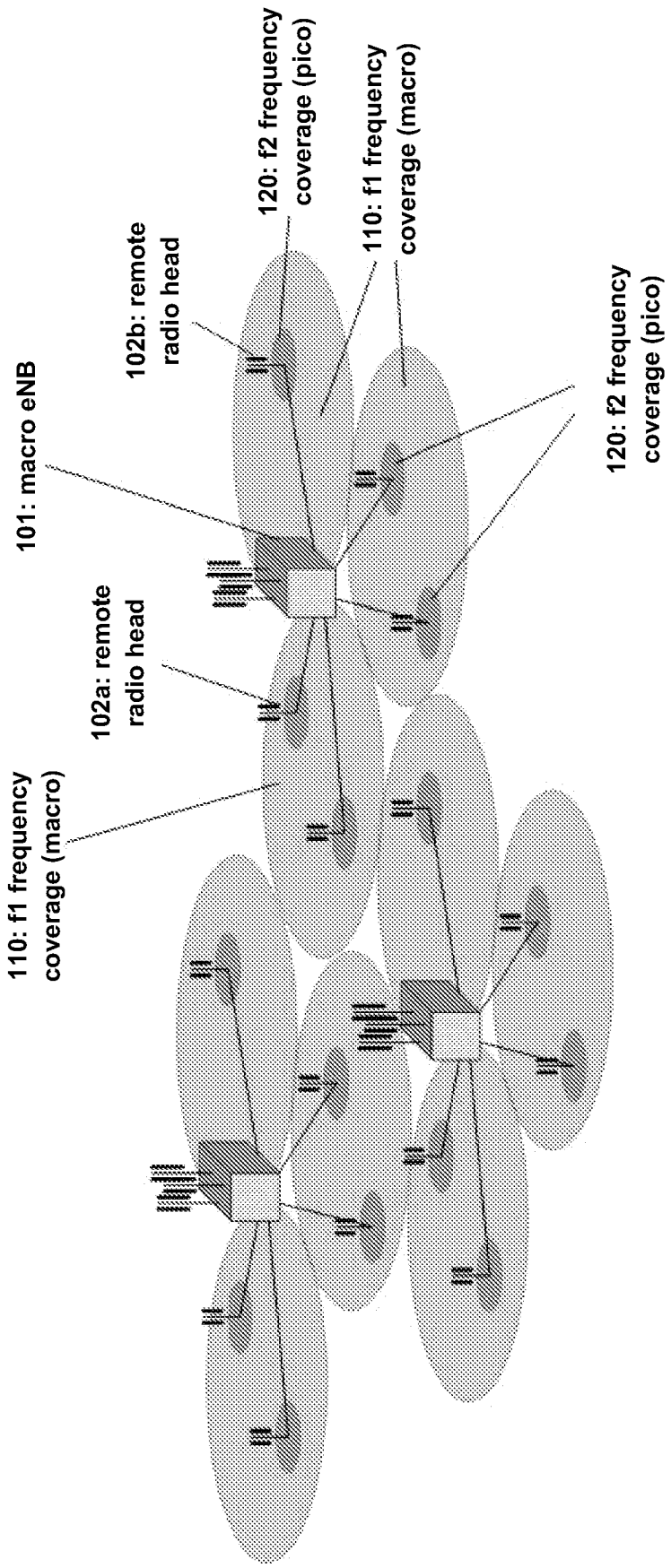


Figure 1: Prior Art

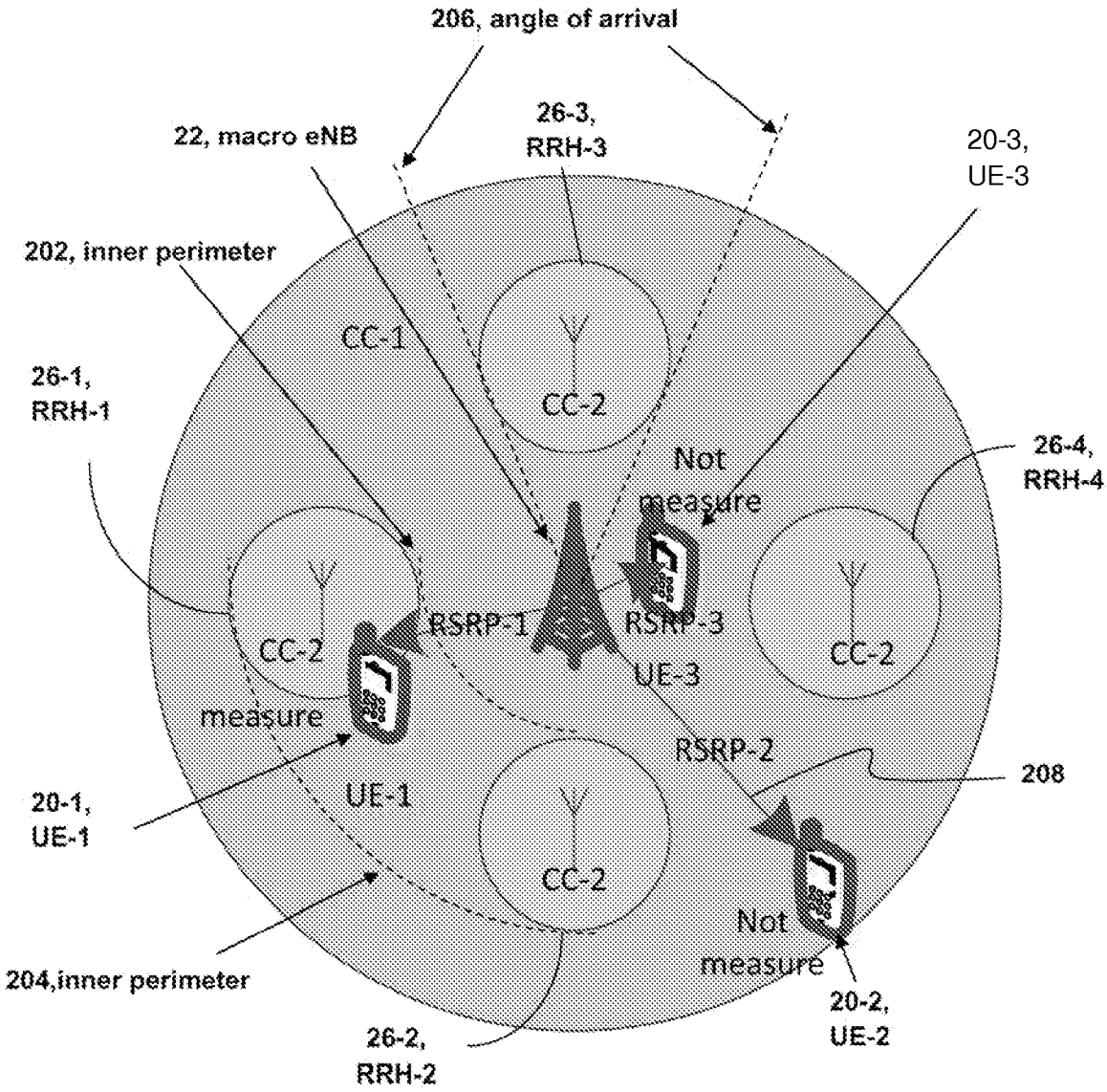

206, angle of arrival
22, macro eNB
26-3,
RRH-3
20-3,
UE-3
202, inner perimeter
CC-1
26-1,
RRH-1
CC-2
Not
measure
26-4,
RRH-4
RSRP-1
RSRP-3
UE-3
CC-2
CC-2
measure
RSRP-2
208
20-1,
UE-1
UE-1
CC-2
Not
measure
204,inner perimeter
20-2,
UE-2
26-2,
RRH-2

Figure 2

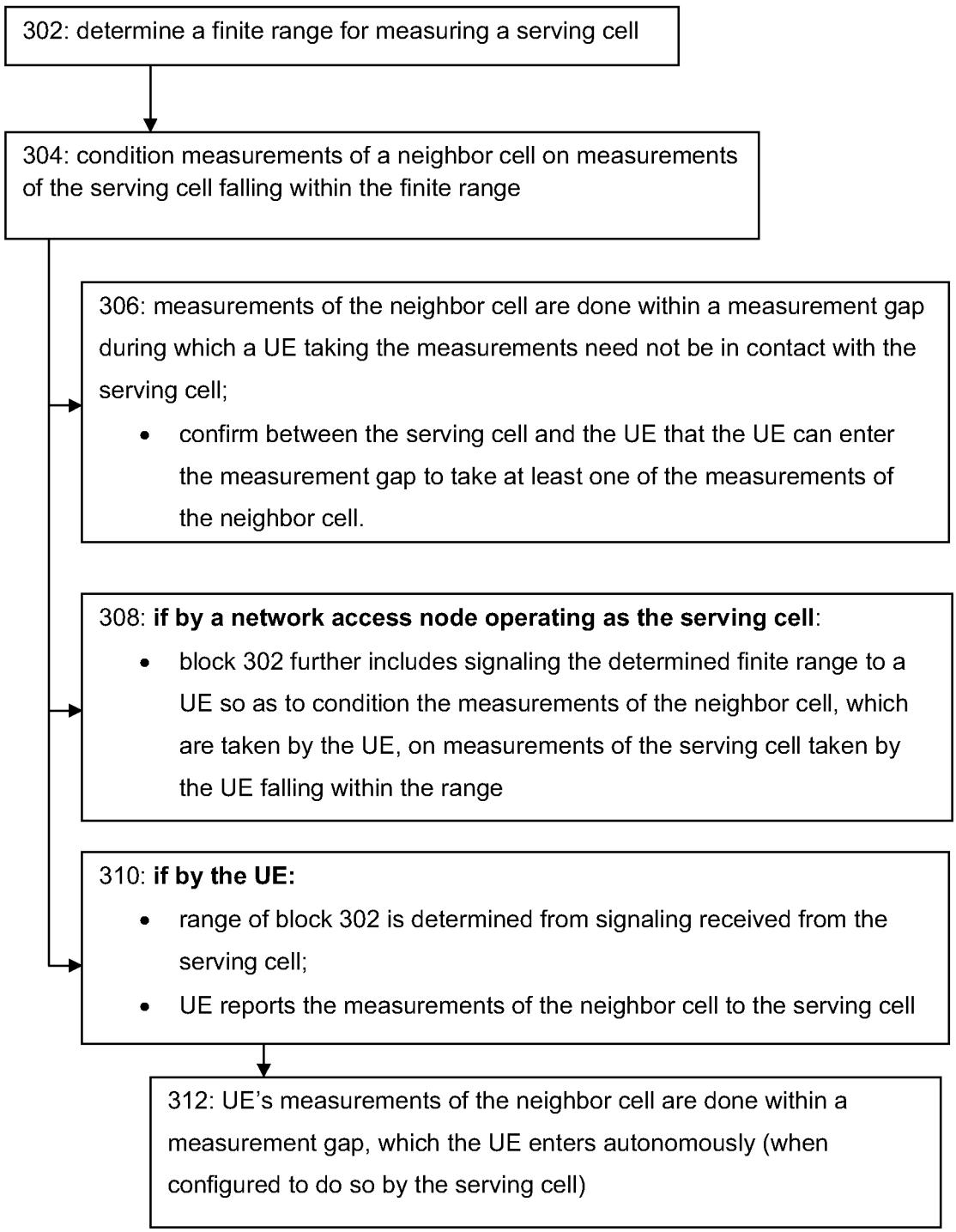

302: determine a finite range for measuring a serving cell
304: condition measurements of a neighbor cell on measurements of the serving cell falling within the finite range
306: measurements of the neighbor cell are done within a measurement gap during which a UE taking the measurements need not be in contact with the serving cell;
• confirm between the serving cell and the UE that the UE can enter the measurement gap to take at least one of the measurements of the neighbor cell.
308: if by a network access node operating as the serving cell:
• block 302 further includes signaling the determined finite range to a UE so as to condition the measurements of the neighbor cell, which are taken by the UE, on measurements of the serving cell taken by the UE falling within the range
310: if by the UE:
• range of block 302 is determined from signaling received from the serving cell;
• UE reports the measurements of the neighbor cell to the serving cell
312: UE's measurements of the neighbor cell are done within a measurement gap, which the UE enters autonomously (when configured to do so by the serving cell)

Figure 3

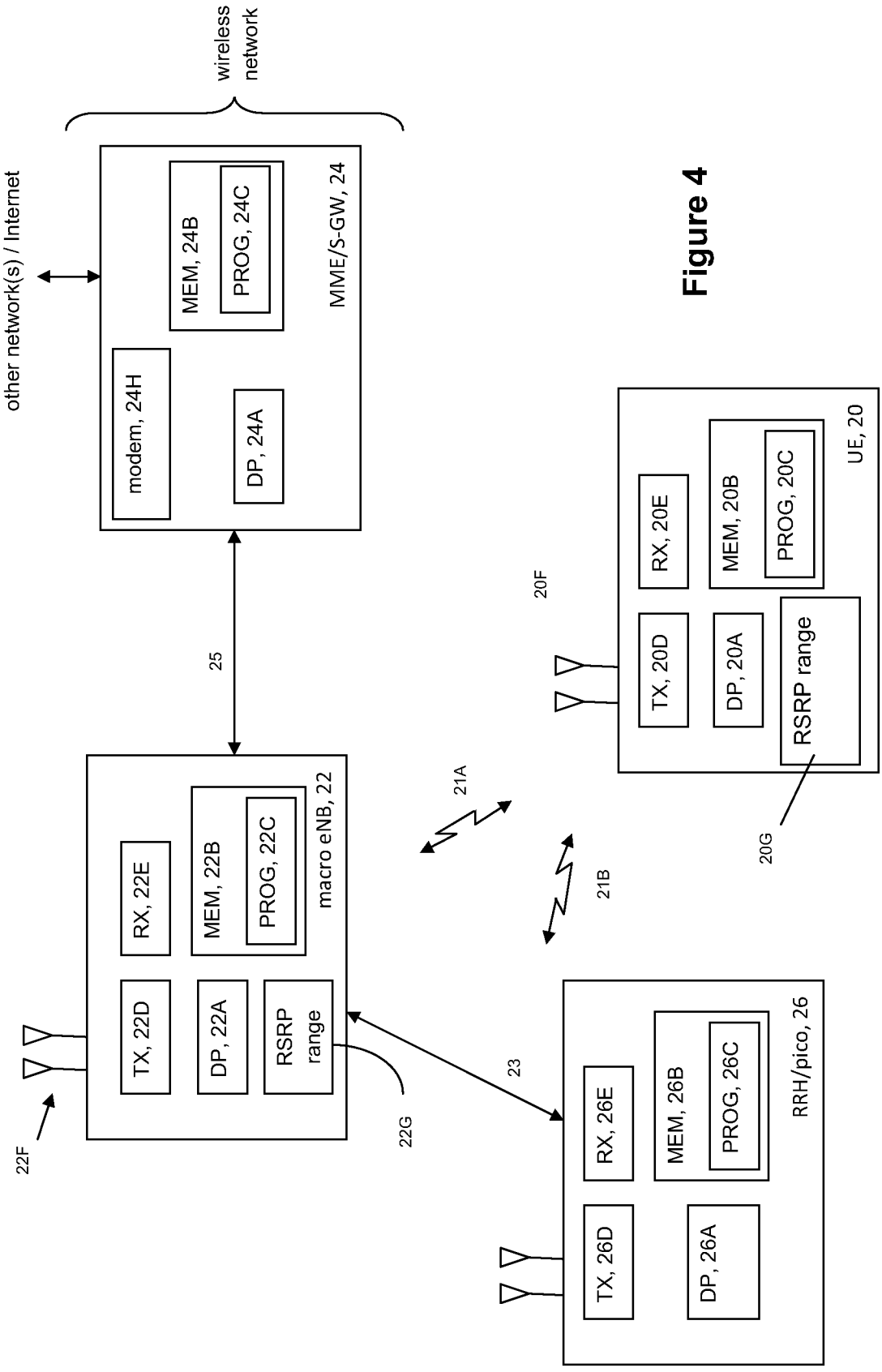

wireless network
other network(s) / Internet
MME/S-GW, 24
MEM, 24B
PROG, 24C
modem, 24H
DP, 24A
25
macro eNB, 22
RX, 22E
MEM, 22B
PROG, 22C
TX, 22D
DP, 22A
RSRP range
22F
22G
23
RRH/pico, 26
RX, 26E
MEM, 26B
PROG, 26C
TX, 26D
DP, 26A
21A
21B
20F
20G
UE, 20
RX, 20E
MEM, 20B
PROG, 20C
TX, 20D
DP, 20A
RSRP range

Figure 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/071354

A. CLASSIFICATION OF SUBJECT MATTER

See the 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: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)

VEN,CNABS,CNKI: measure, femto, pico, cell, finite, limit, range, base station, neighbor, adjacent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN101981974A(QUALCOMM INC.)23 Feburary 2011(23.02.2011) the description paragraphs 0029-0039	1-2,8-9,15-16,22-23
A	CN102150451A(AVAYA INC.)10 August 2011(10.08.2011) the whole document	1-26
A	TW384585B(EUMITCOM TECHNOLOGY INC.)11 March 2000(11.03.2000) the whole document	1-26

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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

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

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

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 November 2012(06.11.2012)	**29 Nov. 2012 (29.11.2012)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer YU, Chenjun Telephone No. (86-10)62411516

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/071354

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN101981974 A	23.02.2011	CA2718948A1	01.10.2009
		VN26119A	25.05.2011
		KR20110000671A	04.01.2011
		JP2011516009A	19.05.2011
		US2009247170A1	01.10.2009
		AU2009228226A1	01.10.2009
		MX2010010554A	30.11.2010
		HK1154457A0	20.04.2012
		WO2009120902A1	01.10.2009
		MX300188B	12.06.2012
		IN201006267P4	10.06.2011
		TW201004433A	16.01.2010
		EP2260660A1	15.12.2010
		PH12010502152A	01.10.2009
CN102150451A	10.08.2011	US8125917B2	28.02.2012
		WO2010040799A1	15.04.2010
		KR20110081773A	14.07.2011
		JP2012505581W	01.03.2012
		US2010091745A1	15.04.2010
		GB2472745A	16.02.2011
		DE112009001813T5	26.01.2012
TW384585B	11.03.2000	NONE	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/071354

A.CLASSFICATION OF SUBJECT MATTER

H04W 48/16 (2009.01)i

H04W 16/00 (2009.01)i