



(51) International Patent Classification:

H04W 36/00 (2009.01) H04W 48/20 (2009.01)
H04W 24/02 (2009.01) H04W 84/04 (2009.01)

(21) International Application Number:

PCT/US2013/027517

(22) International Filing Date:

22 February 2013 (22.02.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/603,141 24 February 2012 (24.02.2012) US
13/773,577 21 February 2013 (21.02.2013) US

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(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, BN, 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, PA, 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, 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,

[Continued on next page]

(54) Title: METHOD AND SYSTEM FOR JOINT PARAMETER OPTIMIZATION FOR MACRO AND FEMTO CELLS

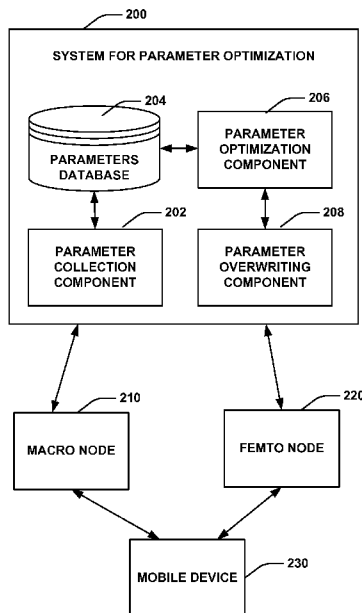


FIG. 2A

(57) Abstract: Disclosed are systems and methods for joint parameter optimization for collocated macrocells and femtocells in a wireless communication network. In one aspect, the method comprises: collecting one or more performance parameters from the one or more collocated macrocells and femtocells, detecting frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells, optimizing one or more cell reselection and handover parameters for the one or more collocated macrocells and femtocells based on the performance parameters, and overwriting one or more corresponding parameters of the collocated macrocells and femtocells with the one or more optimized cell reselection and handover parameters in order to reduce frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells in a wireless communication network.



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).

— before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

Published:

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

METHOD AND SYSTEM FOR JOINT PARAMETER OPTIMIZATION FOR MACRO AND FEMTO CELLS

Claim of Priority under 35 U.S.C. §119

[0001] The present Application for Patent claims priority to Provisional Application No. 61/603,141 filed on February 24, 2012, and assigned to the assignee hereof and hereby expressly incorporated by reference herein.

BACKGROUND

Field

[0002] This disclosure relates generally to the field of wireless communications and more specifically to the system and methods for joint parameter optimization for collocated macrocell and femtocell deployments.

Background

[0003] Wireless communication systems are widely deployed to provide various types of communication content such as, for example, voice, data, and so on. Typical wireless communication systems may be multiple-access systems capable of supporting communication with multiple users by sharing available system resources (*e.g.*, bandwidth, transmit power, etc.). Examples of such multiple-access systems may include code division multiple access (CDMA) systems, time division multiple access (TDMA) systems, frequency division multiple access (FDMA) systems, orthogonal frequency division multiple access (OFDMA) systems, and the like. Additionally, the systems can conform to specifications such as third generation partnership project (3GPP), 3GPP long term evolution (LTE), ultra mobile broadband (UMB), evolution data optimized (EV-DO), *etc.*

[0004] Generally, wireless multiple-access communication systems may simultaneously support communication for multiple mobile devices. Each mobile device may communicate with one or more base stations (*e.g.*, which can be commonly referred as macrocells). To supplement conventional base stations (*e.g.*, macrocells), additional low power base stations (*e.g.*, which can be commonly referred as femtocells or picocells) can be deployed to provide more robust wireless coverage to mobile devices. For example, low power base stations can be deployed for incremental capacity growth,

richer user experience, in-building or other specific geographic coverage, and/or the like. Generally, these low power base stations are often deployed in homes, offices, *etc.* without consideration of a current network environment.

[0005] In a mixed macrocell/femtocell deployment, frequent idle-mode system reselections between macrocells and collocated femtocells can happen by a fast moving mobile device (e.g., a vehicular mobile device) entering and leaving patchy femtocell coverage and/or mobile device ping-ponging between a macrocell and collocated femtocells. Frequent system reselections are not desirable because they can lead to frequent mobile device registrations on different systems, which in turn may cause mobile device's battery drainage, increase in signaling load, missing of pages, and other problems that adversely affect transmission and processing of data and hence user experience. Therefore, it is desirable to configure macrocell and femtocell parameters to avoid frequent system reselection and other problems.

[0006] For macrocells, cell parameters, such as handover or cell reselection parameters, are typically manually configured by an operator after performing some field tests or simulations. For unplanned femtocells deployment, each femtocell typically autonomously learns its environment and configures many of its parameters. Manual configuration for femtocells is generally too difficult and costly due to their large number and random anywhere installation. However, to get best performance in terms of offload to femtocells, total cell capacity, mobility performance of mobile devices, joint optimization of femtocell and macrocell parameters is desired. Particularly, configuration of macrocells can help configuration of femtocells and vice versa.

SUMMARY

[0007] The following presents a simplified summary of one or more aspects of mechanisms joint parameter optimization for collocated macrocells and femtocells deployments. This summary is not an extensive overview of all contemplated aspects of the invention, and is intended to neither identify key or critical elements of the invention nor delineate the scope of any or all aspects thereof. Its sole purpose is to present some concepts of one or more aspects in a simplified form as a prelude to the more detailed description that is presented later.

[0008] In one example aspect, a method for joint parameter optimization for collocated macrocells and femtocells in a wireless communication network comprises: collecting

one or more performance parameters from the one or more collocated macrocells and femtocells, detecting frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells, optimizing one or more cell reselection and handover parameters for the one or more collocated macrocells and femtocells based on the performance parameters, and overwriting one or more corresponding parameters of the collocated macrocells and femtocells with the one or more optimized cell reselection and handover parameters, thereby reducing frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells in a wireless communication network.

[0009] In other aspects, an apparatus may include one or more means for performing the above-noted actions of the method. In yet other aspect, a computer program product may include a computer-readable medium having one or more codes for performing the above-noted actions of the method

[0010] In an additional aspect, an apparatus for wireless communication may include a parameter collection component configured to collect one or more performance parameters from one or more collocated macrocells and femtocells in a wireless communication network. Further, the apparatus may include a parameter optimization component configured to detect frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells, and to optimize one or more of cell reselection and handover parameters for the one or more collocated macrocells and femtocells based on the performance parameters. Additionally, the apparatus may include a parameter overwriting component configured to overwrite one or more corresponding parameters of the collocated macrocells and femtocells with the one or more of optimized cell reselection and handover parameters.

[0011] To the accomplishment of the foregoing and related ends, the one or more aspects comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative features of the one or more aspects. These features are indicative, however, of but a few of the various ways in which the principles of various aspects may be employed, and this description is intended to include all such aspects and their equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The disclosed aspects will hereinafter be described in conjunction with the appended drawings, provided to illustrate and not to limit the disclosed aspects, wherein like designations denote like elements, and in which:

[0013] Fig. 1 is a block diagram of an example wireless communication system having collocated macrocell and femtocell deployments.

[0014] Fig. 2 is a block diagram of an example aspect of a system for joint optimization of parameters for collocated macrocells and femtocells.

[0015] Figs. 3A and 3B are diagrams of various example aspect of joint optimization of cell reselection parameters for collocated macrocell and femtocells.

[0016] Fig. 4 is a flow chart of one example aspect of a method for joint optimization of parameters for collocated macrocells and femtocells.

[0017] Fig. 5 is block diagram of example systems for joint optimization of parameters for collocated macrocells and femtocells.

[0018] Fig. 6 is a block diagram of an example wireless communication system in accordance with various aspects set forth herein.

[0019] Fig. 7 is an illustration of an example wireless network environment that can be employed in conjunction with the various systems and methods described herein.

[0020] Fig. 8 illustrates an example wireless communication system, configured to support a number of devices, in which the aspects herein can be implemented.

[0021] Fig. 9 is an illustration of an exemplary communication system to enable deployment of femtocells within a network environment.

[0022] Fig. 10 illustrates an example of a coverage map having several defined tracking areas.

DETAILED DESCRIPTION

[0023] In various aspects, disclosed herein mechanisms for joint parameter configuration for collocated macrocells and femtocells deployments. Various aspects will be described with reference to the drawings. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of one or more aspects. It may be evident, however, that such aspect(s) may be practiced without these specific details. Furthermore, various aspects

or features will be presented in terms of systems that may include a number of devices, components, modules, and the like. It is to be understood and appreciated that the various systems may include additional devices, components, modules, *etc.* and/or may not include all of the devices, components, modules *etc.* discussed in connection with the figures. A combination of these approaches may also be used.

[0024] The techniques described herein may be used for various wireless communication systems such as CDMA, TDMA, FDMA, OFDMA, SC-FDMA, WiFi carrier sense multiple access (CSMA), and other systems. The terms “system” and “network” are often used interchangeably. A CDMA system may implement a radio technology such as Universal Terrestrial Radio Access (UTRA), cdma2000, *etc.* UTRA includes Wideband-CDMA (W-CDMA) and other variants of CDMA. Further, cdma2000 covers IS-2000, IS-95 and IS-856 standards. A TDMA system may implement a radio technology such as Global System for Mobile Communications (GSM). An OFDMA system may implement a radio technology such as Evolved UTRA (E-UTRA), Ultra Mobile Broadband (UMB), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDM®, *etc.* UTRA and E-UTRA are part of Universal Mobile Telecommunication System (UMTS). 3GPP Long Term Evolution (LTE) is a release of UMTS that uses E-UTRA, which employs OFDMA on the downlink and SC-FDMA on the uplink. UTRA, E-UTRA, UMTS, LTE and GSM are described in documents from an organization named “3rd Generation Partnership Project” (3GPP). Additionally, cdma2000 and UMB are described in documents from an organization named “3rd Generation Partnership Project 2” (3GPP2). Further, such wireless communication systems may additionally include peer-to-peer (*e.g.*, mobile-to-mobile) *ad hoc* network systems often using unpaired unlicensed spectrums, 802.xx wireless LAN, BLUETOOTH and any other short- or long- range, wireless communication techniques.

[0025] The wireless communication system(s) may include a plurality of base stations (BS) utilized for communicating with mobile devices(s). These base stations may include high-power macro BS and low-power femto BS. The femto BS also be referred to as an access point, femto nodes, pico node, micro node, a Node B, evolved Node B (eNB), home Node B (HNB) or home evolved Node B (HeNB), collectively referred to as H(e)NB, or some other terminology. These femto BS are generally considered to be

low-power base stations. For example, a low-power base station transmits at a relatively low power as compared to a macro base station associated with a wireless wide area network (WWAN). As such, the coverage area of the low power base station can be substantially smaller than the coverage area of a macro base station.

[0026] As generally known in the art, a mobile device can also be called a system, device, subscriber unit, subscriber station, mobile station, mobile, remote station, mobile terminal, remote terminal, access terminal, user terminal, terminal, communication device, user agent, user device, or user equipment (UE). A mobile device may be a cellular telephone, a satellite phone, a cordless telephone, a Session Initiation Protocol (SIP) phone, a wireless local loop (WLL) station, a personal digital assistant (PDA), a handheld device having wireless connection capability, a tablet, a computing device, or other processing devices connected via a wireless modem to one or more BS that provide cellular or wireless network access to the mobile device.

[0027] **Fig. 1** shows an example wireless communication system 100 having collocated macrocell and femtocell deployments. System 100 includes a macro base station 102, which forms a macrocell (not shown in Fig. 1, but described in greater detail below with reference in Fig. 9), that can provide one or more mobile devices with access to a wireless network. The communication system 100 also includes femto nodes 104, 106, 108, 110, and 112, which can also provide wireless network access over a backhaul link (not shown) with a mobile network over a broadband internet connection. In one example, femto nodes 104, 106, 108, 110, and/or 112 can be other types of low power base stations, a relay node, a device (*e.g.*, communicating in peer-to-peer or ad-hoc mode with other devices), *etc.* Each femto node forms a femtocell (not shown in Fig. 1, but described in greater detail below with reference in Fig. 9). Moreover, the system 100 includes a mobile device 114 that communicates with macro base station 102 and one or more femto nodes 104 or 106 to receive wireless access to the wireless network.

[0028] In the depicted mixed macrocell/femtocell deployment, frequent system reselections and handovers between macro base station 102 and the collocated femto nodes 104, 106, 108, 110, and 112 can happen by a fast-moving mobile device 114 (*e.g.*, a vehicular mobile device) entering and leaving patchy femtocell coverage and/or mobile device 114 ping-ponging between the macrocell 102 and the femtocells 104, 106, 108, 110, and 112. Frequent system reselections may be considered multiple

attempts by a mobile device or attempt by a number of mobile devices to register and/or deregister with adjacent femtocells or macrocells within a short period of time (e.g. 10 minutes). Frequent handover occur when mobile device actually transfer an ongoing call or data session between a macrocell and a femtocell or between two femtocells. Frequent cell reselections and handovers are not desirable because they may cause frequent mobile device registrations on different systems (e.g., femtocell and macrocells), which in turn may cause device battery drainage, signaling load, missing of pages, and other problems. Therefore, it is desirable to perform joint optimization of femtocell and macrocell parameters to prevent above-described problems.

[0029] **Fig. 2A** illustrates an example system 200 for joint optimization of parameters for collocated macrocell(s) and femtocell(s) deployments. The system 200 may be deployed in a macro node, a femto node, a mobile device, or core network (not shown). In one aspect, the system 200 collects, at regular intervals, performance parameters for macrocells 210 and femtocell 220 using parameter collection component 202. The system 200 stores the collected parameters in a parameters database 204. The system 200 analyzes collected data to detect frequent cell reselections or handovers by mobile devices 230. The system 200 then identifies collocated macrocells 210 and femtocells 220 and optimizes parameters of these cells using parameter optimization component 206 in order to reduce frequent cell reselections and handovers between these cells. The system 200 then overwrites modified parameters of macrocells 210 and femtmocells 220 based on results of joint parameter optimization using overwriting component 208.

[0030] In one example aspect, the parameter collection component 202 may use a communication interface (such as X2, S1, Iur, Iu, or the like) to obtain various performance parameters from macrocells 210 and femtocells 220. These performance parameters may include, but not limited to, the number of reselections, number of handovers, types of handovers (such as intra-frequency, inter-frequency, inter-RAT, handovers to/from macrocell, handovers to/from femtocells, and other), number of call drops, average UL interference, average cell capacity used and available cell capacity, number of users served by the cell, number of connections established, traffic pattern at backhaul or traffic pattern of mobile devices served, and other performance parameters.

[0031] In one example aspect, the parameter optimization component 206 may use network resources to identify a cluster of collocated macrocells and femtocells. The

collocated cell cluster may include, but not limited to, adjacent cells, overlapping cells, or more generally cells that have mutual impact with each other. The parameter optimization component 206 then identifies performance and resource utilization trends within a cell cluster and, in response to the performance and resource utilization trends, changes parameters on macro and femto nodes to allow improved performances and/or even resource utilization within the cells of a cluster. The component 206 then saves changed parameters in the database 204 and instructs parameter overwriting component 208 to communicate new parameters to the appropriate macro and femto cells 210, 220.

[0032] **Fig. 2B** illustrates one example aspect of the parameter optimization component. The parameter optimization component 206 includes a cell reselection optimization component 242 and cell handover optimization component 244. In one example aspect, the cell reselection optimization component 242 is operable to optimize such cell reselection parameters as Q_{hyst} , $Q_{qualmin}$, Q_{offset} , $T_{reselection}$, HCS (Hierarchical Cell Structure), and the like. Optimization of cell reselection parameters is illustrated in the following example scenario. In a dedicated channel deployment, in which femtocells and macrocells are deployed on separate frequencies, femtocells deployed near a highway or freeway may get a lot of unnecessary reselections and registrations from mobile devices coming from a macrocell. The reselection optimization component 242 may change cell reselection parameters to decrease signaling load and paging unreachability of femtocells. Based on joint optimization, neighboring macrocells can change cell reselection parameters to discourage mobile devices from going to femtocells. This can be accomplished via, for example, (i) increasing $Q_{qualmin}$ and/or Q_{offset} and/or $T_{reselection}$ parameters for femtocells; (ii) changing or lowering HCS priority of femtocells; and (iii) increasing a macrocell Q_{hyst} or removing femtocells from a macrocell neighbor list. For femtocells deployed in a low mobility area, joint parameter optimization can be used to force neighboring macrocells to choose cell reselection parameters that encourage mobile devices to go to femtocells. For example, femtocells can make cell reselection parameters sticky to discourage mobile devices from going to macrocells. In one example aspect, the parameter overwriting component 208 can broadcast optimized cell reselection parameters to the macrocells 210 and femtocells 220 in System Information Blocks (e.g., SIB1, SIB3, SIB11, SIB11bis).

[0033] In one aspect, the cell reselection optimization component 242 may also optimize (e.g., reduce) frequency with which femtocell 220 transmits its reselection beacon, which will lower the probability that a fast-moving mobile device 230 will detect the reselection beacon transmitted by the femtocell 220 and reselect to that femtocell, and will delay femtocell reselection for slow-moving mobile devices 230. Particularly, reselection beacons are periodically transmitted by femtocells on the same RF channel(s) as those used by a collocated macrocells in order to temporarily jam (e.g., create interference with) RF signals transmitted by the macrocells and force mobile devices 230 located in the coverage area of the femtocell 220 and the collocated macrocell 210 to reselect from the serving macrocell 210 to the target femtocell 220.

[0034] In another aspect, the cell reselection optimization component 242 may slow down cell reselections by adjusting cell reselection parameters used by the mobile device 230 to determine the time it needs to evaluate cell reselection criteria. For example, macrocell 210 may regulate (e.g., increase) a Treselection parameter used by mobile device 230 to determine the time it needs to evaluate cell reselection criteria. The mobile device 230 uses Treselection parameter for intra-frequency, inter-frequency and inter-RAT reselections. In particular, the mobile device 230 continuously evaluates target cell quality in every DRX cycle for the Treselection time. Therefore, the Treselection parameter may be used to avoid pre-mature reselection to the target cell. To that end, in one aspect, the Treselection parameter may be increased by the cell reselection optimization component 242 in order to delay fast moving mobile device 230 from camping on femtocells 220. Since femtocells often operate on a different RF channel than macrocells, only inter-frequency reselections need to be delayed. In one example, this can be achieved by adjusting the “Inter-frequency ScalingFactor for Treselection” information element (IE) in addition to Treselection parameter. $\text{Reselection Evaluation} = \text{‘Treselections’} \times \text{Scaling Factor}$, where the range of Scaling Factor may be equal to, e.g., 1 to 4.75. In another example, this can be achieved by adjusting a Treselection parameter specific for inter-frequency reselection.

[0035] In another aspect, the cell reselection optimization component 242 can optimise (e.g., increase) Qqualmin parameter in order to shrink the perceived effective coverage area of the femtocell 220, thereby preventing frequent reselections to that cell by fast-moving mobile devices 230. Qqualmin parameter is usually broadcasted per

neighboring cell (or PSC) in SIB messages (e.g., SIB11) by the collocated macrocell. Qqualmin parameter is can also be broadcasted by neighboring femtocells in its SIB messages. Qqualmin indicates the signal-to-interference ratio (E_c/I_o) or received signal power below which mobile device 230 considers the neighboring cell as unsuitable for reselection. As shown in **Fig. 3A**, Qqualmin determines the “entry point” for cell reselections, thereby effectively controlling the reselection radius of the femtocell coverage. Qhyst parameter determines the “exit point” for reselections. Therefore, in order to prevent frequent cell reselections, perceived diameter of Qqualmin coverage should be less than the distance covered by minimum fast moving mobile device in a Treselection time or Scaling Factor times Treselection. For example, (Diameter of Qqualmin coverage) < (min fast moving UE speed) x Scaling Factor x Treselection. For example, for mobile device speed = 10m/s (~ 22.5mph), scaling factor = 4.75, Treselection = 1sec; therefore, (Diameter of Qqualmin coverage) < 47.5m.

[0036] In another aspect, the cell reselection optimization component 242 of the femto node 220 may provide power boosting to increase cells reselection radius. A fixed high value of Qqualmin may impact discovery of slow moving mobile devices 230 because mobile devices that are reasonably closer to the femtocell 220 may not be able to reselect to it. In such a case, the cell reselection optimization component 242 may instruct the femto node 220 to periodically boost its pilot power momentarily to increase its reselection radius. Such power boost can be coordinated with the transmission of the reselection beacon by the femtocell as described above. This is illustrated in **Fig. 3B** in which radius 302 corresponds to Qqualmin based “entry point” during normal operation (also shown in **Fig. 3A**) that prevents reselection by fast moving mobile devices 230, and radius 304 corresponds to Qqualmin based “entry point” during power-boosted beacon operation, which facilitates cell reselection for slow-moving mobile devices 230.

[0037] In alternative aspect, the femto node 220 may prevent frequent reselections by rejecting at least the first registration attempt by idle-mode mobile device 230. For example, when the mobile device send “RRC Connection Request” message, which identifies the mobile device using IMSI, TMSI or P-TMSI identifier, to request a connection with the femtocell 220, the femto node 220 may check for any recent registration attempts by the mobile device 230 with the same ID and if no prior attempts took place respond to the mobile device with a “RRC Connection Reject” message.

However, when a second or subsequent registration message is received from the same mobile device, the femto node 220 may accept the registration from the mobile device 230. It is also possible, while rejecting the mobile device 230, to redirect the mobile device to a different frequency/RAT layer and forbid it from re-registering to the same femtocell or its frequency/RAT for some time (e.g., few seconds). In this case, "RRC Connection Reject" message can be sent with "Redirection info" and "Wait Time".

[0038] In one example aspect, the cell handover optimization component 244 is configured to optimize various handover parameters, such as ABS (Almost Blank Subframes) configuration, Hysteresis, Time-to-trigger (TTT), Cell individual offset, event offset (Ea3-offset), filter coefficient, frequency offset, and other parameters. Optimization of handover parameters is illustrated by the following example scenarios. As density of femtocells increases, to achieve more cell splitting gains, it may be desirable for macrocells to offload more to collocated femtocells. Macrocells may need to provide more subframes to femtocells in case of eICIC (enhanced inter-Cell interference coordination) or ICIC (inter-cell interference coordination) – ABS configuration can be determined by the cell handover optimization component 244 based on the reported density of femtocells. Macrocells may need to encourage handover to femtocells. To that end, the cell handover optimization component 244 can configure hysteresis, Time-to-trigger (TTT), Cell individual offset, event offset (Ea3-offset), frequency offset, and other handover parameters. If the load on femtocells becomes too large, macrocells can make offload to femtocells less aggressive by adjusting parameters or provide it with more ABS resources. If the load on macrocells becomes too large, femtocells can make offload to macrocells difficult by adjusting parameters, such as increasing cell individual offset or event offset or frequently offset or hysteresis or TTT. In one example aspect, the parameter overwriting component 208 can send optimized cell handover parameters to be broadcast in SIBs or to be sent via dedicated messages (e.g., Measurement Control message).

[0039] **Fig. 4** shows an example method 400 for jointly optimizing one or more parameters of one or more collocated macro and femto cells, which can be implemented by system 200 (Fig. 2). At step 410, method 400 includes collecting one or more performance parameters from one or more collocated macrocells and femtocells in a wireless communication network. For example, in an aspect, the system 200 collects, at

some intervals, performance parameters for macrocells 210 and femtocell 220 using parameter collection component 202. At step 420, method 400 includes storing the collected parameters in a parameters database. For example, in an aspect, the system 200 stores the collected parameters in a parameters database 204. At step 430, method 400 includes identifying one or more collocated ones of the macrocells and femtocells. For example, parameter optimization component 206 may use network resources to identify a cluster of collocated macrocells and femtocells, and identify one or more collocated ones of the macrocells and femtocells. At step 440, method 400 includes detecting frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells. For example, in an aspect, the system 200 may analyze collected data to detect frequent cell reselections or handovers by mobile devices 230 between collocated macro and femto cells. At step 450, method 400 includes optimizing one or more of cell reselection and handover parameters for the one or more collocated macrocells and femtocells based on the performance parameters. For example, in an aspect, the system 200 optimizes cell reselection and handover parameters of these cells based on collected performance parameters from various cells using parameter optimization component 206 in order to reduce frequent cell reselections and handovers between cells. At step 460, method 400 includes overwriting one or more corresponding parameters of the one or more collocated macrocells and femtocells with the one or more of optimized cell reselection and handover parameters. For example, in an aspect, the system 200 overwrites modified parameters of macrocells 210 and femtocells 220 based on results of joint parameter optimization using overwriting component 208.

[0040] Fig. 5 shows system 500 for jointly optimizing one or more parameters of one or more collocated macro and femto cells. System 500 may be implemented in a macro node, such as node 210 (Fig. 1), femto node, such as node 220 (Fig. 1) or core network (not shown). It is to be appreciated that system 500 is represented as including functional blocks, which can be functional blocks that represent functions implemented by a processor, software, or combination thereof (*e.g.*, firmware). System 500 includes a logical grouping 502 of electrical components that can act in conjunction. For instance, logical grouping 502 can include: an electrical component 504 for collecting one or more performance parameters from macro cells and femto cells; an electrical

component 504 for detecting frequent cell reselections or handovers, e.g. between the one or more collocated macro cells and femto cells; an electrical component 506 for optimizing one or more of cell reselection and handover parameters for the one or more collocated macro cells and femto cells; and an electrical component 508 for overwriting one or more corresponding parameters of the one or more collocated macro cells and femto cells with one or more of optimized cell reselection and handover parameters. Additionally, system 500 can include a memory 512 that retains instructions for executing functions associated with the electrical components 504, 505, 506 and 508. While shown as being external to memory 512, it is to be understood that one or more of the electrical components 504, 505, 506 and 508 can exist within memory 512. In one example, electrical components 504, 505, 506 and 508 can comprise at least one processor, or each electrical component 504, 505, 506 and 508 can be a corresponding module of at least one processor. Moreover, in an additional or alternative example, electrical components 504, 505, 506 and 508 can be a computer program product comprising a computer readable medium, where each electrical component 504, 505, 506 and 508 can be corresponding code.

[0041] Referring now to **Fig. 6**, a wireless communication system 600 in which mechanisms for joint optimization of parameters of collocated macro and femto cells can be implemented. System 600 comprises a base station 602, which may be a femto node, such as nodes 102 or 202 or system 500, and may include the components and implement the functions described above with respect to Figs. 1-5. In one aspect, base station 602 can include multiple antenna groups. For example, one antenna group can include antennas 604 and 606, another group can comprise antennas 608 and 610, and an additional group can include antennas 612 and 614. Two antennas are illustrated for each antenna group; however, more or fewer antennas can be utilized for each group. Base station 602 can additionally include a transmitter chain and a receiver chain, each of which can in turn comprise a plurality of components associated with signal transmission and reception (*e.g.*, processors, modulators, multiplexers, demodulators, demultiplexers, antennas, *etc.*), as is appreciated.

[0042] Base station 602 can communicate with one or more mobile devices such as mobile device 616 and mobile device 622; however, it is to be appreciated that base station 602 can communicate with substantially any number of mobile devices similar to

mobile devices 616 and 622. Mobile devices 616 and 622 can be, for example, cellular phones, smart phones, laptops, handheld communication devices, handheld computing devices, satellite radios, global positioning systems, PDAs, and/or any other suitable device for communicating over wireless communication system 600. As depicted, mobile device 616 is in communication with antennas 612 and 614, where antennas 612 and 614 transmit information to mobile device 616 over a forward link 618 and receive information from mobile device 616 over a reverse link 620. Moreover, mobile device 622 is in communication with antennas 604 and 606, where antennas 604 and 606 transmit information to mobile device 622 over a forward link 624 and receive information from mobile device 622 over a reverse link 626. In a frequency division duplex (FDD) system, forward link 618 can utilize a different frequency band than that used by reverse link 620, and forward link 624 can employ a different frequency band than that employed by reverse link 626, for example. Further, in a time division duplex (TDD) system, forward link 618 and reverse link 620 can utilize a common frequency band and forward link 624 and reverse link 626 can utilize a common frequency band.

[0043] Each group of antennas and/or the area in which they are designated to communicate can be referred to as a sector of base station 602. For example, antenna groups can be designed to communicate to mobile devices in a sector of the areas covered by base station 602. In communication over forward links 618 and 624, the transmitting antennas of base station 602 can utilize beamforming to improve signal-to-noise ratio of forward links 618 and 624 for mobile devices 616 and 622. Also, while base station 602 utilizes beamforming to transmit to mobile devices 616 and 622 scattered randomly through an associated coverage, mobile devices in neighboring cells can be subject to less interference as compared to a base station transmitting through a single antenna to all its mobile devices. Moreover, mobile devices 616 and 622 can communicate directly with one another using a peer-to-peer or ad hoc technology as depicted. According to an example, system 600 can be a multiple-input multiple-output (MIMO) communication system.

[0044] **Fig. 7** shows an example wireless communication system 700 in which systems and methods for joint optimization of parameters of collocated macro and femto cells can be used. The wireless communication system 700 depicts one base station 710, which can include a femto node, and one mobile device 750 for sake of brevity.

However, it is to be appreciated that system 700 can include more than one base station and/or more than one mobile device, wherein additional base stations and/or mobile devices can be substantially similar or different from example base station 710 and mobile device 750 described below. In addition, it is to be appreciated that base station 710 and/or mobile device 750 can employ the systems (**Figs. 1, 2, 3, 5, and 6**) and/or methods (**Fig. 4**) described herein to facilitate wireless communication there between. For example, components or functions of the systems and/or methods described herein can be part of a memory 732 and/or 772 or processors 730 and/or 770 described below, and/or can be executed by processors 730 and/or 770 to perform the disclosed functions.

[0045] At base station 710, traffic data for a number of data streams is provided from a data source 712 to a transmit (TX) data processor 714. According to an example, each data stream can be transmitted over a respective antenna. TX data processor 714 formats, codes, and interleaves the traffic data stream based on a particular coding scheme selected for that data stream to provide coded data.

[0046] The coded data for each data stream can be multiplexed with pilot data using orthogonal frequency division multiplexing (OFDM) techniques. Additionally or alternatively, the pilot symbols can be frequency division multiplexed (FDM), time division multiplexed (TDM), or code division multiplexed (CDM). The pilot data is typically a known data pattern that is processed in a known manner and can be used at mobile device 750 to estimate channel response. The multiplexed pilot and coded data for each data stream can be modulated (*e.g.*, symbol mapped) based on a particular modulation scheme (*e.g.*, binary phase-shift keying (BPSK), quadrature phase-shift keying (QPSK), M-phase-shift keying (M-PSK), M-quadrature amplitude modulation (M-QAM), *etc.*) selected for that data stream to provide modulation symbols. The data rate, coding, and modulation for each data stream can be determined by instructions performed or provided by processor 730.

[0047] The modulation symbols for the data streams can be provided to a TX MIMO processor 720, which can further process the modulation symbols (*e.g.*, for OFDM). TX MIMO processor 720 then provides N_T modulation symbol streams to N_T transmitters (TMTR) 722a through 722t. In various embodiments, TX MIMO processor 720 applies beamforming weights to the symbols of the data streams and to the antenna from which the symbol is being transmitted.

[0048] Each transmitter 722 receives and processes a respective symbol stream to provide one or more analog signals, and further conditions (*e.g.*, amplifies, filters, and upconverts) the analog signals to provide a modulated signal suitable for transmission over the MIMO channel. Further, N_T modulated signals from transmitters 722a through 722t are transmitted from N_T antennas 724a through 724t, respectively.

[0049] At mobile device 750, the transmitted modulated signals are received by N_R antennas 752a through 752r and the received signal from each antenna 752 is provided to a respective receiver (RCVR) 754a through 754r. Each receiver 754 conditions (*e.g.*, filters, amplifies, and downconverts) a respective signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding “received” symbol stream.

[0050] An RX data processor 760 can receive and process the N_R received symbol streams from N_R receivers 754 based on a particular receiver processing technique to provide N_T “detected” symbol streams. RX data processor 760 can demodulate, deinterleave, and decode each detected symbol stream to recover the traffic data for the data stream. The processing by RX data processor 760 is complementary to that performed by TX MIMO processor 720 and TX data processor 714 at base station 710.

[0051] The reverse link message can comprise various types of information regarding the communication link and/or the received data stream. The reverse link message can be processed by a TX data processor 738, which also receives traffic data for a number of data streams from a data source 736, modulated by a modulator 780, conditioned by transmitters 754a through 754r, and transmitted back to base station 710.

[0052] At base station 710, the modulated signals from mobile device 750 are received by antennas 724, conditioned by receivers 722, demodulated by a demodulator 740, and processed by a RX data processor 742 to extract the reverse link message transmitted by mobile device 750. Further, processor 730 can process the extracted message to determine which precoding matrix to use for determining the beamforming weights.

[0053] Processors 730 and 770 can direct (*e.g.*, control, coordinate, manage, *etc.*) operation at base station 710 and mobile device 750, respectively. Respective processors 730 and 770 can be associated with memory 732 and 772 that store program

codes and data. Processors 730 and 770 can also perform functionalities described herein to support selecting a paging area identifier for one or more femto nodes.

[0054] **Fig. 8** illustrates a wireless communication system 800, configured to support a number of users, in which the systems and methods for joint optimization of parameters of collocated macro and femto cells may be implemented. The system 800 provides communication for multiple cells 802, such as, for example, macro cells 802A - 802G, with each cell being serviced by a corresponding access node 804 (*e.g.*, access nodes 804A - 804G). As shown in **Fig. 8**, mobile devices 806 (*e.g.*, mobile devices 806A - 806L) can be dispersed at various locations throughout the system over time. Each mobile device 806 can communicate with one or more access nodes 804 on a forward link (FL) and/or a reverse link (RL) at a given moment, depending upon whether the mobile device 806 is active and whether it is in soft handoff, for example. The wireless communication system 800 can provide service over a large geographic region. In some aspects, some of the mobile devices 806, such as devices 806A, 806H, and 806J, may be femto nodes, such as nodes 102 or 202 or system 500, and may include the components and implement the functions described above with respect to Figs. 1-5.

[0055] **Fig. 9** illustrates an exemplary communication system 900 where one or more femto nodes are deployed within a macro network environment and in which the systems and methods for joint optimization of parameters of collocated macro and femto cells can be implemented. Specifically, the system 900 includes multiple femto nodes 910A and 910B (*e.g.*, femtocell nodes or H(e)NB) installed in a relatively small scale network environment (*e.g.*, in one or more user residences 930), which, in one aspect, may correspond to femto nodes 104, 106, 108, 110, and 112 of Figs. 1-5. Each femto node 910 can be coupled to a wide area network 940 (*e.g.*, the Internet) and a mobile operator core network 950 *via* a digital subscriber line (DSL) router, a cable modem, a wireless link, or other connectivity means (not shown). As will be discussed below, each femto node 910 can be configured to serve associated mobile devices 920 (*e.g.*, mobile device 920A) and, optionally, alien mobile devices 920 (*e.g.*, mobile device 920B). In other words, access to femto nodes 910 can be restricted such that a given mobile device 920 can be served by a set of designated (*e.g.*, home) femto node(s) 910 but may not be served by any non-designated femto nodes 910 (*e.g.*, a neighbor's femto node).

[0056] **Fig. 10** illustrates an example of a coverage map 1000 where several tracking areas 1002 (or routing areas or location areas) are defined, each of which includes several macro coverage areas 1004. Here, areas of coverage associated with tracking areas 1002A, 1002B, and 1002C are delineated by the wide lines and the macro coverage areas 1004 are represented by the hexagons. The tracking areas 1002 also include femto coverage areas 1006 corresponding to respective femto nodes, such as nodes 102 or 202 or system 100, and which may include the components and implement the functions described above with respect to Figs. 1-5. In this example, each of the femto coverage areas 1006 (*e.g.*, femto coverage area 1006C) is depicted within a macro coverage area 1004 (*e.g.*, macro coverage area 1004B). It should be appreciated, however, that a femto coverage area 1006 may not lie entirely within a macro coverage area 1004. In practice, a large number of femto coverage areas 1006 can be defined with a given tracking area 1002 or macro coverage area 1004. Also, one or more pico coverage areas (not shown) can be defined within a given tracking area 1002 or macro coverage area 1004.

[0057] Referring again to **Fig. 9**, the owner of a femto node 910 can subscribe to mobile service, such as, for example, 3G mobile service, offered through the mobile operator core network 950. In another example, the femto node 910 can be operated by the mobile operator core network 950 to expand coverage of the wireless network. In addition, a mobile device 920 can be capable of operating both in macro environments and in smaller scale (*e.g.*, residential) network environments. Thus, for example, depending on the current location of the mobile device 920, the mobile device 920 can be served by a macro cell access node 960 or by any one of a set of femto nodes 910 (*e.g.*, the femto nodes 910A and 910B that reside within a corresponding user residence 930). For example, when a subscriber is outside his home, he is served by a standard macro cell access node (*e.g.*, node 960) and when the subscriber is at home, he is served by a femto node (*e.g.*, node 910A). Here, it should be appreciated that a femto node 910 can be backward compatible with existing mobile devices 920.

[0058] A femto node 910 can be deployed on a single frequency or, in the alternative, on multiple frequencies. Depending on the particular configuration, the single frequency or one or more of the multiple frequencies can overlap with one or more frequencies used by a macro cell access node (*e.g.*, node 960). In some aspects, an

mobile device 920 can be configured to connect to a preferred femto node (*e.g.*, the home femto node of the mobile device 920) whenever such connectivity is possible. For example, whenever the mobile device 920 is within the user's residence 930, it can communicate with the home femto node 910.

[0059] In some aspects, if the mobile device 920 operates within the mobile operator core network 950 but is not residing on its most preferred network (*e.g.*, as defined in a preferred roaming list), the mobile device 920 can continue to search for the most preferred network (*e.g.*, femto node 910) using a Better System Reselection (BSR), which can involve a periodic scanning of available systems to determine whether better systems are currently available, and subsequent efforts to associate with such preferred systems. Using an acquisition table entry (*e.g.*, in a preferred roaming list), in one example, the mobile device 920 can limit the search for specific band and channel. For example, the search for the most preferred system can be repeated periodically. Upon discovery of a preferred femto node, such as femto node 910, the mobile device 920 selects the femto node 910 for camping within its coverage area.

[0060] A femto node can be restricted in some aspects. For example, a given femto node can only provide certain services to certain mobile devices. In deployments with so-called restricted (or closed) association, a given mobile device can only be served by the macro cell mobile network and a defined set of femto nodes (*e.g.*, the femto nodes 910 that reside within the corresponding user residence 930). In some implementations, a femto node can be restricted to not provide, for at least one mobile device, at least one of: signaling, data access, registration, paging, or service.

[0061] In some aspects, a restricted femto node (which can also be referred to as a Closed Subscriber Group H(e)NB) is one that provides service to a restricted provisioned set of mobile devices. This set can be temporarily or permanently extended as necessary. In some aspects, a Closed Subscriber Group (CSG) can be defined as the set of access nodes (*e.g.*, femto nodes) that share a common access control list of mobile devices. A channel on which all femto nodes (or all restricted femto nodes) in a region operate can be referred to as a femto channel.

[0062] Various relationships can thus exist between a given femto node and a given mobile device. For example, from the perspective of a mobile device, an open femto

node can refer to a femto node with no restricted association. A restricted femto node can refer to a femto node that is restricted in some manner (*e.g.*, restricted for association and/or registration). A home femto node can refer to a femto node on which the mobile device is authorized to access and operate on. A guest femto node can refer to a femto node on which a mobile device is temporarily authorized to access or operate on. An alien femto node can refer to a femto node on which the mobile device is not authorized to access or operate on, except for perhaps emergency situations (*e.g.*, 911 calls).

[0063] From a restricted femto node perspective, a home mobile device can refer to an mobile device that authorized to access the restricted femto node. A guest mobile device can refer to a mobile device with temporary access to the restricted femto node. An alien mobile device can refer to a mobile device that does not have permission to access the restricted femto node, except for perhaps emergency situations, for example, 911 calls (*e.g.*, an access terminal that does not have the credentials or permission to register with the restricted femto node).

[0064] For convenience, the disclosure herein describes various functionality in the context of a femto node. It should be appreciated, however, that a pico node can provide the same or similar functionality as a femto node, but for a larger coverage area. For example, a pico node can be restricted, a home pico node can be defined for a given mobile device, and so on.

[0065] The various illustrative logics, logical blocks, modules, components, and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but, in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, *e.g.*, a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. Additionally, at least one processor may comprise one or

more modules operable to perform one or more of the steps and/or actions described above. An exemplary storage medium may be coupled to the processor, such that the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. Further, in some aspects, the processor and the storage medium may reside in an ASIC. Additionally, the ASIC may reside in a user terminal. In the alternative, the processor and the storage medium may reside as discrete components in a user terminal.

[0066] In one or more aspects, the functions, methods, or algorithms described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored or transmitted as one or more instructions or code on a computer-readable medium, which may be incorporated into a computer program product. Computer-readable media includes both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A storage medium may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, substantially any connection may be termed a computer-readable medium. For example, if software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk and blu-ray disc where disks usually reproduce data magnetically, while discs usually reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media.

[0067] As used in this application, the terms “component,” “module,” “system” and the like are intended to include a computer-related entity, such as but not limited to hardware, firmware, a combination of hardware and software, software, or software in

execution. For example, a component may be, but is not limited to being, a process running on a processor, a processor, an object, an executable, a thread of execution, a program, and/or a computer. By way of illustration, both an application running on a computing device and the computing device can be a component. One or more components can reside within a process and/or thread of execution and a component may be localized on one computer and/or distributed between two or more computers. In addition, these components can execute from various computer readable media having various data structures stored thereon. The components may communicate by way of local and/or remote processes such as in accordance with a signal having one or more data packets, such as data from one component interacting with another component in a local system, distributed system, and/or across a network such as the Internet with other systems by way of the signal.

[0068] While, for purposes of simplicity of explanation, the methodology shown and described as a series of acts, it is to be understood and appreciated that the methodologies are not limited by the order of acts, as some acts may, in accordance with one or more embodiments, occur in different orders and/or concurrently with other acts from that shown and described herein. For example, it is to be appreciated that a methodology could alternatively be represented as a series of interrelated states or events, such as in a state diagram. Moreover, not all illustrated acts may be required to implement a methodology in accordance with one or more embodiments.

[0069] While the foregoing disclosure discusses illustrative aspects and/or embodiments, it should be noted that various changes and modifications could be made herein without departing from the scope of the described aspects and/or embodiments as defined by the appended claims. Furthermore, although elements of the described aspects and/or embodiments may be described or claimed in the singular, the plural is contemplated unless limitation to the singular is explicitly stated. Additionally, all or a portion of any aspect and/or embodiment may be utilized with all or a portion of any other aspect and/or embodiment, unless stated otherwise.

CLAIMS

1. A method for wireless communication, comprising:
collecting one or more performance parameters from one or more collocated macrocells and femtocells in a wireless communication network;
detecting frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells;
optimizing one or more of cell reselection and handover parameters for the one or more collocated macrocells and femtocells based on the performance parameters; and
overwriting one or more corresponding parameters of the one or more collocated macrocells and femtocells with the one or more of optimized cell reselection and handover parameters.
2. The method of claim 1, wherein the collected performance parameters for a macrocell or femtocell include one or more of: the number of cell reselections, number of cell handovers, types of handovers, number of call drops, average UL interference, average cell capacity used and available cell capacity, number of users served by the cell, number of connections established, traffic pattern at backhaul, and traffic pattern of mobile devices served by the cell.
3. The method of claim 1, wherein optimizing one or more cell reselection parameters includes changing Qqualmin parameter of a macrocell.
4. The method of claim 1, wherein optimizing one or more cell reselection parameters includes changing Qoffset parameter of a macrocell.
5. The method of claim 1, wherein optimizing one or more cell reselection parameters includes changing Tselection parameter of a femtocell.
6. The method of claim 1, wherein optimizing one or more cell reselection parameters includes changing HCS priority of a femtocell.

7. The method of claim 1, wherein optimizing one or more cell reselection parameters includes changing Q_{hyst} of a macrocell.

8. The method of claim 1, wherein optimizing one or more cell reselection parameters includes changing frequency of transmitting a reselection beacon by the femtocell.

9. The method of claim 1, wherein optimizing one or more cell handover parameters includes allocating additional subframes to a femtocell.

10. The method of claim 1, wherein optimizing one or more cell handover parameters includes changing hysteresis or time-to-trigger of a femtocell.

11. The method of claim 1, wherein the one or more of optimized cell reselection and handover parameters reduce frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells.

12. An apparatus for wireless communication, comprising:
a parameter collection component configured to collect one or more performance parameters from one or more collocated macrocells and femtocells in a wireless communication network;
a parameter optimization component configured to:
detect frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells; and
optimize one or more of cell reselection and handover parameters for the one or more collocated macrocells and femtocells based on the performance parameters;
and
a parameter overwriting component configured to overwrite one or more corresponding parameters of the collocated macrocells and femtocells with the one or more of optimized cell reselection and handover parameters.

13. The apparatus of claim 12, wherein the collected performance parameters for a macrocell or femtocell include one or more of: the number of cell reselections, number of cell handovers, types of handovers, number of call drops, average UL interference, average cell capacity used and available cell capacity, number of users served by the cell, number of connections established, traffic pattern at backhaul, and traffic pattern of mobile devices served by the cell.

14. The apparatus of claim 12, wherein the parameter optimization component is further configured to change a Qqualmin parameter of a macrocell.

15. The apparatus of claim 12, wherein the parameter optimization component is further configured to change a Qoffset parameter of a macrocell.

16. The apparatus of claim 12, wherein the parameter optimization component is further configured to change a Tselection parameter of a femtocell.

17. The apparatus of claim 12, wherein the parameter optimization component is further configured to change a HCS priority of a femtocell.

18. The apparatus of claim 12, wherein the parameter optimization component is further configured to change a Qhyst of a macrocell.

19. The apparatus of claim 12, wherein the parameter optimization component is further configured to change a frequency of transmitting a reselection beacon by the femtocell.

20. The apparatus of claim 12, wherein the parameter optimization component is further configured to allocate additional subframes to a femtocell.

21. The apparatus of claim 12, wherein the parameter optimization component is further configured to change a hysteresis or time-to-trigger of a femtocell.

22. The apparatus of claim 12, wherein the one or more of optimized cell reselection and handover parameters reduce frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells.

23. A computer program product wireless communication, the product comprising a non-transitory computer-readable medium comprising:

a first set of codes for collecting one or more performance parameters from one or more collocated macrocells and femtocells in a wireless communication network;

a second set of codes for detecting frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells;

a third set of codes for optimizing one or more of cell reselection and handover parameters for the one or more collocated macrocells and femtocells based on the performance parameters; and

a fourth set of codes for overwriting one or more corresponding parameters of the collocated macrocells and femtocells with the one or more of optimized cell reselection and handover parameters.

24. The product of claim 23, wherein the collected performance parameters for a macrocell or femtocell include one or more of: the number of cell reselections, number of cell handovers, types of handovers, number of call drops, average UL interference, average cell capacity used and available cell capacity, number of users served by the cell, number of connections established, traffic pattern at backhaul, and traffic pattern of mobile devices served by the cell.

25. The product of claim 23, wherein codes for optimizing one or more cell reselection parameters include codes for changing $Q_{qualmin}$ parameter of a macrocell.

26. The product of claim 23, wherein codes for optimizing one or more cell reselection parameters include codes for changing Q_{offset} parameter of a macrocell.

27. The product of claim 23, wherein codes for optimizing one or more cell reselection parameters include codes for changing Treselection parameter of a femtocell.

28. The product of claim 23, wherein codes for optimizing one or more cell reselection parameters include codes for changing HCS priority of a femtocell.

29. The product of claim 23, wherein codes for optimizing one or more cell reselection parameters include codes for changing Qhyst of a macrocell.

30. The product of claim 23, wherein codes for optimizing one or more cell reselection parameters include codes for changing frequency of transmitting a reselection beacon by the femtocell.

31. The product of claim 23, wherein codes for optimizing one or more cell handover parameters include codes for allocating additional subframes to a femtocell.

32. The product of claim 23, wherein codes for optimizing one or more cell handover parameters include codes for changing hysteresis or time-to-trigger of a femtocell.

33. The product of claim 23, wherein the one or more of optimized cell reselection and handover parameters reduce frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells.

34. An apparatus for wireless communication, comprising:
means for collecting one or more performance parameters from one or more collocated macrocells and femtocells in a wireless communication network;
means for detecting frequent cell reselections or frequent cell handovers by mobile devices between the one or more collocated macrocells and femtocells;

means for optimizing one or more of cell reselection and handover parameters for the one or more collocated macrocells and femtocells based on the performance parameters; and

means for overwriting one or more corresponding parameters of the collocated macrocells and femtocells with the one or more of optimized cell reselection and handover parameters.

35. The apparatus of claim 34, wherein the collected performance parameters for a macrocell or femtocell include one or more of: the number of cell reselections, number of cell handovers, types of handovers, number of call drops, average UL interference, average cell capacity used and available cell capacity, number of users served by the cell, number of connections established, traffic pattern at backhaul, and traffic pattern of mobile devices served by the cell.

36. The apparatus of claim 34, wherein means for optimizing one or more cell reselection parameters includes means for changing Qqualmin parameter of a macrocell.

37. The apparatus of claim 34, wherein means for optimizing one or more cell reselection parameters includes means for changing Qoffset parameter of a macrocell.

38. The apparatus of claim 34, wherein means for optimizing one or more cell reselection parameters includes means for changing Tselection parameter of a femtocell.

39. The apparatus of claim 34, wherein means for optimizing one or more cell reselection parameters includes means for changing HCS priority of a femtocell.

40. The apparatus of claim 34, wherein means for optimizing one or more cell reselection parameters includes means for changing Qhyst of a macrocell.

41. The apparatus of claim 34, wherein means for optimizing one or more cell reselection parameters includes means for changing frequency of transmitting a reselection beacon by the femtocell.

42. The apparatus of claim 34, wherein means for optimizing one or more cell handover parameters includes means for allocating additional subframes to a femtocell.

43. The apparatus of claim 34, wherein means for optimizing one or more cell handover parameters includes means for changing hysteresis or time-to-trigger of a femtocell.

44. The apparatus of claim 34, wherein the one or more optimized cell reselection and handover parameters reduce frequent cell reselections or frequent cell handovers by mobile devices between the one or more of collocated macrocells and femtocells.

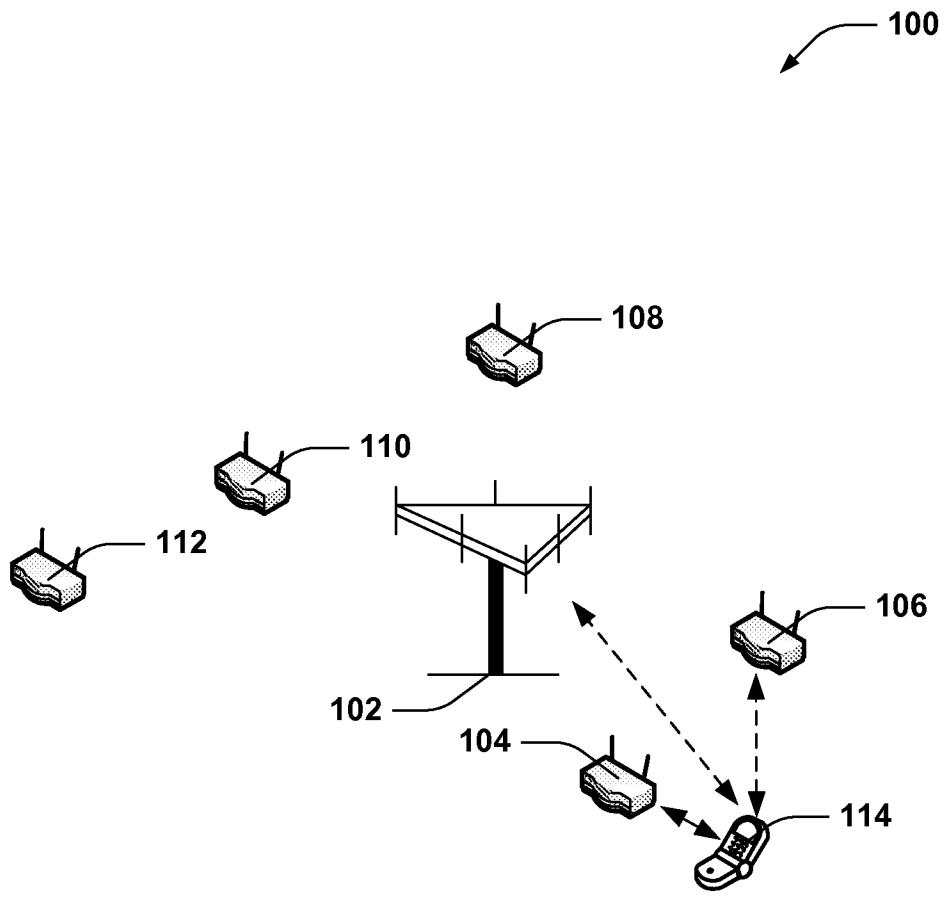


FIG. 1

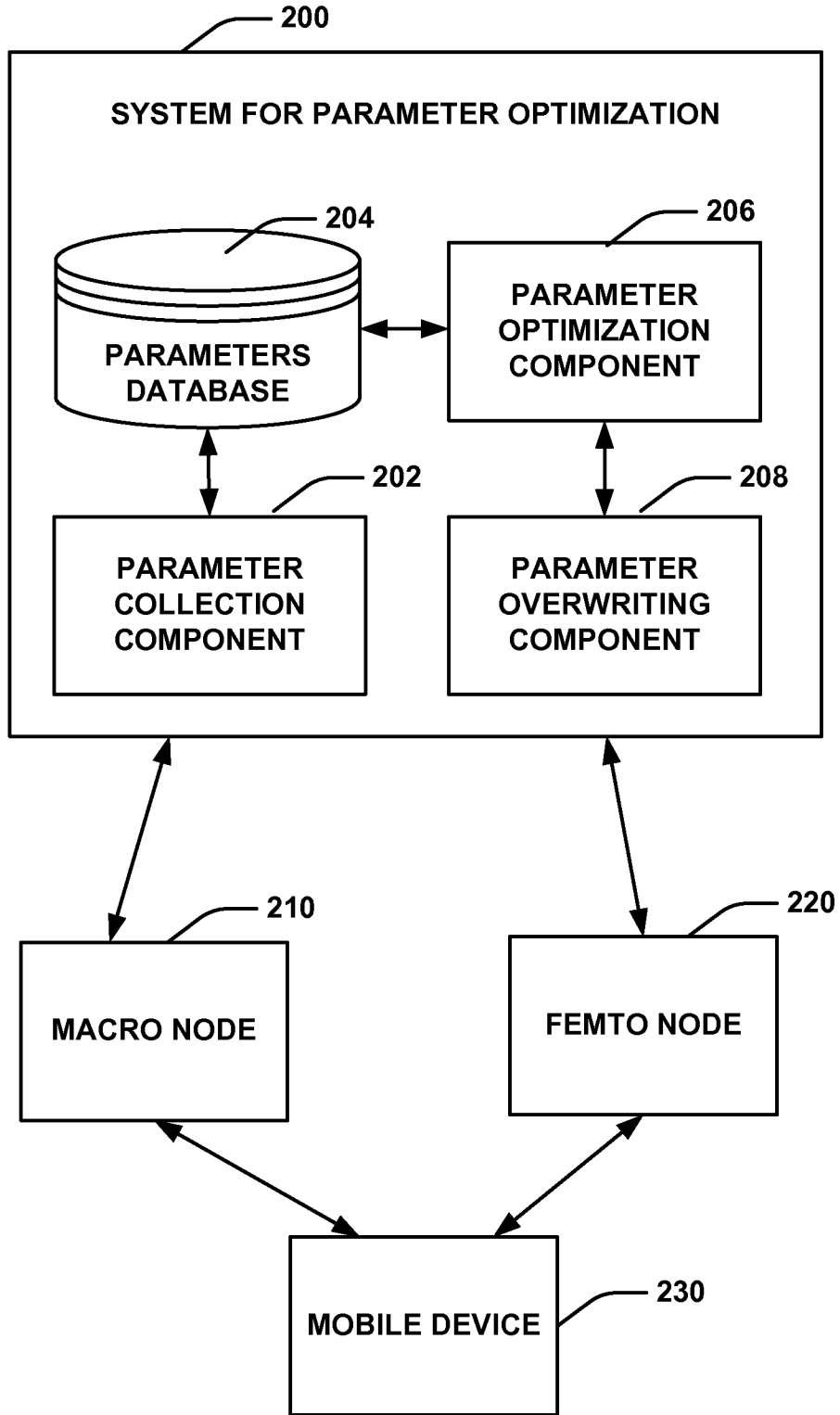


FIG. 2A

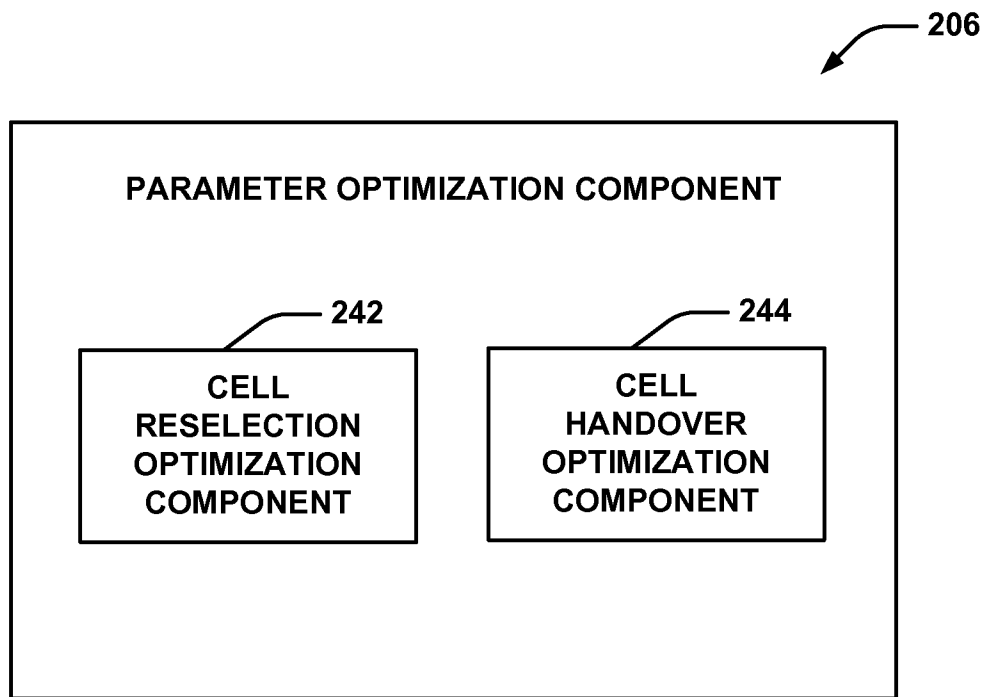


FIG. 2B

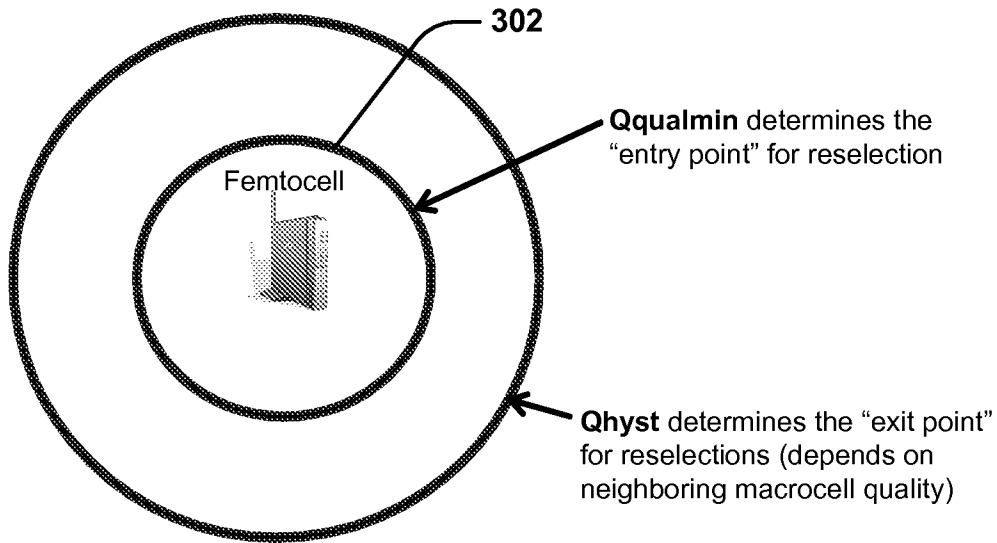


FIG. 3A

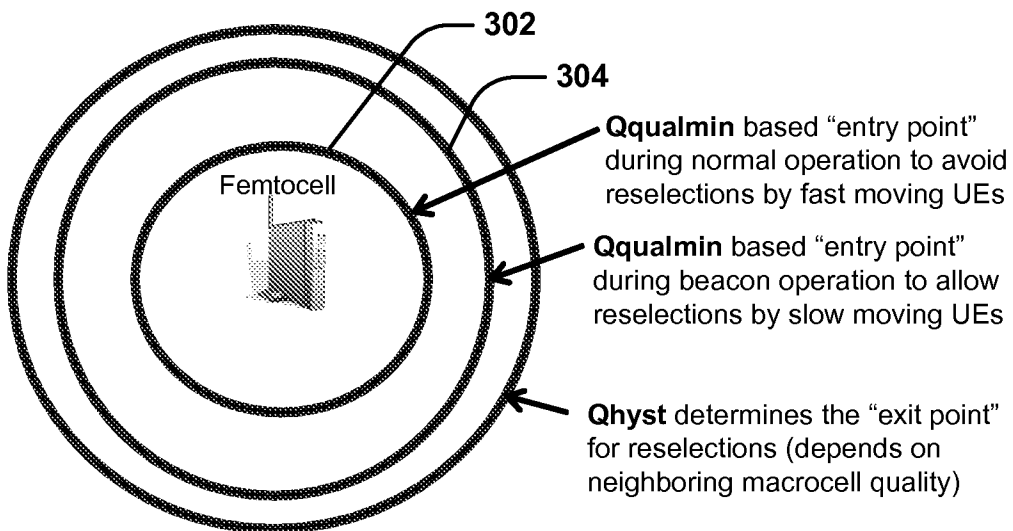


FIG. 3B

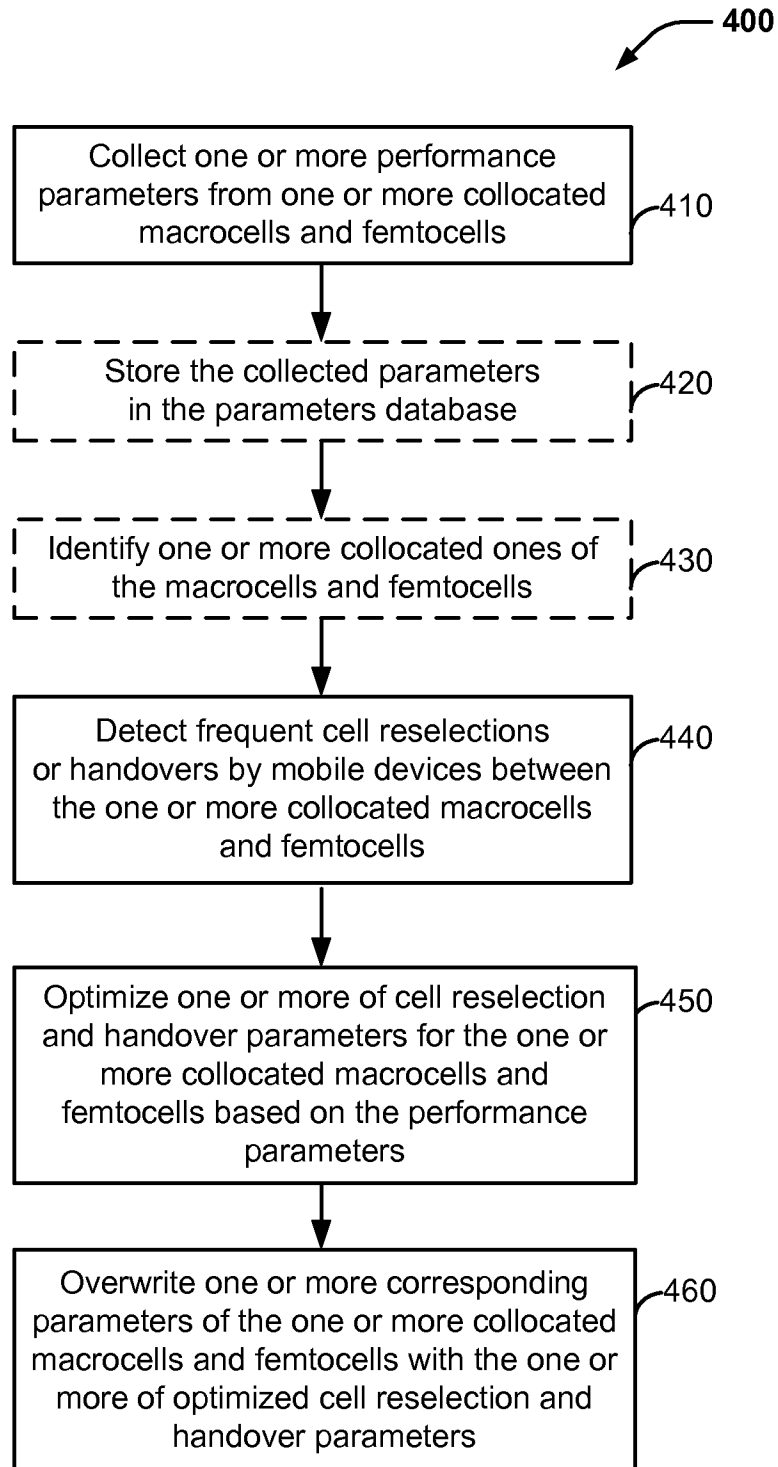


FIG. 4

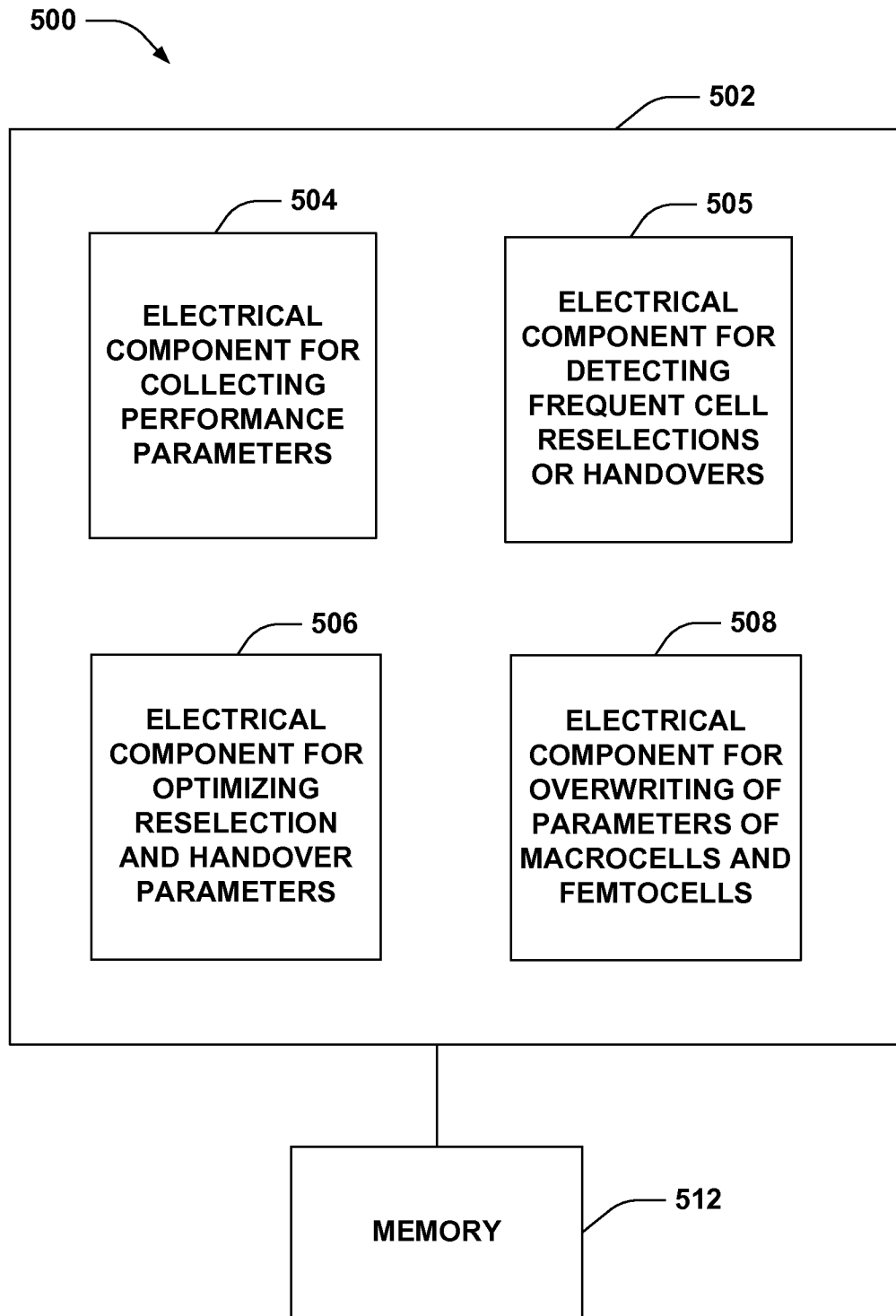


FIG. 5

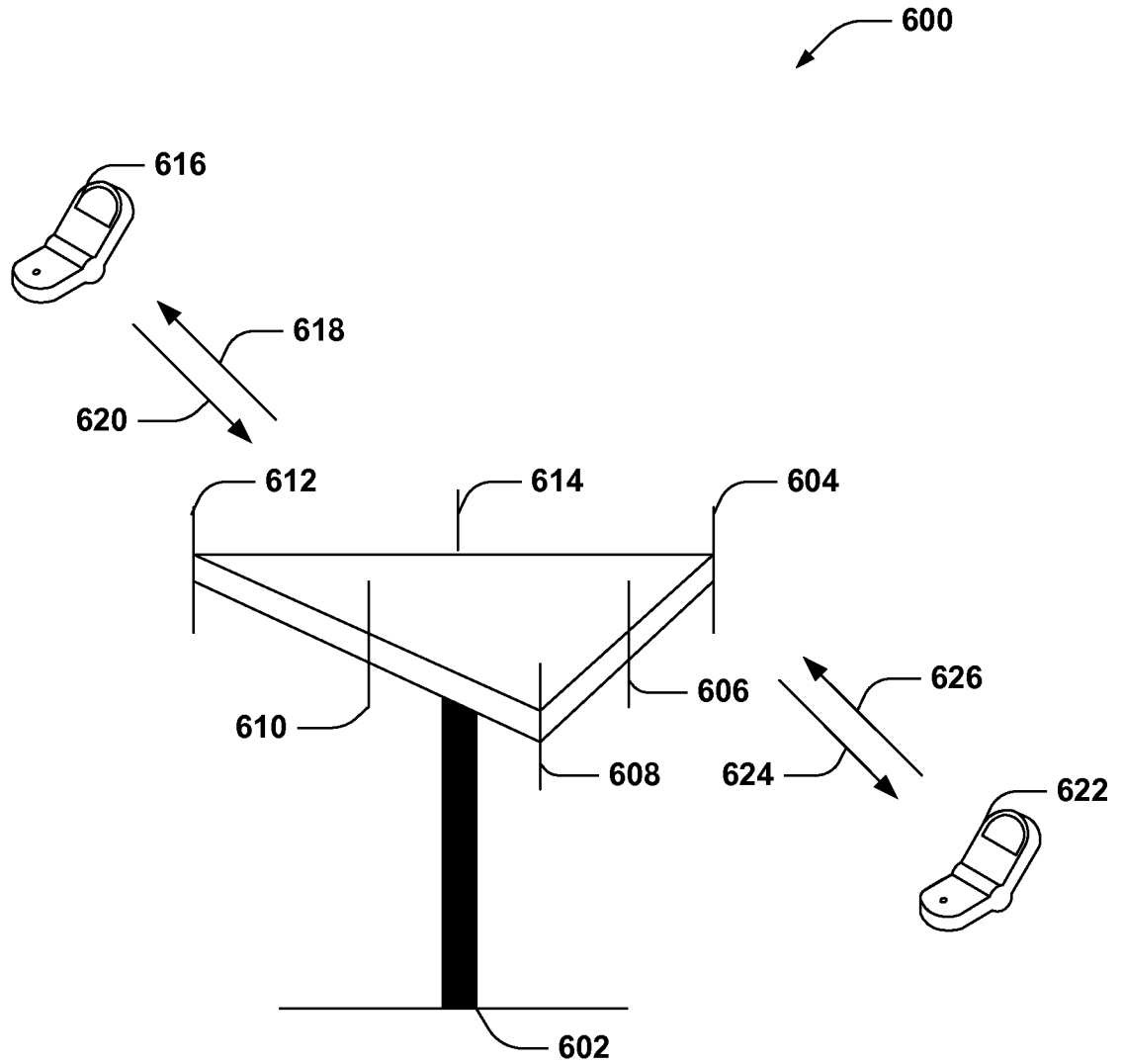


FIG. 6

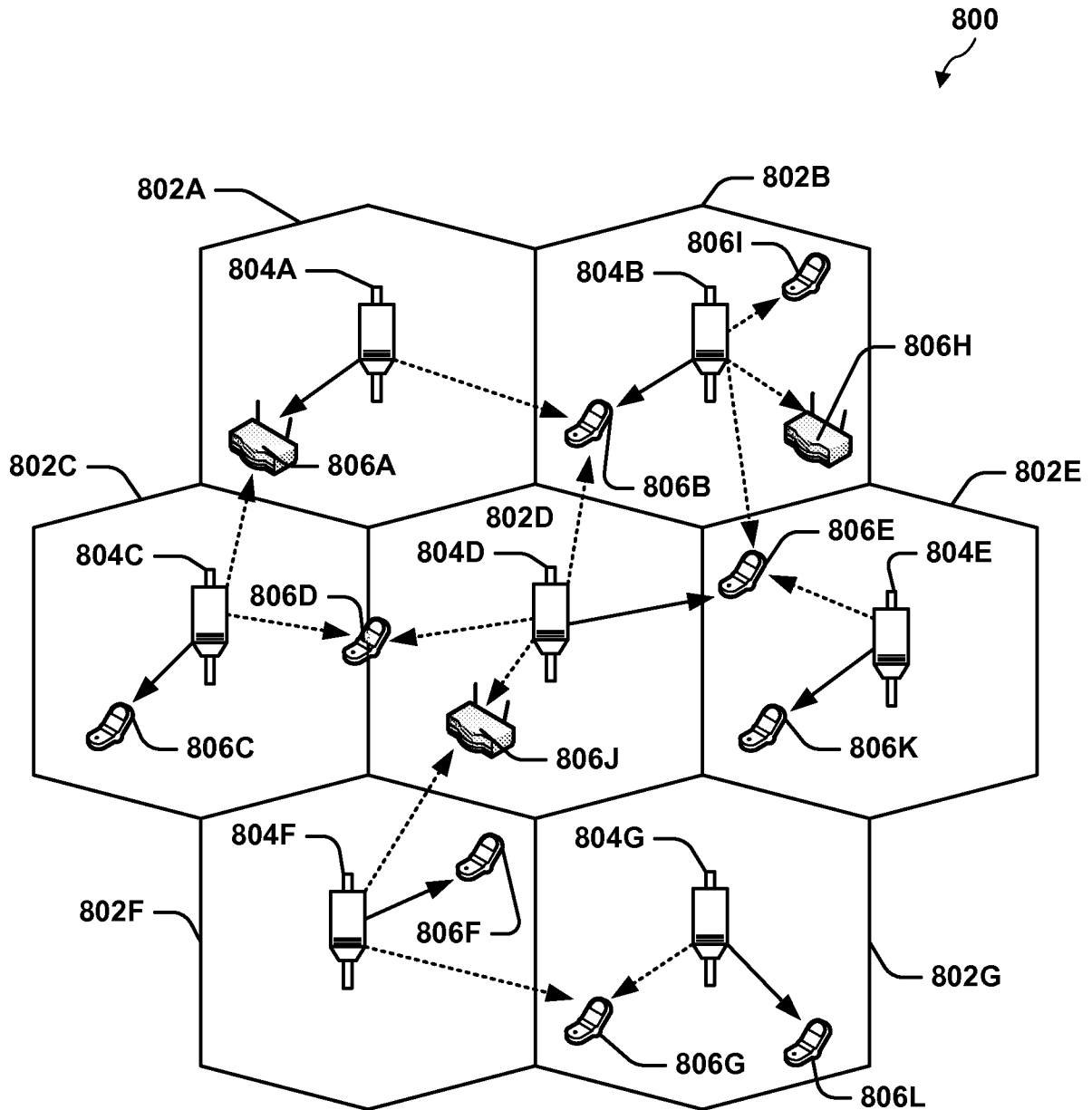


FIG. 8

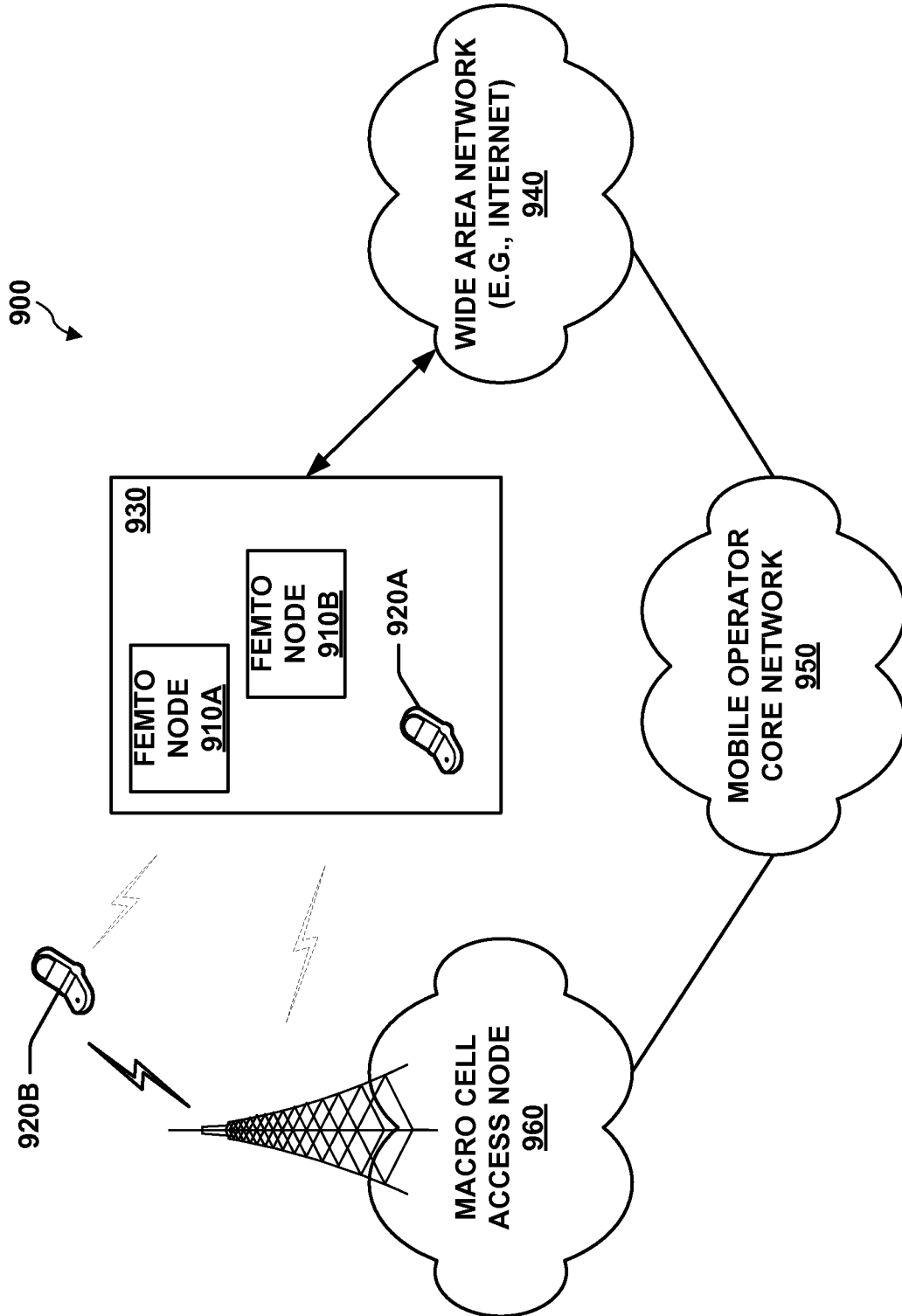


FIG. 9

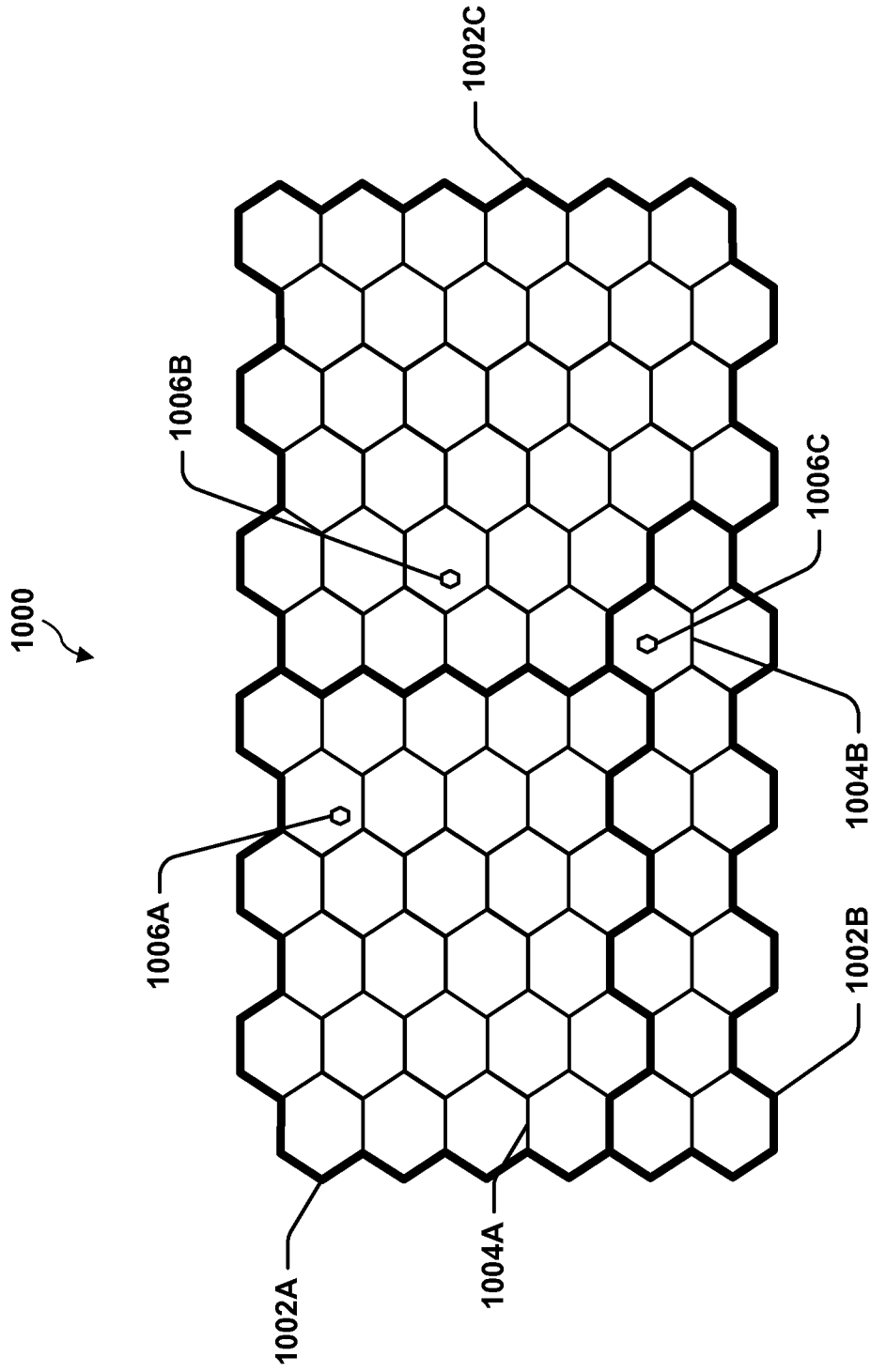


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/027517

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H04W36/00
 ADD. H04W24/02 H04W48/20 H04W84/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
 Minimum documentation searched (classification system followed by classification symbols)
 H04W

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/250891 A1 (ZOU JIALIN [US] ET AL) 13 October 2011 (2011-10-13)	1-4,6,7, 10-15, 17,18, 21-26, 28,29, 32-37, 39,40, 43,44
Y	abstract paragraphs [0006] - [0010], [0013], [0026], [0030] - [0032], [0034], [0036] - [0041], [0043] - [0048], [0051] figures 2,3,6 ----- -/--	5,8,9, 16,19, 20,27, 30,31, 38,41,42

Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search 10 June 2013	Date of mailing of the international search report 18/06/2013
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Dutrieux, Yann
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/027517

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>WO 2011/048410 A1 (UBIQUISYS LTD [GB]; GIUSTINA ANDREA [IT]; AL HOUSAMI HOUSAM [GB]) 28 April 2011 (2011-04-28)</p> <p>abstract page 1, line 7 - page 2, line 22 page 7, line 15 - page 8, line 29 page 9, line 25 - page 13, line 22 page 15, line 4 - page 15, line 25 page 17, line 24 - page 18, line 27 figures 4,5</p>	<p>1,2,4,7, 10,12, 13,15, 18,21, 23,24, 26,29, 32,34, 35,37, 40,43</p>
Y	<p>-----</p> <p>US 2010/240368 A1 (FOX DAVID [GB] ET AL) 23 September 2010 (2010-09-23)</p> <p>abstract paragraphs [0001], [0002], [0031], [0038] - [0041], [0043] - [0045], [0048], [0050], [0054], [0055], [0083], [0084], [0089] - [0091], [0097] - [0104] paragraphs [0137], [0154] - [0166]</p>	<p>5,16,27, 38</p>
Y	<p>-----</p> <p>US 2011/177808 A1 (GROKOP LEONARD H [US] ET AL) 21 July 2011 (2011-07-21)</p> <p>abstract paragraph [0046]</p>	<p>8,19,30, 41</p>
Y	<p>-----</p> <p>US 2010/220597 A1 (JI TINGFANG [US] ET AL) 2 September 2010 (2010-09-02)</p> <p>abstract paragraph [0071]</p> <p>-----</p>	<p>9,20,31, 42</p>

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2013/027517

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011250891 A1	13-10-2011	CN 102939781 A EP 2559297 A1 KR 20130009838 A US 2011250891 A1 WO 2011126932 A1	20-02-2013 20-02-2013 23-01-2013 13-10-2011 13-10-2011
WO 2011048410 A1	28-04-2011	CN 102648647 A EP 2491741 A1 GB 2474503 A JP 2013509070 A KR 20120099687 A US 2012282931 A1 WO 2011048410 A1	22-08-2012 29-08-2012 20-04-2011 07-03-2013 11-09-2012 08-11-2012 28-04-2011
US 2010240368 A1	23-09-2010	EP 2174520 A2 US 2010240368 A1 WO 2009007720 A2	14-04-2010 23-09-2010 15-01-2009
US 2011177808 A1	21-07-2011	CN 102474828 A EP 2457406 A1 JP 2013500641 A KR 20120047976 A TW 201129177 A US 2011177808 A1 WO 2011011792 A1	23-05-2012 30-05-2012 07-01-2013 14-05-2012 16-08-2011 21-07-2011 27-01-2011
US 2010220597 A1	02-09-2010	TW 201112791 A US 2010220597 A1 WO 2010099485 A1	01-04-2011 02-09-2010 02-09-2010