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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
6 August 2015 (06.08.2015)

(10) International Publication Number
WO 2015/113309 A1

(51) International Patent Classification:
H04W 4/06 (2009.01) *H04W 24/10* (2009.01)

(21) International Application Number:
PCT/CN2014/071849

(22) International Filing Date:
30 January 2014 (30.01.2014)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **QUALCOMM INCORPORATED** [US/US]; 5775 Morehouse Drive, San Diego, California 92121-1714 (US).

(72) Inventors; and
(71) Applicants *(for US only)*: **ZHU, Xipeng** [CN/CN]; 2601 North Tower, Beijing Kerry Center, No.1 Guang Hua Road, Chao Yang District, Beijing 10020 (CN). **WANG, Jun** [US/US]; 5775 Morehouse Drive, San Diego, California 92121-1714 (US). **ZHANG, Xiaoxia** [CN/US]; 5775 Morehouse Drive, San Diego, California 92121-1714 (US).

(74) Agent: **LEE AND LI - LEAVEN IPR AGENCY LTD.**; Room 1008, Tower W1, Oriental Plaza, 1 East Chang An Avenue, Dong Cheng District, Beijing 100738 (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, 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, IR, IS, JP, KE, KG, 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, SA, 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, 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, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *of inventorship (Rule 4.17(iv))*

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

(54) **Title**: MBSFN MEASUREMENTS FOR MDT

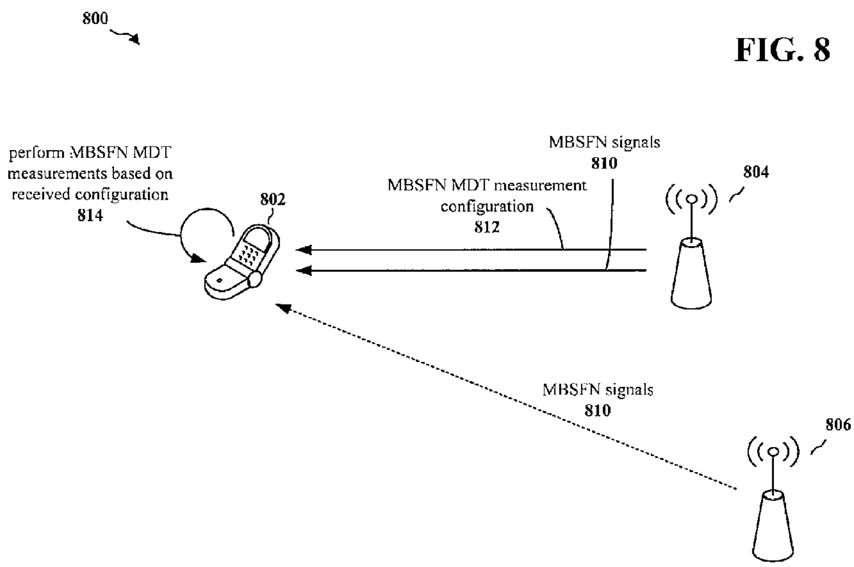


FIG. 8

(57) **Abstract**: A method, an apparatus, and a computer program product for wireless communication are provided. The apparatus may be a UE. The UE receives a configuration for performing MBSFN MDT measurements. The UE performs the MBSFN MDT measurements based on the received configuration. The UE may receive MBSFN signals. The UE may perform the MBSFN MDT measurements by determining at least one of an MBSFN RSRP, an MBSFN RSRQ, or an MCH BLER of the received MBSFN signals. The UE may receive the configuration for performing the MBSFN MDT measurements through unicast / RRC signaling or through a broadcast. When receiving the configuration for performing the MBSFN MDT measurements through a broadcast, the UE may receive the configuration through the MCCH or through a SIB.

WO 2015/113309 A1

MBSFN MEASUREMENTS FOR MDT

BACKGROUND

Field

[0001] The present disclosure relates generally to communication systems, and more particularly, to Multicast Broadcast Single Frequency Network (MBSFN) measurements for minimization of driving tests (MDT).

Background

[0002] Wireless communication systems are widely deployed to provide various telecommunication services such as telephony, video, data, messaging, and broadcasts. Typical wireless communication systems may employ multiple-access technologies capable of supporting communication with multiple users by sharing available system resources (e.g., bandwidth, transmit power). Examples of such multiple-access technologies 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, single-carrier frequency division multiple access (SC-FDMA) systems, and time division synchronous code division multiple access (TD-SCDMA) systems.

[0003] These multiple access technologies have been adopted in various telecommunication standards to provide a common protocol that enables different wireless devices to communicate on a municipal, national, regional, and even global level. An example of an emerging telecommunication standard is Long Term Evolution (LTE). LTE is a set of enhancements to the Universal Mobile Telecommunications System (UMTS) mobile standard promulgated by Third Generation Partnership Project (3GPP). LTE is designed to better support mobile broadband Internet access by improving spectral efficiency, lowering costs, improving services, making use of new spectrum, and better integrating with other open standards using OFDMA on the downlink (DL), SC-FDMA on the uplink (UL), and multiple-input multiple-output (MIMO) antenna technology. However, as the demand for mobile broadband access continues to increase, there exists a need for further improvements in LTE technology. Preferably, these improvements should be applicable to other multi-access technologies and the telecommunication standards that employ these technologies.

SUMMARY

[0004] In an aspect of the disclosure, a method, a computer program product, and an apparatus are provided. The apparatus may be a user equipment (UE). The UE receives a configuration for performing MBSFN MDT measurements. In addition, the UE performs the MBSFN MDT measurements based on the received configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a diagram illustrating an example of a network architecture.

[0006] FIG. 2 is a diagram illustrating an example of an access network.

[0007] FIG. 3 is a diagram illustrating an example of a DL frame structure in LTE.

[0008] FIG. 4 is a diagram illustrating an example of an UL frame structure in LTE.

[0009] FIG. 5 is a diagram illustrating an example of a radio protocol architecture for the user and control planes.

[0010] FIG. 6 is a diagram illustrating an example of an evolved Node B and user equipment in an access network.

[0011] FIG. 7A is a diagram illustrating an example of an evolved Multimedia Broadcast Multicast Service channel configuration in a Multicast Broadcast Single Frequency Network.

[0012] FIG. 7B is a diagram illustrating a format of a Multicast Channel Scheduling Information Media Access Control control element.

[0013] FIG. 8 is a first diagram for illustrating exemplary methods in relation to MBSFN measurements for MDT.

[0014] FIG. 9 is a second diagram for illustrating exemplary methods in relation to MBSFN measurements for MDT.

[0015] FIG. 10 is a flow chart of a method of wireless communication.

[0016] FIG. 11 is a conceptual data flow diagram illustrating the data flow between different modules/means/components in an exemplary apparatus.

[0017] FIG. 12 is a diagram illustrating an example of a hardware implementation for an apparatus employing a processing system.

DETAILED DESCRIPTION

[0018] The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations and is not intended to represent the only configurations in which the concepts described herein may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some instances, well known structures and components are shown in block diagram form in order to avoid obscuring such concepts.

[0019] Several aspects of telecommunication systems will now be presented with reference to various apparatus and methods. These apparatus and methods will be described in the following detailed description and illustrated in the accompanying drawings by various blocks, modules, components, circuits, steps, processes, algorithms, etc. (collectively referred to as "elements"). These elements may be implemented using electronic hardware, computer software, or any combination thereof. Whether such elements are implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system.

[0020] By way of example, an element, or any portion of an element, or any combination of elements may be implemented with a "processing system" that includes one or more processors. Examples of processors include microprocessors, microcontrollers, digital signal processors (DSPs), field programmable gate arrays (FPGAs), programmable logic devices (PLDs), state machines, gated logic, discrete hardware circuits, and other suitable hardware configured to perform the various functionality described throughout this disclosure. One or more processors in the processing system may execute software. Software shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise.

[0021] Accordingly, in one or more exemplary embodiments, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or encoded as one or more instructions or code on a computer-readable medium. Computer-readable media includes computer storage media. Storage media 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 a random-access memory (RAM), a read-only memory (ROM), an electrically erasable programmable ROM (EEPROM), compact disk ROM (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. Combinations of the above should also be included within the scope of computer-readable media.

[0022] FIG. 1 is a diagram illustrating an LTE network architecture 100. The LTE network architecture 100 may be referred to as an Evolved Packet System (EPS) 100. The EPS 100 may include one or more user equipment (UE) 102, an Evolved UMTS Terrestrial Radio Access Network (E-UTRAN) 104, an Evolved Packet Core (EPC) 110, and an Operator's Internet Protocol (IP) Services 122. The EPS can interconnect with other access networks, but for simplicity those entities/interfaces are not shown. As shown, the EPS provides packet-switched services, however, as those skilled in the art will readily appreciate, the various concepts presented throughout this disclosure may be extended to networks providing circuit-switched services.

[0023] The E-UTRAN includes the evolved Node B (eNB) 106 and other eNBs 108, and may include a Multicast Coordination Entity (MCE) 128. The eNB 106 provides user and control planes protocol terminations toward the UE 102. The eNB 106 may be connected to the other eNBs 108 via a backhaul (e.g., an X2 interface). The MCE 128 allocates time/frequency radio resources for evolved Multimedia Broadcast Multicast Service (MBMS) (eMBMS), and determines the radio configuration (e.g., a modulation and coding scheme (MCS)) for the eMBMS. The MCE 128 may be a separate entity or part of the eNB 106. The eNB 106 may also be referred to as a base station, a Node B, an access point, a base transceiver station, a radio base station, a radio transceiver, a transceiver function, a basic service set (BSS), an extended service set (ESS), or some other suitable terminology. The eNB 106 provides an access point to the EPC 110 for a UE 102. Examples of UEs 102 include a cellular phone, a smart phone, a session initiation protocol (SIP) phone, a laptop, a personal digital assistant (PDA), a satellite radio, a global positioning system, a multimedia device, a video device, a digital audio player (e.g., MP3 player), a camera, a game console, a tablet, or any other similar functioning device. The UE 102 may also be referred to by those skilled in the art as a mobile station, a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a wireless communications device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless terminal, a remote terminal, a handset, a user agent, a mobile client, a client, or some other suitable terminology.

[0024] The eNB 106 is connected to the EPC 110. The EPC 110 may include a Mobility Management Entity (MME) 112, a Home Subscriber Server (HSS) 120, other MMEs 114, a Serving Gateway 116, a Multimedia Broadcast Multicast Service (MBMS) Gateway 124, a Broadcast Multicast Service Center (BM-SC) 126, and a Packet Data Network (PDN) Gateway 118. The MME 112 is the control node that processes the signaling between the UE 102 and the EPC 110. Generally, the MME 112 provides bearer and connection management. User IP packets may be transferred through the Serving Gateway 116, which itself is connected to the PDN Gateway 118. The PDN Gateway 118 provides UE IP address allocation as well as other functions. The PDN Gateway 118 and the BM-SC 126 are connected to the IP Services 122. The IP Services 122 may include the Internet, an intranet, an IP Multimedia Subsystem (IMS), a PS Streaming Service (PSS), and/or other IP services. The BM-SC 126 may provide functions for MBMS user service provisioning and delivery. The BM-SC 126 may serve as an entry point for content provider MBMS transmission, may be used to authorize and initiate MBMS Bearer Services within a PLMN, and may be used to schedule and deliver MBMS transmissions. The MBMS Gateway 124 may be used to distribute MBMS traffic to the eNBs (e.g., 106, 108) belonging to a Multicast Broadcast Single Frequency Network (MBSFN) area broadcasting a particular service, and may be responsible for session management (start/stop) and for collecting eMBMS related charging information.

[0025] FIG. 2 is a diagram illustrating an example of an access network 200 in an LTE network architecture. In this example, the access network 200 is divided into a number of cellular regions (cells) 202. One or more lower power class eNBs 208 may have cellular regions 210 that overlap with one or more of the cells 202. The lower power class eNB 208 may be a femto cell (e.g., home eNB (HeNB)), pico cell, micro cell, or remote radio head (RRH). The macro eNBs 204 are each assigned to a respective cell 202 and are configured to provide an access point to the EPC 110 for all the UEs 206 in the cells 202. There is no centralized controller in this example of an access network 200, but a centralized controller may be used in alternative configurations. The eNBs 204 are responsible for all radio related functions including radio bearer control, admission control, mobility control, scheduling, security, and connectivity to the serving gateway 116. An eNB may support one or multiple (e.g., three) cells (also referred to as a sectors). The term "cell" can refer to the smallest coverage area of an eNB and/or an eNB subsystem serving are particular coverage area. Further, the terms "eNB," "base station," and "cell" may be used interchangeably herein.

[0026] The modulation and multiple access scheme employed by the access network 200 may vary depending on the particular telecommunications standard being deployed. In LTE applications, OFDM is used on the DL and SC-FDMA is used on the UL to support both frequency division duplex (FDD) and time division duplex (TDD). As those skilled in the art will readily appreciate from the detailed description to follow, the various concepts presented herein are well suited for LTE applications. However, these concepts may be readily extended to other telecommunication standards employing other modulation and multiple access techniques. By way of example, these concepts may be extended to Evolution-Data Optimized (EV-DO) or Ultra Mobile Broadband (UMB). EV-DO and UMB are air interface standards promulgated by the 3rd Generation Partnership Project 2 (3GPP2) as part of the CDMA2000 family of standards and employs CDMA to provide broadband Internet access to mobile stations. These concepts may also be extended to Universal Terrestrial Radio Access (UTRA) employing Wideband-CDMA (W-CDMA) and other variants of CDMA, such as TD-SCDMA; Global System for

Mobile Communications (GSM) employing TDMA; and Evolved UTRA (E-UTRA), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, and Flash-OFDM employing OFDMA. UTRA, E-UTRA, UMTS, LTE and GSM are described in documents from the 3GPP organization. CDMA2000 and UMB are described in documents from the 3GPP2 organization. The actual wireless communication standard and the multiple access technology employed will depend on the specific application and the overall design constraints imposed on the system.

[0027] The eNBs 204 may have multiple antennas supporting MIMO technology. The use of MIMO technology enables the eNBs 204 to exploit the spatial domain to support spatial multiplexing, beamforming, and transmit diversity. Spatial multiplexing may be used to transmit different streams of data simultaneously on the same frequency. The data streams may be transmitted to a single UE 206 to increase the data rate or to multiple UEs 206 to increase the overall system capacity. This is achieved by spatially precoding each data stream (i.e., applying a scaling of an amplitude and a phase) and then transmitting each spatially precoded stream through multiple transmit antennas on the DL. The spatially precoded data streams arrive at the UE(s) 206 with different spatial signatures, which enables each of the UE(s) 206 to recover the one or more data streams destined for that UE 206. On the UL, each UE 206 transmits a spatially precoded data stream, which enables the eNB 204 to identify the source of each spatially precoded data stream.

[0028] Spatial multiplexing is generally used when channel conditions are good. When channel conditions are less favorable, beamforming may be used to focus the transmission energy in one or more directions. This may be achieved by spatially precoding the data for transmission through multiple antennas. To achieve good coverage at the edges of the cell, a single stream beamforming transmission may be used in combination with transmit diversity.

[0029] In the detailed description that follows, various aspects of an access network will be described with reference to a MIMO system supporting OFDM on the DL. OFDM is a spread-spectrum technique that modulates data over a number of subcarriers within an OFDM symbol. The subcarriers are spaced apart at precise frequencies. The spacing provides “orthogonality” that enables a receiver to recover the data from the subcarriers. In the time domain, a guard interval (e.g., cyclic prefix) may be added to each OFDM symbol to combat inter-OFDM-symbol interference. The UL may use SC-FDMA in the form of a DFT-spread OFDM signal to compensate for high peak-to-average power ratio (PAPR).

[0030] FIG. 3 is a diagram 300 illustrating an example of a DL frame structure in LTE. A frame (10 ms) may be divided into 10 equally sized subframes. Each subframe may include two consecutive time slots. A resource grid may be used to represent two time slots, each time slot including a resource block. The resource grid is divided into multiple resource elements. In LTE, for a normal cyclic prefix, a resource block contains 12 consecutive subcarriers in the frequency domain and 7 consecutive OFDM symbols in the time domain, for a total of 84 resource elements. For an extended cyclic prefix, a resource block contains 12 consecutive subcarriers in the frequency domain and 6 consecutive OFDM symbols in the time domain, for a total of 72 resource elements. Some of the resource elements, indicated as R 302, 304, include DL reference signals (DL-RS). The DL-RS include Cell-specific RS (CRS) (also sometimes called common RS) 302 and UE-specific RS (UE-RS) 304. UE-RS 304 is transmitted only on the resource blocks upon which the corresponding physical DL shared channel (PDSCH) is mapped. The number of bits carried by each resource element depends on the modulation scheme. Thus, the more resource blocks that a UE receives and the higher the modulation scheme, the higher the data rate for the UE.

[0031] FIG. 4 is a diagram 400 illustrating an example of an UL frame structure in LTE. The available resource blocks for the UL may be partitioned into a data section and a control section. The control section may be formed at the two edges of the system bandwidth and may have a configurable size. The resource blocks in the control section may be assigned to UEs for transmission of control information. The data section may include all resource blocks not included in the control section. The UL frame structure results in the data section including contiguous subcarriers, which may allow a single UE to be assigned all of the contiguous subcarriers in the data section.

[0032] A UE may be assigned resource blocks 410a, 410b in the control section to transmit control information to an eNB. The UE may also be assigned resource blocks 420a, 420b in the data section to transmit data to the eNB. The UE may transmit control information in a physical UL control channel (PUCCH) on the assigned resource blocks in the control section. The UE may transmit only data or both data and control information in a physical UL shared channel (PUSCH) on the assigned resource blocks in the data section. A UL transmission may span both slots of a subframe and may hop across frequency.

[0033] A set of resource blocks may be used to perform initial system access and achieve UL synchronization in a physical random access channel (PRACH) 430. The PRACH 430 carries a random sequence and cannot carry any UL data/signaling. Each random access preamble occupies a bandwidth corresponding to six consecutive resource blocks. The starting frequency is specified by the network. That is, the transmission of the random access preamble is restricted to certain time and frequency resources. There is no frequency hopping for the PRACH. The PRACH attempt is carried in a single subframe (1 ms) or in a sequence of few contiguous subframes and a UE can make only a single PRACH attempt per frame (10 ms).

[0034] FIG. 5 is a diagram 500 illustrating an example of a radio protocol architecture for the user and control planes in LTE. The radio protocol architecture for the UE and the eNB is shown with three layers: Layer 1, Layer 2, and Layer 3. Layer 1 (L1 layer) is the lowest layer and implements various physical layer signal processing functions. The L1 layer will be referred to herein as the physical layer 506. Layer 2 (L2 layer) 508 is above the physical layer 506 and is responsible for the link between the UE and eNB over the physical layer 506.

[0035] In the user plane, the L2 layer 508 includes a media access control (MAC) sublayer 510, a radio link control (RLC) sublayer 512, and a packet data convergence protocol (PDCP) 514 sublayer, which are terminated at the eNB on the network side. Although not shown, the UE may have several upper layers above the L2 layer 508 including a network layer (e.g., IP layer) that is terminated at the PDN gateway 118 on the network side, and an application layer that is terminated at the other end of the connection (e.g., far end UE, server, etc.).

[0036] The PDCP sublayer 514 provides multiplexing between different radio bearers and logical channels. The PDCP sublayer 514 also provides header compression for upper layer data packets to reduce radio transmission overhead, security by ciphering the data packets, and handover support for UEs between eNBs. The RLC sublayer 512 provides segmentation and reassembly of upper layer data packets, retransmission of lost data packets, and reordering of data packets to compensate for out-of-order reception due to hybrid automatic repeat request (HARQ). The MAC sublayer 510 provides multiplexing between logical and transport channels. The MAC sublayer 510 is also responsible for allocating the various radio resources (e.g., resource blocks) in one cell among the UEs. The MAC sublayer 510 is also responsible for HARQ operations.

[0037] In the control plane, the radio protocol architecture for the UE and eNB is substantially the same for the physical layer 506 and the L2 layer 508 with the exception that there is no header compression function for the control plane. The control plane also includes a radio resource control (RRC) sublayer 516 in Layer 3 (L3 layer). The RRC sublayer 516 is responsible for obtaining radio resources (e.g., radio bearers) and for configuring the lower layers using RRC signaling between the eNB and the UE.

[0038] FIG. 6 is a block diagram of an eNB 610 in communication with a UE 650 in an access network. In the DL, upper layer packets from the core network are provided to a controller/processor 675. The controller/processor 675 implements the functionality of the L2 layer. In the DL, the controller/processor 675 provides header compression, ciphering, packet segmentation and reordering, multiplexing between logical and transport channels, and radio resource allocations to the UE 650 based on various priority metrics. The controller/processor 675 is also responsible for HARQ operations, retransmission of lost packets, and signaling to the UE 650.

[0039] The transmit (TX) processor 616 implements various signal processing functions for the L1 layer (i.e., physical layer). The signal processing functions include coding and interleaving to facilitate forward error correction (FEC) at the UE 650 and mapping to signal constellations based on various modulation schemes (e.g., binary phase-shift keying (BPSK), quadrature phase-shift keying (QPSK), M-phase-shift keying (M-PSK), M-quadrature amplitude modulation (M-QAM)). The coded and modulated symbols are then split into parallel streams. Each stream is then mapped to an OFDM subcarrier, multiplexed with a reference signal (e.g., pilot) in the time and/or frequency domain, and then combined together using an Inverse Fast Fourier Transform (IFFT) to produce a physical channel carrying a time domain OFDM symbol stream. The OFDM stream is spatially precoded to produce multiple spatial streams. Channel estimates from a channel estimator 674 may be used to determine the coding and modulation scheme, as well as for spatial processing. The channel estimate may be derived from a reference signal and/or channel condition feedback transmitted by the UE 650. Each spatial stream may then be provided to a different antenna 620 via a separate transmitter 618TX. Each transmitter 618TX may modulate an RF carrier with a respective spatial stream for transmission.

[0040] At the UE 650, each receiver 654RX receives a signal through its respective antenna 652. Each receiver 654RX recovers information modulated onto an RF carrier and provides the information to the receive (RX) processor 656. The RX processor 656 implements various signal processing functions of the L1 layer. The RX processor 656 may perform spatial processing on the information to recover any spatial streams destined for the UE 650. If multiple spatial streams are destined for the UE 650, they may be combined by the RX processor 656 into a single OFDM symbol stream. The RX processor 656 then converts the OFDM symbol stream from the time-domain to the frequency domain using a Fast Fourier Transform (FFT). The frequency domain signal comprises a separate OFDM symbol stream for each subcarrier of the OFDM signal. The symbols on each subcarrier, and the reference signal, are recovered and demodulated by determining the most likely signal constellation points transmitted by the eNB 610. These soft decisions may be based on channel estimates computed by the channel estimator 658. The soft decisions are then decoded and deinterleaved to recover the data and control signals that were originally transmitted by the eNB 610 on the physical channel. The data and control signals are then provided to the controller/processor 659.

[0041] The controller/processor 659 implements the L2 layer. The controller/processor can be associated with a memory 660 that stores program codes and data. The memory 660 may be referred to as a computer-readable medium. In the UL, the controller/processor 659 provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, control signal processing to recover upper layer packets from the core network. The upper layer packets are then provided to a data sink 662, which represents all the protocol layers above the L2 layer. Various control signals may also be provided to the data sink 662 for L3 processing. The controller/processor 659 is also responsible for error detection using an acknowledgement (ACK) and/or negative acknowledgement (NACK) protocol to support HARQ operations.

[0042] In the UL, a data source 667 is used to provide upper layer packets to the controller/processor 659. The data source 667 represents all protocol layers above the L2 layer. Similar to the functionality described in connection with the DL transmission by the eNB 610, the controller/processor 659 implements the L2 layer for the user plane and the control plane by providing header compression, ciphering, packet segmentation and reordering, and multiplexing between logical and transport channels based on radio resource allocations by the eNB 610. The controller/processor 659 is also responsible for HARQ operations, retransmission of lost packets, and signaling to the eNB 610.

[0043] Channel estimates derived by a channel estimator 658 from a reference signal or feedback transmitted by the eNB 610 may be used by the TX processor 668 to select the appropriate coding and modulation schemes, and to facilitate spatial processing. The spatial streams generated by the TX processor 668 may be provided to different antenna 652 via separate transmitters 654TX. Each transmitter 654TX may modulate an RF carrier with a respective spatial stream for transmission.

[0044] The UL transmission is processed at the eNB 610 in a manner similar to that described in connection with the receiver function at the UE 650. Each receiver 618RX receives a signal through its respective antenna 620. Each receiver 618RX recovers information modulated onto an RF carrier and provides the information to a RX processor 670. The RX processor 670 may implement the L1 layer.

[0045] The controller/processor 675 implements the L2 layer. The controller/processor 675 can be associated with a memory 676 that stores program codes and data. The memory 676 may be referred to as a computer-readable medium. In the UL, the control/processor 675 provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, control signal processing to recover upper layer packets from the UE 650. Upper layer packets from the controller/processor 675 may be provided to the core network. The controller/processor 675 is also responsible for error detection using an ACK and/or NACK protocol to support HARQ operations.

[0046] FIG. 7A is a diagram 750 illustrating an example of an evolved MBMS (eMBMS) channel configuration in an MBSFN. The eNBs 752 in cells 752' may form a first MBSFN area and the eNBs 754 in cells 754' may form a second MBSFN area. The eNBs 752, 754 may each be associated with other MBSFN areas, for example, up to a total of eight MBSFN areas. A cell within an MBSFN area may be designated a reserved cell. Reserved cells do not provide multicast/broadcast content, but are time-synchronized to the cells 752', 754' and may have restricted power on MBSFN resources in order to limit interference to the MBSFN areas. Each eNB in an MBSFN area synchronously transmits the same eMBMS control information and data. Each area may support broadcast, multicast, and unicast services. A unicast service is a service intended for a specific user, e.g., a voice call. A multicast service is a service that may be received by a group of users, e.g., a subscription video service. A broadcast service is a service that may be received by all users, e.g., a news broadcast. Referring to FIG. 7A, the first MBSFN area may support a first eMBMS broadcast service, such as by providing a particular news broadcast to UE 770. The second MBSFN area may support a second eMBMS broadcast service, such as by providing a different news broadcast to UE 760. Each MBSFN area supports a plurality of physical multicast channels (PMCH) (e.g., 15 PMCHs). Each PMCH corresponds to a multicast channel (MCH). Each MCH can multiplex a plurality (e.g., 29) of multicast logical channels. Each MBSFN area may have one multicast control channel (MCCH). As such, one MCH may multiplex one MCCH and a plurality of multicast traffic channels (MTCHs) and the remaining MCHs may multiplex a plurality of MTCHs.

[0047] A UE can camp on an LTE cell to discover the availability of eMBMS service access and a corresponding access stratum configuration. In a first step, the UE may acquire a system information block (SIB) 13 (SIB13). In a second step, based on the SIB13, the UE may acquire an MBSFN Area Configuration message on an MCCH. In a third step, based on the MBSFN Area Configuration message, the UE may acquire an MCH scheduling information (MSI) MAC control element. The SIB13 may indicate (1) an MBSFN area identifier of each MBSFN area supported by the cell; (2) information for acquiring the MCCH such as an MCCH repetition period (e.g., 32, 64, …, 256 frames), an MCCH offset (e.g., 0, 1, …, 10 frames), an MCCH modification period (e.g., 512, 1024 frames), a signaling modulation and coding scheme (MCS), subframe allocation information indicating which subframes of the radio frame as indicated by repetition period and offset can transmit MCCH; and (3) an MCCH change notification configuration. There is one MBSFN Area Configuration message for each MBSFN area. The MBSFN Area Configuration message may indicate (1) a temporary mobile group identity (TMGI) and an optional session identifier of each MTCH identified by a logical channel identifier within the PMCH, and (2) allocated resources (i.e., radio frames and subframes) for transmitting each PMCH of the MBSFN area and the allocation period (e.g., 4, 8, ..., 256 frames) of the allocated resources for all the PMCHs in the area, and (3) an MCH scheduling period (MSP) (e.g., 8, 16, 32, ..., or 1024 radio frames) over which the MSI MAC control element is transmitted.

[0048] FIG. 7B is a diagram 790 illustrating the format of an MSI MAC control element. The MSI MAC control element may be sent once each MSP. The MSI MAC control element may be sent in the first subframe of each scheduling period of the PMCH. The MSI MAC control element can indicate the stop frame and subframe of each MTCH within the PMCH. There may be one MSI per PMCH per MBSFN area.

[0049] In wireless communications, operators may desire to collect network information to assess network quality, improve network quality, and discover network problems such as coverage holes. One method of collecting network information is to perform driving tests in which a person may drive to various areas of the network using a measurement vehicle and obtain radio measurements. The measurement vehicle may be equipped with measurement devices, test terminals, a Global Positioning System (GPS) receiver to obtain geographical location, and other equipment. With this equipment, a person could drive along a route and measure a network's characteristics.

[0050] This conventional driving test, however, presents several disadvantages. A conventional drive test demands significant time and human resources in order to obtain reliable data. The need to drive a vehicle also contributes to air pollution. Furthermore, because routes are typically limited to roads and motorways, a conventional driving test cannot measure network quality information indoors, such as within houses and building complexes, or in areas inaccessible to vehicles. As a result, a need exists to obtain network quality information while minimizing driving tests.

[0051] FIG. 8 is a first diagram 800 for illustrating exemplary methods in relation to MBSFN measurements for MDT. The eNBs 804, 806 may transmit the MBSFN signals 810, such as MTCH data, within their MBSFN areas. For example, the eNBs 804, 806 may transmit the MBSFN signals 810 to the UE 802. Although FIG. 8 depicts two eNBs transmitting the MBSFN signals 810 to the UE 802, more than two eNBs may transmit the MBSFN signals 810 to one or more UEs within an MBSFN area. As shown in FIG. 8, the eNB 804 may transmit an MBSFN MDT measurement configuration 812, which is used by UEs to perform MBSFN MDT measurements. The MBSFN MDT measurement configuration 812 may include MBSFN MDT measurement parameters for performing the MBSFN MDT measurements.

[0052] The eNB 804 may transmit the MBSFN MDT measurement configuration 812 via RRC signaling (unicast) and/or broadcast messages to one or more UEs. The eNB 804 may transmit the MBSFN MDT measurement configuration 812 via a dedicated control channel, such as via dedicated RRC signaling (unicast), while the UE 802, for example, is in an RRC connected mode/state. The eNB 804 may transmit the MBSFN MDT measurement configuration 812 in a Logged Measurement Configuration message or a new RRC message. The UE 802 may indicate to the eNB 804 whether the UE 802 is capable of performing MBSFN MDT measurements. The UE 802 may indicate whether the UE 802 is capable of performing the MBSFN MDT measurements in a UE radio capability bit (e.g., inside *UE-BasedNetwPerfMeasParameters* information element (IE)). The eNB 804 may transmit the MBSFN MDT measurement configuration 812 to the UE 802 via RRC signaling only when the UE 802 indicates that the UE 802 is capable of performing the MBSFN MDT measurement configuration 812.

[0053] Alternatively, the eNB 804 may transmit the MBSFN MDT measurement configuration 812 via a broadcast transmission. For example, the MBSFN MDT measurement configuration 812 may be transmitted on the MCCH to the UE 802 and other idle and/or connected UEs within the MBSFN area. For another example, the MBSFN MDT measurement configuration 812 may be transmitted in system information that is broadcast. The system information may be in a SIB X, where X is 13, 15, or greater than or equal to 17.

[0054] If the UE 802 supports MBSFN MDT measurements, the UE 802 may perform the MBSFN MDT measurements after receiving the MBSFN MDT measurement configuration 812 from the eNB 804. The UE 802 may perform MBSFN MDT measurements based on the received MBSFN MDT measurement configuration 812.

To perform the MBSFN MDT measurements, the UE 802 may determine an MBSFN reference signal received power (RSRP), an MBSFN reference signal received quality (RSRQ), or an MCH block error rate (BLER) of the received MBSFN signals 810. For example, the UE 802 may determine an MBSFN RSRP/RSRQ of reference signals within the MTCHs of MBSFN signals 810. For another example, the UE 802 may determine an MCH BLER of the MTCHs of the MBSFN signals 810. These measurements may be performed for all MTCHs or a subset of MTCHs that the UE is capable of receiving. These measurements may be made within a subframe and on carriers on which the UE 802 is decoding PMCH.

[0055] A wireless network may only need a subset of UEs, or even only one UE, to perform MBSFN MDT measurements. In one scenario, the MBSFN MDT measurement configuration 812 may include a mask. In such a scenario, the UE 802 may determine whether to perform the MBSFN MDT measurements based on the mask. For example, the eNB 804 may send an International Mobile Subscriber Identity (IMSI), Globally Unique Temporary ID (GUTI), SAE-Temporary Mobile Subscriber Identity (S-TMSI), and/or International Mobile Equipment Identity (IMEI) mask in the MBSFN MDT measurement configuration 812. The UE 802 may combine the received mask with an identifier (e.g., IMSI, GUTI, S-TMSI, IMEI, etc.) to determine whether to perform the MBSFN MDT measurements. For example, the MBSFN MDT measurement configuration 812 may contain an IMSI mask such that when, for the UE 802, the result of an and operation between the IMSI and IMSI mask is not equal to zero, the UE 802 performs the MBSFN measurement. In another example, the MBSFN MDT measurement configuration 812 may contain a mask restriction such that only UEs associated with particular IMEIs perform the MBSFN MDT measurements. In another scenario, the MBSFN MDT measurement configuration 812 may include a threshold. In such a scenario, the UE 802 may generate a random number and compare the random number to the threshold. Based on the comparison, the UE 802 may determine whether to perform the MBSFN MDT measurements. For example, the eNB 804 may provide a threshold of 80, and the UE 802 may generate a random number between 0 and 99. If the generated random number is less than the threshold, the UE 802 may perform the MBSFN MDT measurements. Otherwise, if the generated random number is greater than the threshold, the UE 802 may not perform the MBSFN MDT measurements.

[0056] The MBSFN MDT measurements may also be restricted based on a subset of TMGIs, PMCHs, and/or MBSFN areas. In such a configuration, the eNB 804 may provide the subset of the TMGIs, PMCHs, and/or MBSFN areas to the UE 802. The UE 802 may determine whether the UE 802 is receiving MBSFN signals 810 associated with the subset of the TMGIs, PMCHs, and/or MBSFN areas, and may determine to perform the MBSFN MDT measurements only when the UE 802 is receiving MBSFN signals 810 associated with the subset of the TMGIs, PMCHs, and/or MBSFN areas. For example, assume the UE 802 receives an indication that only UEs that receive an MTCH on PMCH 0 and PMCH 1 should perform the MBSFN MDT measurements. The UE 802 may determine whether the UE 802 is receiving any MTCHs on PMCH 0 or PMCH 1. If the UE 802 determines that the UE 802 is receiving any MTCHs on PMCH 0 or PMCH 1, the UE 802 may determine to perform the MBSFN MDT measurements.

[0057] As discussed *supra*, the MBSFN MDT measurement configuration 812 may include information indicating one or more MBSFN areas, one or more PMCHs, and/or one or more TMGIs. In one scenario, if the MBSFN MDT measurement configuration 812 indicates one or more MBSFN areas, the UE 802 may determine to perform the MBSFN MDT measurements when the UE 802 is receiving the MBSFN signals 810 in at least one of the one or more MBSFN areas, and the UE 802 may determine to refrain from performing the MBSFN MDT measurements when the UE 802 is not receiving the MBSFN signals 810 from any of the one or more MBSFN areas. In another scenario, if the MBSFN MDT measurement configuration 812 indicates one or more PMCHs, the UE 802 may determine to perform the MBSFN MDT measurements when the UE 802 is receiving an MTCH of any of the one or more PMCHs, and the UE 802 may refrain from performing the MBSFN MDT measurements when the UE 802 is not receiving an MTCH of any of the one or more PMCHs. In another scenario, if the MBSFN MDT measurement configuration 812 indicates one or more TMGIs, the UE 802 may determine to perform the MBSFN MDT measurements when the UE 802 is receiving an MTCH associated with any of the one or more TMGIs, and the UE 802 may determine to refrain from performing the MBSFN MDT measurements when the UE 802 is not receiving an MTCH corresponding to any one of the one or more TMGIs.

[0058] The MBSFN MDT measurement configuration 812 may include a flag indicating whether the MBSFN measurement should be performed while the UE 802 is in an RRC idle mode, an RRC connected mode, or both the RRC idle and RRC connected modes. The MBSFN MDT measurement configuration 812 may contain multiple parameters: MDT session ID, applicable RRC states (MBSFN measurement in idle mode, connected mode, or both), MDT area (MBSFN area (MBSFN Area ID(s)), MBMS SAI list, TAI list, PLMN list, geographical area), PMCH index(es), measurement timer (logging duration), measurement duration, minimum number of sample subframes to be considered valid for the UE to report a measurement, keep valid timer, and specific UE or a group of UEs. This parameter list may be modified to include any combination of these measurements and other related measurements including parameters of unicast logged MDT.

[0059] When the MBSFN MDT measurements have been performed, the UE 802 may transmit a message to the eNB 804 indicating that the MBSFN MDT measurements have been performed and that an MBSFN MDT measurement report is available. For example, the UE 802 may indicate the availability using an information element (e.g., *logMBSFNMeasAvailable*) in an RRC Connection Setup Complete message, RRC Connection Reconfiguration Complete message, UE Information Response message, or RRC Connection Reestablishment Complete message. The UE 802 may indicate measurement availability of MBSFN RSRP, MBSFN RSRQ, MCH BLER, or any combination of these measurements and other measurements. The UE 802 may also transmit a message to the eNB 804 indicating that an MBSFN MDT measurement report is available. In another scenario, the UE 802 may transmit a message to the eNB 804 indicating that the MBSFN MDT measurement report is available upon both the MBSFN MDT measurement report and a unicast logged MDT measurement report being available using an information element (e.g., *logMeasAvailable*) in the RRC Connection Setup Complete message, RRC Connection Reconfiguration Complete message, UE Information Response message, or RRC Connection Reestablishment Complete message. A logged MDT measurement report may be a measurement by the UE 802 during the idle state of the UE 802. The measurements are stored in a measurement log for reporting to the eNB 804 at a later point in time. In another scenario, the UE 802 may transmit a message to the eNB 804, or another eNB, indicating that an MDT measurement report is available upon the MBSFN MDT measurement report or a unicast logged MDT measurement report being available.

[0060] The eNB 804 may transmit to the UE 802 a request for the MBSFN MDT measurement report. This request from the eNB 804 may be received by the UE 802 in a UE Information Request message containing an information element (e.g., *logMBSFNMeasReportReq*).

[0061] When the UE 802 is in an RRC connected state, the UE 802 may transmit the MBSFN MDT measurement report to the eNB 804. The UE 802 may transmit the MBSFN MDT measurement report upon receiving a request from the eNB 804. In another scenario, the UE 802 may transmit the MBSFN MDT measurement report when the UE 802 has received SIB 13 broadcasted from the eNB 804. The MBSFN MDT measurement report may be sent to the eNB 804 in a UE Information Response message. In one scenario, the MBSFN MDT measurement report may be sent with a unicast logged MDT measurement report. In another scenario, the MBSFN MDT measurement report is sent separately from a unicast MDT measurement report. By sending the MBSFN MDT measurement report, the UE 802 verifies actual MBSFN signal reception. The reporting supports planning and reconfiguration for MBSFN areas and MBMS operation parameter selection.

[0062] An MBSFN MDT measurement report may include the following parameters: serving cell ID; and, for each MBSFN area and/or PMCH Index, one or more sequences containing a timestamp, the MBSFN area, the MBSFN MDT RSRP measurement, the MBSFN MDT RSRQ measurement, the MBSFN MDT MCH BLER, and/or location information in various combinations. This parameter list may be modified to include any combination of these parameters and other parameters.

[0063] FIG. 9 is a second diagram 900 for illustrating exemplary methods in relation to MBSFN measurements for MDT. The Operations, Administration, and Management (OAM) entity may decide whether to transmit the MBSFN MDT measurement configuration via RRC signaling (unicast) and/or via a broadcast transmission (e.g., via MCCH or system information). In one example, OAM may determine to transmit the MBSFN MDT measurement configuration via RRC signaling when the MBSFN MDT measurement configuration is UE-specific (e.g., the OAM would like different UEs to have different sets of MBSFN MDT measurement parameters), and may determine to transmit the MBSFN MDT measurement configuration via a broadcast transmission when the MBSFN MDT measurement configuration is area-based / not UE-specific (e.g., the OAM would like all UEs to have the same sets of MBSFN MDT measurement parameters).

[0064] An MBSFN MDT measurement configuration specific to a UE may be sent from the OAM to a HSS. The HSS may send the UE-specific MBSFN MDT measurement configuration to the MCE and/or MME, which sends the MBSFN MDT measurement configuration to one or more eNBs. This is known as signaling based MDT. Afterwards, the eNB transmits the UE-specific MBSFN MDT measurement configuration to one or more UEs via dedicated RRC signaling.

[0065] The OAM may send the MBSFN MDT measurement configuration to one or more MBSFN areas. The OAM may send an area-based MBSFN MDT measurement configuration to the MCE, which sends the MBSFN MDT measurement configuration to one or more eNBs. Upon receiving the area-based MBSFN MDT measurement configuration, the eNB may transmit the MBSFN MDT measurement configuration to one or more UEs via an MCCH channel for both idle and connected UEs within the MBSFN area. This is known as management based MDT.

[0066] If the UE supports MBSFN MDT measurements, the UE may perform the MBSFN MDT measurements upon receiving the MBSFN MDT measurement configuration from the eNB. The MBSFN MDT measurements may be performed based on the received MBSFN MDT measurement configuration and MBSFN signals.

[0067] When the MBSFN MDT measurements have been performed, the UE may transmit a message to the eNB via RRC signaling and indicate that an MBSFN MDT measurement report is available. The eNB may transmit to the UE a request for the MBSFN MDT report. When the UE is in an RRC connected state, the UE may transmit to the eNB the MBSFN MDT measurement report, which may also include a unicast logged MDT measurement report. Upon receiving a report from the UE, the eNB may transmit the report to the network for storage and/or analysis.

[0068] FIG. 10 is a flow chart 1000 of a method of wireless communication. The method may be performed by a UE (e.g., the UE 802). At step 1002, the UE may send, to a base station (e.g., the eNB 804), information indicating whether the UE is capable of performing MBSFN MDT measurements. For example, the UE may provide an indication to the base station informing the base station whether the UE is capable of performing the MBSFN MDT measurements. If the UE indicates that the UE is capable of performing the MBSFN MDT measurements, the MBSFN MDT measurement configuration may be received via RRC signaling (unicast). In another example, when the MBSFN MDT measurement configuration is received via RRC signaling, the UE may provide an indication to the base station informing the base station whether the UE is capable of performing the MBSFN MDT measurements. When the MBSFN MDT measurement configuration is received via a broadcast transmission (e.g., MCCH or SIB), the UE may not indicate to the base station whether the UE is capable of performing MBSFN MDT measurements.

[0069] In step 1004, the UE may receive a configuration (e.g., MBSFN MDT measurement configuration 812) for performing MBSFN MDT measurements. If the UE receives the configuration for performing MBSFN MDT measurements via RRC signaling, the UE may receive the configuration only if the UE indicated to the base station in step 1002 that the UE is capable of performing the MBSFN MDT measurements. The configuration may be received by the UE via RRC signaling or a broadcast. The broadcast may be an MCCH broadcast or a system information broadcast. For the system information broadcast, the configuration may be received in a SIB X, where X is 13, 15, or greater than or equal to 17.

[0070] In step 1006, if the UE can perform MBSFN MDT measurements, the UE determines whether to perform the MBSFN MDT measurements based on the received configuration (e.g., mask, random number, and/or received TMGI/PMCH/MBSFN area). The masks may include IMSI, GUTI, S-TMSI, IMEI, and/or others. The configuration may contain a combination of restrictions. For example, the configuration may contain a random number and an MBSFN area restriction such that only UEs within a particular MBSFN area that generate a random number below a certain threshold perform the MBSFN MDT measurement. In another example, the configuration may contain a IMSI mask such that when, for a UE, the result of an and operation between the IMSI and IMSI mask is not equal to zero, the UE performs the MBSFN measurement. In another example, the configuration may contain a mask restriction such that only UEs associated with particular IMEIs perform the MBSFN MDT measurements. In another example, the configuration may contain a TMGI restriction such that only UEs receiving one or more MTCHs corresponding to one or more TMGIs perform the measurement. In another example, the configuration may contain a PMCH restriction such that only UEs receiving an MTCH associated with a PMCH of a set of PMCHs perform the measurement. Additional combinations of configurations may be used. In one example, the UE receives a restriction when the UE receives the configuration via a broadcast transmission. In another example, the UE does not receive a restriction when the UE receives the configuration via RRC signaling.

[0071] In step 1008, after the UE has determined whether to perform the MBSFN MDT measurements, the UE may receive MBSFN signals (e.g., MBSFN signals 810). In step 1010, the UE may perform the MBSFN MDT measurements based on the received configuration by determining at least one of an MBSFN RSRP, MBSFN RSRQ, or an MCH BLER of the received MBSFN signals. For example, the UE may measure the RSRP of the received MBSFN signals. In another example, the UE may measure the RSRQ of the received MBSFN signals. In another example, the UE may determine the MCH BLER of the received MBSFN signals. In another example, the UE may measure both the RSRP and RSRQ of the received MBSFN signals. In yet another example, the UE may measure the RSRP and determine the MCH BLER of the received MBSFN signals.

[0072] In addition, MBSFN RSRP, RSRQ and MCH BLER may be determined according to various configurations. For example, the measurements may be made for a minimum number of subframes and/or on carriers where the UE is decoding PMCH. The measurements may also be made while the UE is in idle mode, connected mode, or both. These measurements may be made over a predetermined time duration or at a predetermined periodicity. Also, the measurements may remain valid for only a predetermined period of time.

[0073] In step 1012, the UE may send information to the base station indicating that the MBSFN MDT measurements have been performed and that an MBSFN MDT measurement report is available. For example, the UE may indicate the availability of a report using an information element (e.g., *logMBSFNMeasAvailable*) in a message (e.g., RRC Connection Setup Complete message, RRC Connection Reconfiguration Complete message, UE Information Response message, or RRC Connection Reestablishment Complete message). In the message, the UE may further indicate the measurement availability of MBSFN RSRP, MBSFN RSRQ, MCH BLER, or any combination of these measurements and other measurements.

[0074] Additionally, the UE may send information to the base station notifying the base station that a MBSFN MDT measurement report is available when both the MBSFN MDT measurement report and a unicast logged MDT measurement report are available. Alternatively, the UE may send information to the base station indicating that an MDT measurement report is available upon the MBSFN MDT measurement report or a unicast logged MDT measurement report being available.

[0075] In step 1014, the UE may receive from the base station a request for the MBSFN MDT measurement report. For example, this request from the base station may be received by the UE in a UE Information Request message containing an information element (e.g., *logMBSFNMeasReportReq*).

[0076] In step 1016, upon receiving the request from the base station, the UE may send to the base station the MBSFN MDT measurement report while the UE is in an RRC connected state. In one example, the UE may send the MBSFN MDT measurement report only if the UE received SIB 13 from the base station. The measurement report to the base station may be sent in a UE Information Response message. The MDT measurement report may be sent by itself or with a unicast logged MDT measurement report. The measurement report may include the following parameters: serving cell ID; and, for each MBSFN area and/or PMCH Index, one or more sequences containing a timestamp, the MBSFN area, the location information, the MBSFN RSRP measurement, the MBSFN RSRQ measurement, and/or the MBSFN MCH BLER, in various combinations.

[0077] FIG. 11 is a conceptual data flow diagram 1100 illustrating the data flow between different modules/means/components in an exemplary apparatus 1102. The apparatus may be a UE. The UE includes a receiving module 1104 that is configured to receive a configuration for performing MBSFN MDT measurements. The UE further includes an MBSFN MDT measurement module 1106 that is configured to perform the MBSFN MDT measurements based on the received configuration. The receiving module 1104 may be configured to receive MBSFN signals. The MBSFN MDT measurement module 1106 may be configured to perform the MBSFN MDT measurements by determining at least one of an MBSFN RSRP, an MBSFN RSRQ, or an MCH BLER of the received MBSFN signals. The UE may further include a transmission module 1108 that is configured to send to a base station 1150 information indicating whether the UE is capable of performing the MBSFN MDT measurements. The configuration may be received based on whether the information indicates that the UE is capable of performing the MBSFN MDT measurements. The configuration may be received via dedicated RRC signaling. The configuration may be received via an MCCH. The configuration may be received in system information via a broadcast transmission. The configuration may be received in a SIB X, where X is 13, 15, or greater than or equal to 17. The MBSFN MDT measurement module 1106 may be configured to determine whether to perform the MBSFN MDT measurements based on the received configuration. The configuration may include a mask and the MBSFN MDT measurement module 1106 may determine whether to perform the MBSFN MDT measurements based on the mask. The configuration may include a threshold and the MBSFN MDT measurement module 1106 may be configured to generate a random number, and to compare the random number to the threshold. The MBSFN MDT measurement module 1106 may be configured to determine whether to perform the MBSFN MDT measurements based on the comparison. The configuration may include information indicating at least one of one or more MBSFN areas, one or more PMCHs, or one or more TMGIs. The information may indicate one or more MBSFN areas. The MBSFN MDT measurement module 1106 may determine to perform the MBSFN MDT measurements when the UE is receiving MBSFN signals in at least one of the one or more MBSFN areas, and may determine to refrain from performing the MBSFN MDT measurements when the UE is not receiving MBSFN signals from any of the one or more MBSFN areas. The information may indicate one or more PMCHs. The MBSFN MDT measurement module 1106 may determine to perform the MBSFN MDT measurements when the UE is receiving an MTCH of any of the one or more PMCHs, and may determine to refrain from performing the MBSFN MDT measurements when the UE is not receiving an MTCH of any of the one or more PMCHs. The information may indicate one or more TMGIs. The MBSFN MDT measurement module 1106 may be configured to determine to perform the MBSFN MDT measurements when the UE is receiving an MTCH corresponding to any of the one or more TMGIs, and to determine to refrain from performing the MBSFN MDT measurements when the UE is not receiving an MTCH corresponding to any of the one or more TMGIs. The configuration may include a flag indicating whether the MBSFN MDT measurement should be performed in an idle mode, a connected mode, or both the idle and connected modes.

[0078] The transmission module 1108 may be configured to send information to a base station 1150 indicating that the MBSFN MDT measurements have been performed and that an MBSFN MDT measurement report is available. The receiving module 1104 may be configured to receive from the base station 1150 a request for the MBSFN MDT measurement report. The request may be received in a UE Information Request message. The transmission module 1108 may be configured to send to the base station 1150 the MBSFN MDT measurement report while the UE is in an RRC connected state. The MBSFN MDT measurement module 1106 may be configured to determine whether a SIB 13 was received from the base station 1150. The transmission module 1108 may be configured to send the MBSFN MDT measurement report only when the SIB 13 is received from the base station 1150. The MBSFN MDT measurement report may be sent in a UE Information Response message. The MBSFN MDT measurement report may be sent with a unicast logged MDT measurement report. The MBSFN MDT measurement report may be sent separately from a unicast MDT measurement report. The transmission module 1108 may be configured to send the information to the base station 1150 indicating that the MBSFN MDT measurement report is available upon the MBSFN MDT measurement report being available. The transmission module 1108 may be configured to send the information to the base station 1150 indicating that the MBSFN MDT measurement report is available upon both the MBSFN MDT measurement report and a unicast logged MDT measurement report being available. The transmission module 1108 may be configured to send information to the base station 1150 indicating that an MDT measurement report is available upon the MBSFN MDT measurement report or a unicast logged MDT measurement report being available.

[0079] The apparatus may include additional modules that perform each of the steps of the algorithm in the aforementioned flow charts of FIG. 10. As such, each step in the aforementioned flow chart of FIG. 10 may be performed by a module and the apparatus may include one or more of those modules. The modules may be one or more hardware components specifically configured to carry out the stated processes/algorithm, implemented by a processor configured to perform the stated processes/algorithm, stored within a computer-readable medium for implementation by a processor, or some combination thereof.

[0080] FIG. 12 is a diagram 1200 illustrating an example of a hardware implementation for an apparatus 1102' employing a processing system 1214. The processing system 1214 may be implemented with a bus architecture, represented generally by the bus 1224. The bus 1224 may include any number of interconnecting buses and bridges depending on the specific application of the processing system 1214 and the overall design constraints. The bus 1224 links together various circuits including one or more processors and/or hardware modules, represented by the processor 1204, the modules 1104, 1106, 1108, and the computer-readable medium / memory 1206. The bus 1224 may also link various other circuits such as timing sources, peripherals, voltage regulators, and power management circuits, which are well known in the art, and therefore, will not be described any further.

[0081] The processing system 1214 may be coupled to a transceiver 1210. The transceiver 1210 is coupled to one or more antennas 1220. The transceiver 1210 provides a means for communicating with various other apparatus over a transmission medium. The transceiver 1210 receives a signal from the one or more antennas 1220, extracts information from the received signal, and provides the extracted information to the processing system 1214. In addition, the transceiver 1210 receives information from the processing system 1214, and based on the received information, generates a signal to be applied to the one or more antennas 1220. The processing system 1214 includes a processor 1204 coupled to a computer-readable medium / memory 1206. The processor 1204 is responsible for general processing, including the execution of software stored on the computer-readable medium / memory 1206. The software, when executed by the processor 1204, causes the processing system 1214 to perform the various functions described *supra* for any particular apparatus. The computer-readable medium / memory 1206 may also be used for storing data that is manipulated by the processor 1204 when executing software. The processing system further includes at least one of the modules 1104, 1106, and 1108. The modules may be software modules running in the processor 1204, resident/stored in the computer readable medium / memory 1206, one or more hardware modules coupled to the processor 1204, or some combination thereof. The processing system 1214 may be a component of the UE 650 and may include the memory 660 and/or at least one of the TX processor 668, the RX processor 656, and the controller/processor 659.

[0082] In one configuration, the apparatus 1102/1102' for wireless communication includes means for receiving a configuration for performing MBSFN MDT measurements. The apparatus further includes means for performing the MBSFN MDT measurements based on the received configuration. The apparatus may include means for receiving MBSFN signals, in which the MBSFN MDT measurements include determining at least one of an MBSFN RSRP, an MBSFN RSRQ, or a MCH BLER of the received MBSFN signals. The apparatus may include means for sending to a base station information indicating whether the apparatus is capable of performing the MBSFN MDT measurements. The configuration may be received via dedicated RRC signaling or a MCCH. The configuration may also be received in system information via a broadcast transmssion. The apparatus may include means for determining whether to perform the MBSFN MDT measurements based on the received configuration. The configuration may include a mask and the apparatus determines whether to perform the MBSFN MDT measurements based on the mask. The configuration may include a threshold, and the apparatus is further configured to generate a random number and compare the random number to the threshold. The apparatus then determines whether to perform the MBSFN MDT measurements based on the comparison. The configuration may include information indicating at least one of one or more MBSFN areas, one or more PMCHs, or one or more TMGIs. The configuration may include a flag indicating whether the MBSFN MDT measurement should be performed in an idle mode, a connected mode, or both the idle and connected modes. The apparatus may include means for sending information to a base station indicating that the MBSFN MDT measurements have been performed and that an MBSFN MDT measurement report is available. The apparatus may include means for receiving from the base station a request for the MBSFN MDT measurement report. The apparatus may include means for sending to the base station the MBSFN MDT measurement report while the apparatus is in a RRC connected state. The apparatus may include means for determining whether a SIB 13 was received from the base station, wherein the apparatus sends the MBSFN MDT measurement report only when the SIB 13 is received from the base station. The apparatus may send information to the base station indicating that an MDT measurement report is available upon the MBSFN MDT measurement report or a unicast logged MDT measurement report being available.

[0083] The aforementioned means may be one or more of the aforementioned modules of the apparatus 1102 and/or the processing system 1214 of the apparatus 1102' configured to perform the functions recited by the aforementioned means. As described *supra*, the processing system 1214 may include the TX Processor 668, the RX Processor 656, and the controller/processor 659. As such, in one configuration, the aforementioned means may be the TX Processor 668, the RX Processor 656, and the controller/processor 659 configured to perform the functions recited by the aforementioned means.

[0084] It is understood that the specific order or hierarchy of steps in the processes / flow charts disclosed is an illustration of exemplary approaches. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes / flow charts may be rearranged. Further, some steps may be combined or omitted. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

[0085] The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean “one and only one” unless specifically so stated, but rather “one or more.” The word “exemplary” is used herein to mean “serving as an example, instance, or illustration.” Any aspect described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other aspects." Unless specifically stated otherwise, the term "some" refers to one or more. Combinations such as "at least one of A, B, or C," "at least one of A, B, and C," and "A, B, C, or any combination thereof" include any combination of A, B, and/or C, and may include multiples of A, multiples of B, or multiples of C. Specifically, combinations such as "at least one of A, B, or C," "at least one of A, B, and C," and "A, B, C, or any combination thereof" may be A only, B only, C only, A and B, A and C, B and C, or A and B and C, where any such combinations may contain one or more member or members of A, B, or C. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed as a means plus function unless the element is expressly recited using the phrase "means for."

WHAT IS CLAIMED IS:
CLAIMS

1. A method of wireless communication of a user equipment (UE), comprising:
receiving a configuration for performing Multicast Broadcast Single Frequency Network (MBSFN) minimizing driving test (MDT) measurements; and
performing the MBSFN MDT measurements based on the received configuration.

2. The method of claim 1, further comprising receiving MBSFN signals, wherein the MBSFN MDT measurements comprise determining at least one of an MBSFN reference signal received power (RSRP), an MBSFN reference signal received quality (RSRQ), or a multicast channel (MCH) block error rate (BLER) of the received MBSFN signals.

3. The method of claim 1, further comprising sending to a base station information indicating whether the UE is capable of performing the MBSFN MDT measurements.

4. The method of claim 3, wherein the configuration is received based on whether the information indicates that the UE is capable of performing the MBSFN MDT measurements.

5. The method of claim 1, wherein the configuration is received through dedicated radio resource control (RRC) signaling.

6. The method of claim 1, wherein the configuration is received through a multicast control channel (MCCH).

7. The method of claim 1, wherein the configuration is received in system information through a broadcast.

8. The method of claim 7, wherein the configuration is received in a system information block (SIB) X, where X is 13, 15, or greater than or equal to 17.

9. The method of claim 1, further comprising determining whether to perform the MBSFN MDT measurements based on the received configuration.

10. The method of claim 9, wherein the configuration includes a mask and the UE determines whether to perform the MBSFN MDT measurements based on the mask.

11. The method of claim 9, wherein the configuration includes a threshold and the method further comprises:

generating a random number; and

comparing the random number to the threshold,

wherein the UE determines whether to perform the MBSFN MDT measurements based on the comparison.

12. The method of claim 9, wherein the configuration includes information indicating at least one of: one or more MBSFN areas, one or more physical multicast channels (PMCHs), or one or more temporary mobile group identities (TMGIs).

13. The method of claim 12, wherein the information indicates one or more MBSFN areas, wherein the UE determines to perform the MBSFN MDT measurements when the UE is receiving MBSFN signals in at least one of the one or more MBSFN areas, and determines to refrain from performing the MBSFN MDT measurements when the UE is not receiving MBSFN signals from any of the one or more MBSFN areas.

14. The method of claim 12, wherein the information indicates one or more PMCHs, wherein the UE determines to perform the MBSFN MDT measurements when the UE is receiving a multicast traffic channel (MTCH) of any of the one or more PMCHs, and determines to refrain from performing the MBSFN MDT measurements when the UE is not receiving an MTCH of any of the one or more PMCHs.

15. The method of claim 12, wherein the information indicates one or more TMGIs, wherein the UE determines to perform the MBSFN MDT measurements when the UE is receiving a multicast traffic channel (MTCH) corresponding to any of the one or more TMGIs, and determines to refrain from performing the MBSFN MDT measurements

when the UE is not receiving an MTCH corresponding to any of the one or more TMGIs.

16. The method of claim 9, wherein the configuration includes a flag indicating whether the MBSFN MDT measurement should be performed in an idle mode, a connected mode, or both the idle and connected modes.

17. The method of claim 1, further comprising sending information to a base station indicating that the MBSFN MDT measurements have been performed and that an MBSFN MDT measurement report is available.

18. The method of claim 17, further comprising receiving from the base station a request for the MBSFN MDT measurement report.

19. The method of claim 18, wherein the request is received in a UE Information Request message.

20. The method of claim 18, further comprising sending to the base station the MBSFN MDT measurement report while the UE is in a radio resource control (RRC) connected state.

21. The method of claim 20, further comprising determining whether a system information block (SIB) 13 was received from the base station, wherein the UE sends the MBSFN MDT measurement report only when the SIB 13 is received from the base station.

22. The method of claim 20, wherein the MBSFN MDT measurement report is sent in a UE Information Response message.

23. The method of claim 20, wherein the MBSFN MDT measurement report is sent with a unicast logged MDT measurement report.

24. The method of claim 20, wherein the MBSFN MDT measurement report is sent separately from a unicast MDT measurement report.

25. The method of claim 17, wherein the UE sends the information to the base station indicating that the MBSFN MDT measurement report is available upon the MBSFN MDT measurement report being available.

26. The method of claim 17, wherein the UE sends the information to the base station indicating that the MBSFN MDT measurement report is available upon both the MBSFN MDT measurement report and a unicast logged MDT measurement report being available.

27. The method of claim 17, wherein the UE sends information to the base station indicating that an MDT measurement report is available upon the MBSFN MDT measurement report or a unicast logged MDT measurement report being available.

28. An apparatus for wireless communication, the apparatus being a user equipment (UE), comprising:

means for receiving a configuration for performing Multicast Broadcast Single Frequency Network (MBSFN) minimizing driving test (MDT) measurements; and

means for performing the MBSFN MDT measurements based on the received configuration.

29. The apparatus of claim 28, further comprising means for receiving MBSFN signals, wherein the MBSFN MDT measurements comprise determining at least one of an MBSFN reference signal received power (RSRP), an MBSFN reference signal received quality (RSRQ), or a multicast channel (MCH) block error rate (BLER) of the received MBSFN signals.

30. The apparatus of claim 28, further comprising means for sending to a base station information indicating whether the UE is capable of performing the MBSFN MDT measurements.

31. The apparatus of claim 28, wherein the configuration is received through dedicated radio resource control (RRC) signaling.

32. The apparatus of claim 28, wherein the configuration is received through a multicast control channel (MCCH).

33. The apparatus of claim 28, wherein the configuration is received in system information through a broadcast.

34. The apparatus of claim 28, further comprising means for determining whether to perform the MBSFN MDT measurements based on the received configuration.

35. The apparatus of claim 34, wherein the configuration includes a mask and the UE determines whether to perform the MBSFN MDT measurements based on the mask.

36. The apparatus of claim 34, wherein the configuration includes a threshold and the apparatus further comprises:

means for generating a random number; and

means for comparing the random number to the threshold,

wherein the UE determines whether to perform the MBSFN MDT measurements based on the comparison.

37. The apparatus of claim 34, wherein the configuration includes information indicating at least one of: one or more MBSFN areas, one or more physical multicast channels (PMCHs), or one or more temporary mobile group identities (TMGIs).

38. The apparatus of claim 34, wherein the configuration includes a flag indicating whether the MBSFN MDT measurement should be performed in an idle mode, a connected mode, or both the idle and connected modes.

39. The apparatus of claim 28, further comprising means for sending information to a base station indicating that the MBSFN MDT measurements have been performed and that an MBSFN MDT measurement report is available.

40. The apparatus of claim 39, further comprising means for receiving from the base station a request for the MBSFN MDT measurement report.

41. The apparatus of claim 40, further comprising means for sending to the base station the MBSFN MDT measurement report while the UE is in a radio resource control (RRC) connected state.

42. The apparatus of claim 41, further comprising means for determining whether a system information block (SIB) 13 was received from the base station, wherein the UE sends the MBSFN MDT measurement report only when the SIB 13 is received from the base station.

43. The apparatus of claim 28, wherein the UE sends information to the base station indicating that an MDT measurement report is available upon the MBSFN MDT measurement report or a unicast logged MDT measurement report being available.

44. An apparatus for wireless communication, the apparatus being a user equipment (UE), comprising:

a memory; and

at least one processor coupled to the memory and configured to:

receive a configuration for performing Multicast Broadcast Single Frequency Network (MBSFN) minimizing driving test (MDT) measurements; and

perform the MBSFN MDT measurements based on the received configuration.

45. A computer program product of a user equipment (UE), comprising:

a computer-readable medium comprising code for:

receiving a configuration for performing Multicast Broadcast Single Frequency Network (MBSFN) minimizing driving test (MDT) measurements; and

performing the MBSFN MDT measurements based on the received configuration.

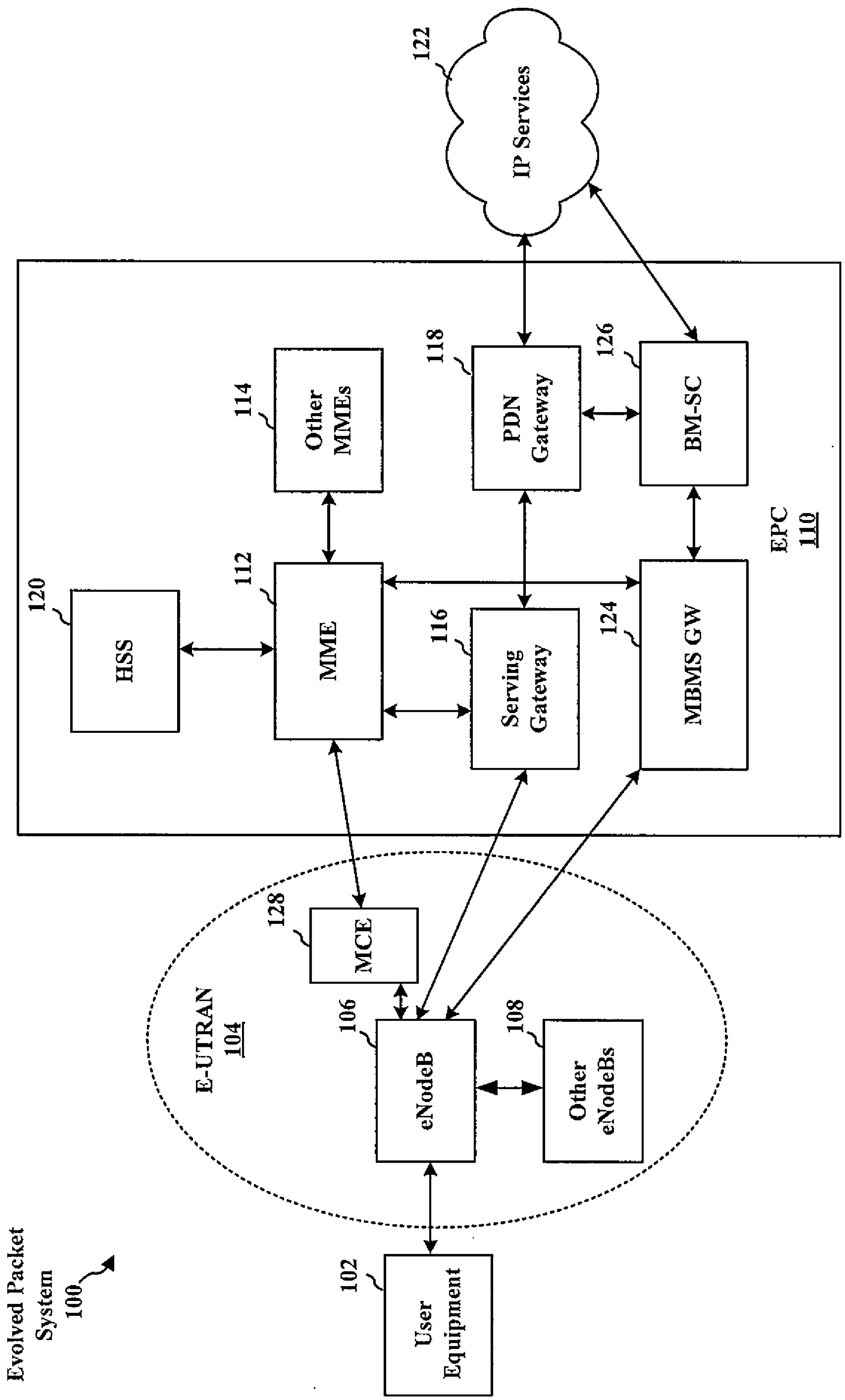

Evolved Packet System
100
User Equipment
102
E-UTRAN
104
eNodeB
106
Other eNodeBs
108
MCE
128
EPC
110
MME
112
Other MMEs
114
Serving Gateway
116
PDN Gateway
118
HSS
120
IP Services
122
MBMS GW
124
BM-SC
126

FIG. 1

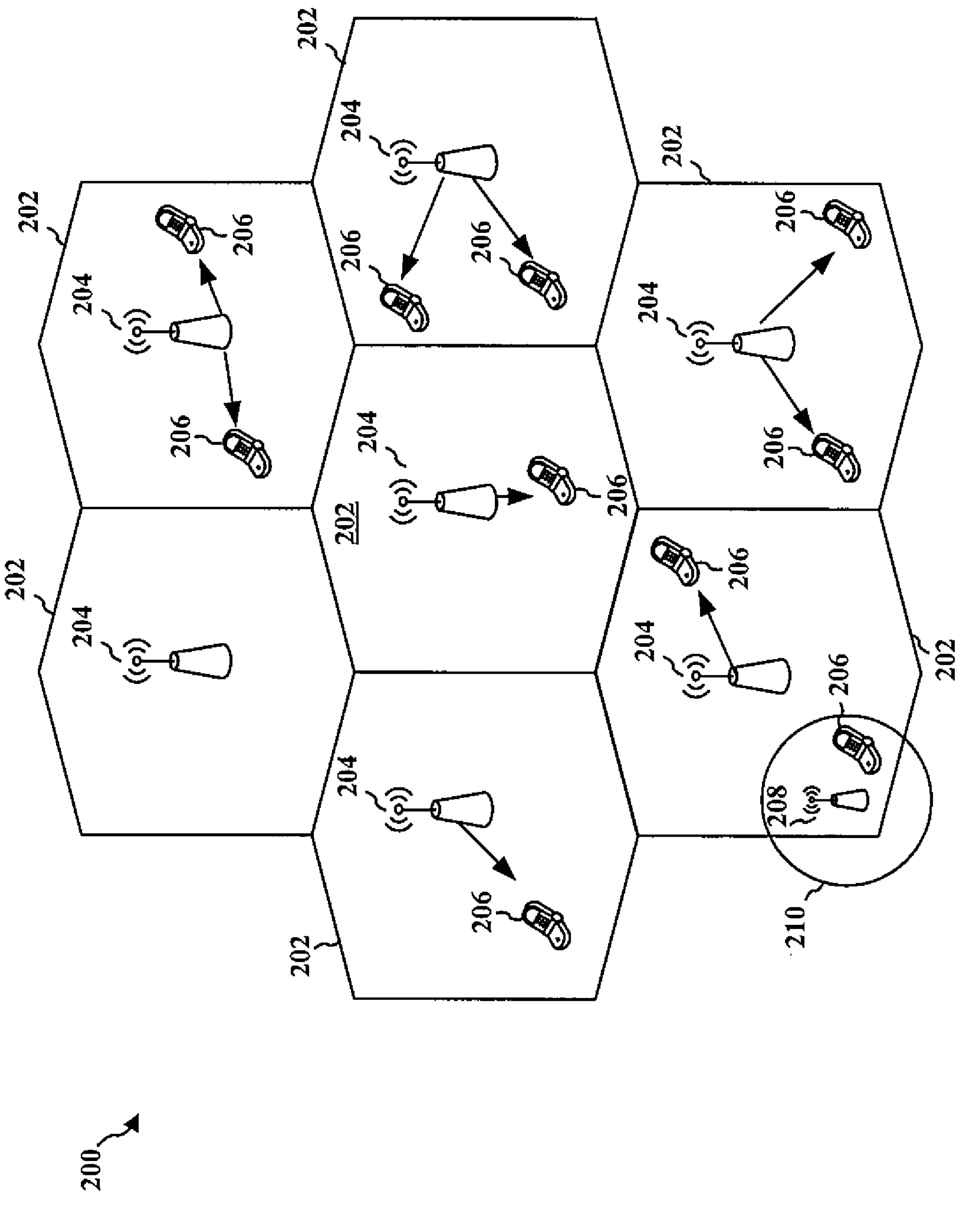


FIG. 2

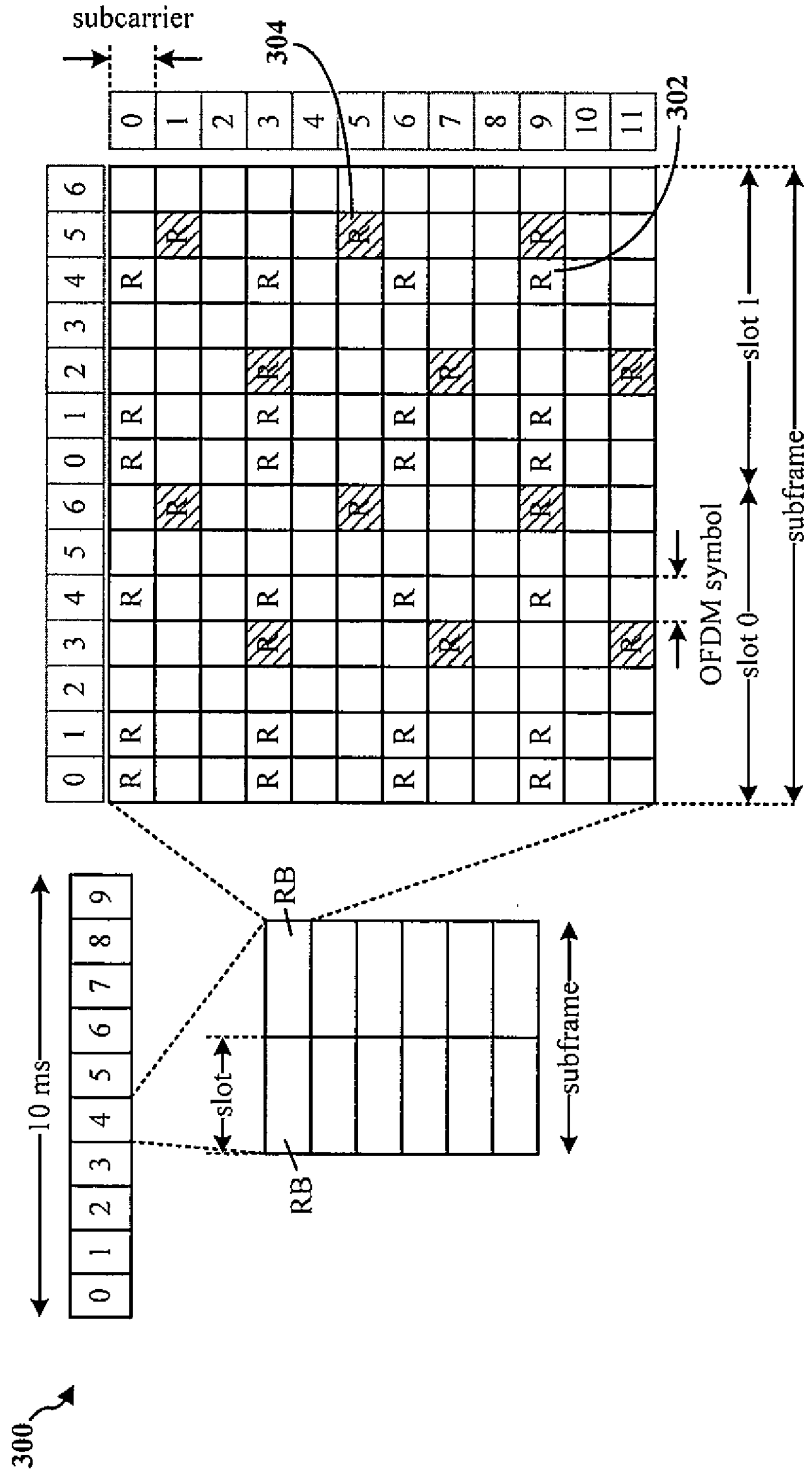

300
10 ms
0 1 2 3 4 5 6 7 8 9
RB
RB
slot
subframe
subcarrier
304
302
0 1 2 3 4 5 6 7 8 9 10 11
0 1 2 3 4 5 6 0 1 2 3 4 5 6
R
OFDM symbol
slot 0
slot 1
subframe

FIG. 3

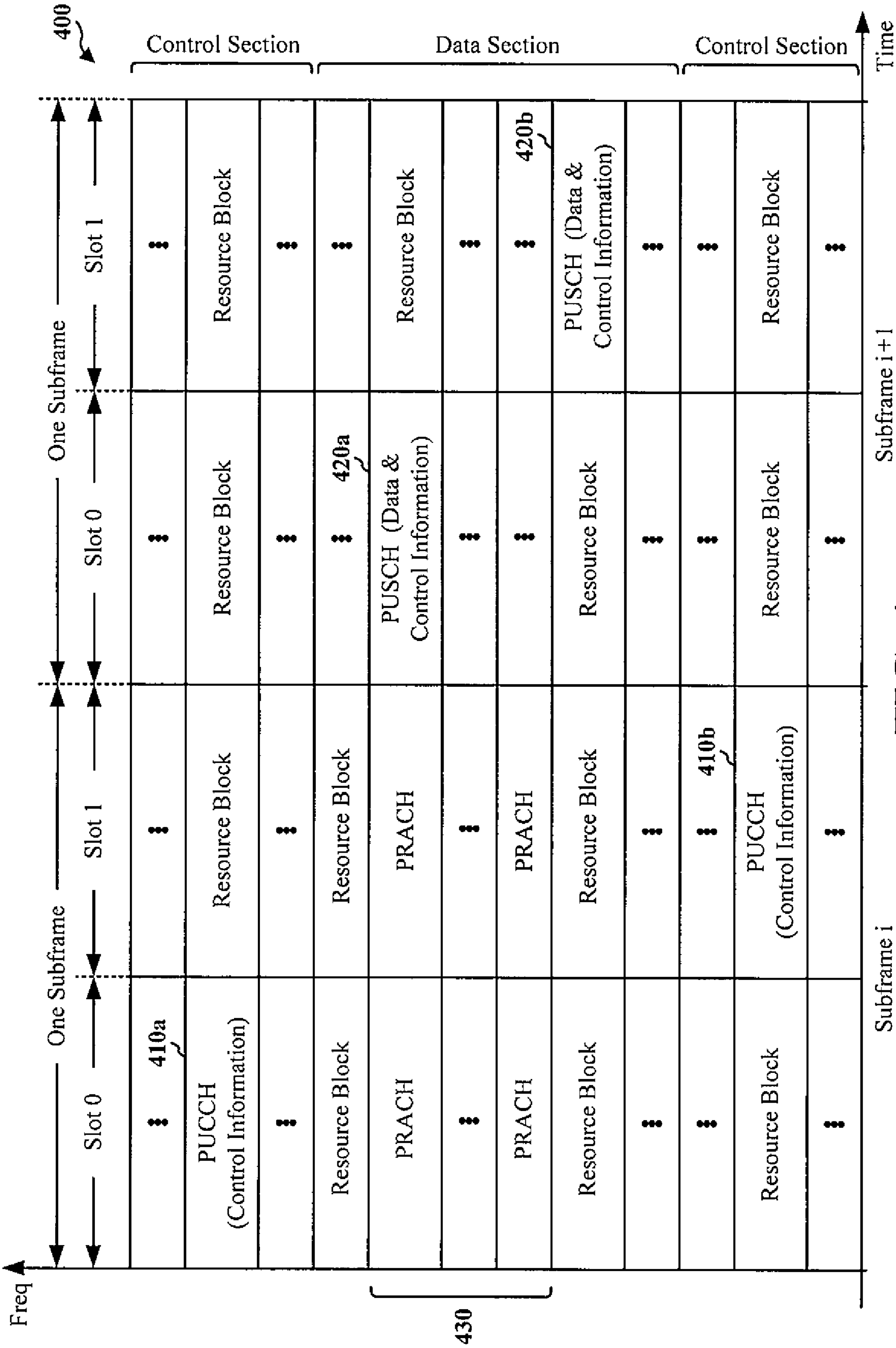
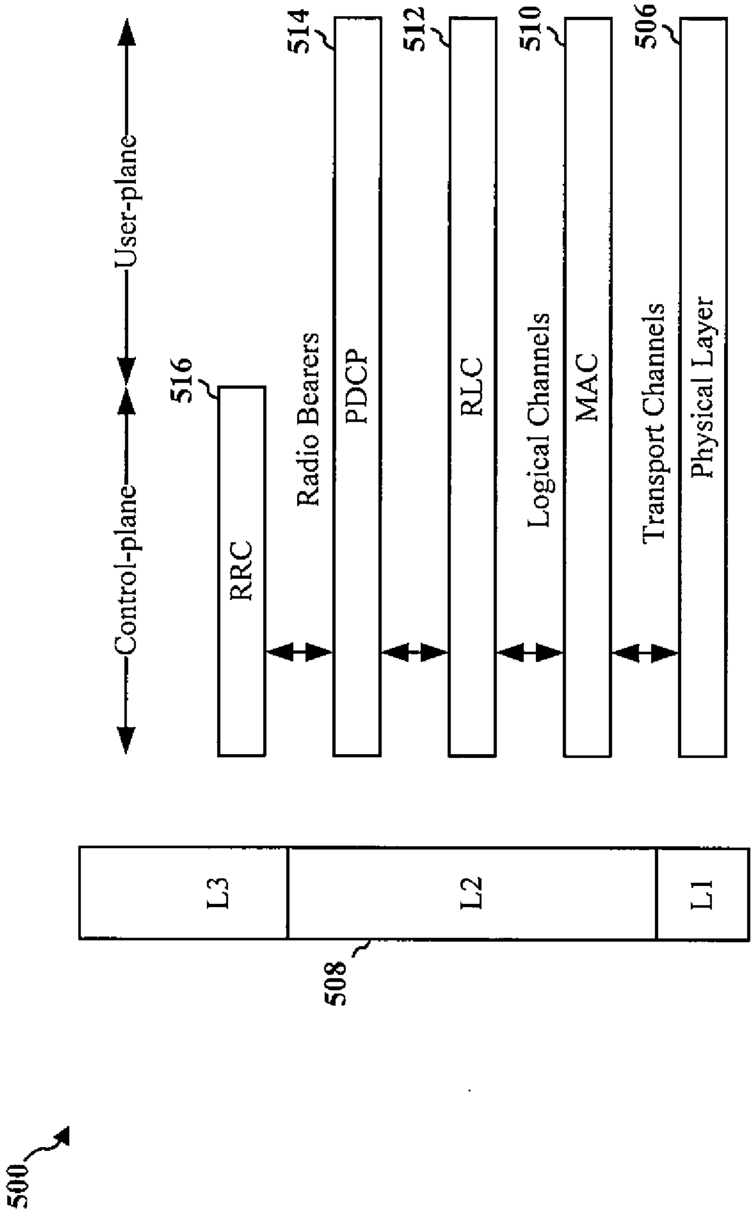

400
Control Section
Data Section
Control Section
Time
Freq
One Subframe
One Subframe
Slot 0
Slot 1
Slot 0
Slot 1
410a
PUCCH (Control Information)
410b
PUCCH (Control Information)
420a
PUSCH (Data & Control Information)
420b
PUSCH (Data & Control Information)
Resource Block
PRACH
430
Subframe i
Subframe i+1

FIG. 4



Control-plane
User-plane
516
RRC
Radio Bearers
514
PDCP
512
RLC
Logical Channels
510
MAC
Transport Channels
506
Physical Layer
L3
L2
L1
508
500

FIG. 5

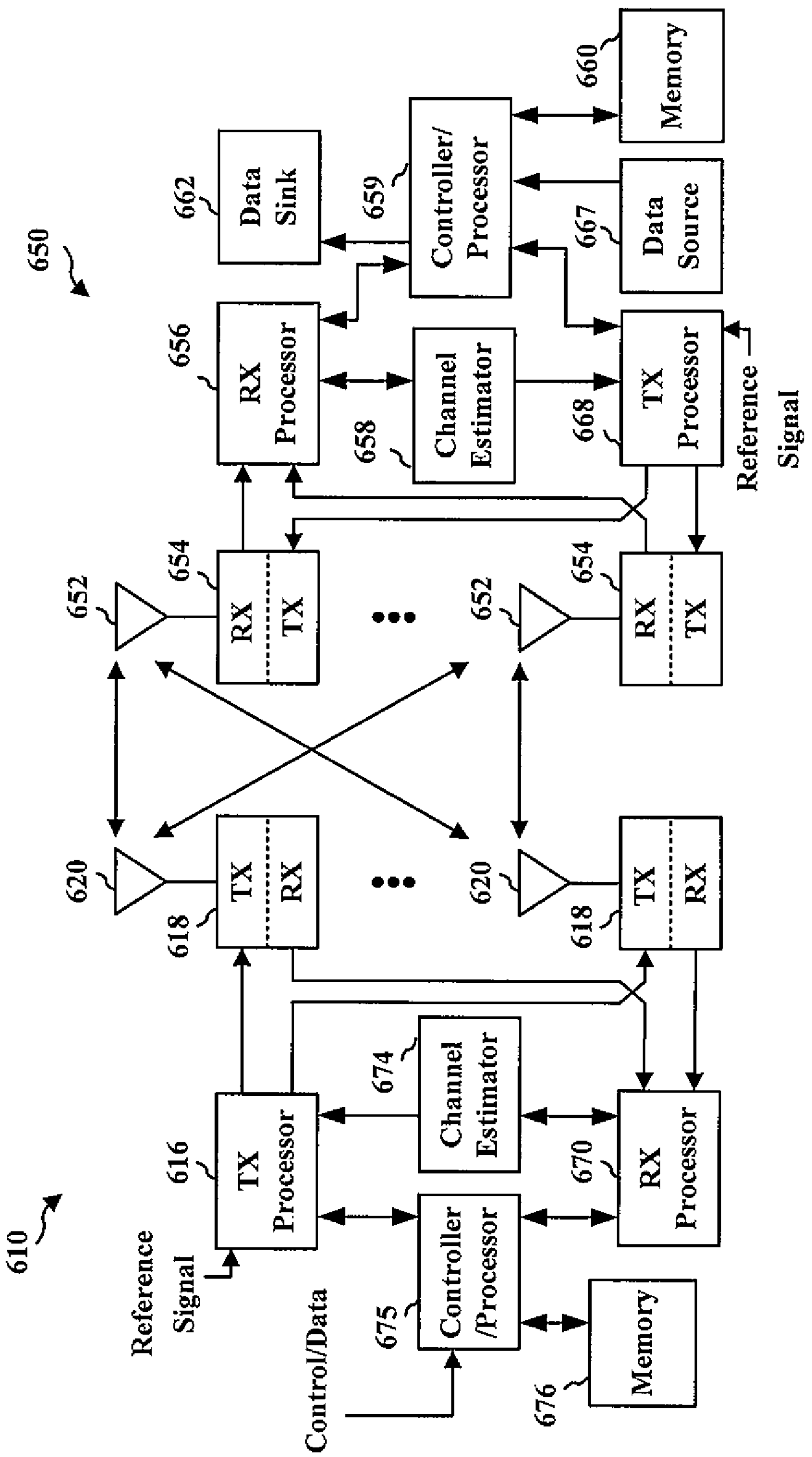

650
610
Reference Signal
TX Processor
616
Control/Data
Controller /Processor
675
Memory
676
Channel Estimator
674
RX Processor
670
TX
RX
618
620
652
RX
TX
654
RX Processor
656
Channel Estimator
658
TX Processor
668
Reference Signal
Data Sink
662
Controller/ Processor
659
Data Source
667
Memory
660

FIG. 6

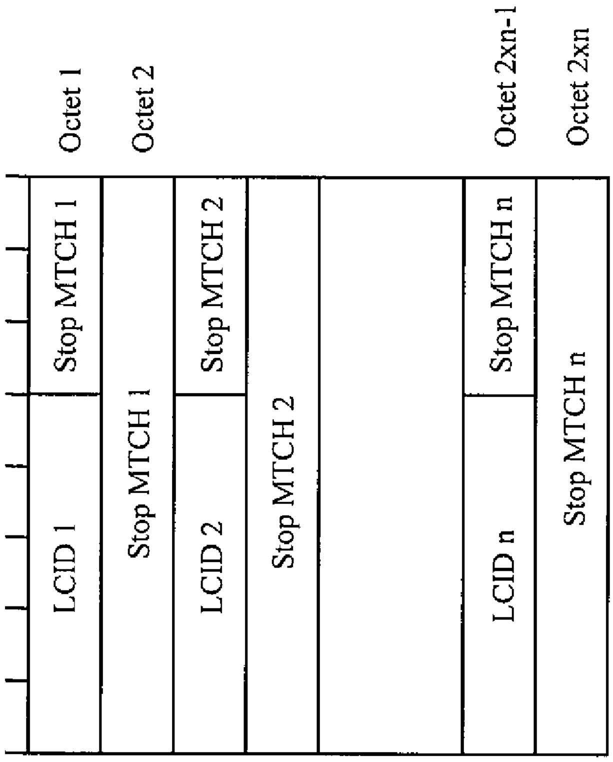

Octet 1
Octet 2
Octet 2xn-1
Octet 2xn
LCID 1
Stop MTCH 1
Stop MTCH 1
LCID 2
Stop MTCH 2
Stop MTCH 2
LCID n
Stop MTCH n
Stop MTCH n

FIG. 7B

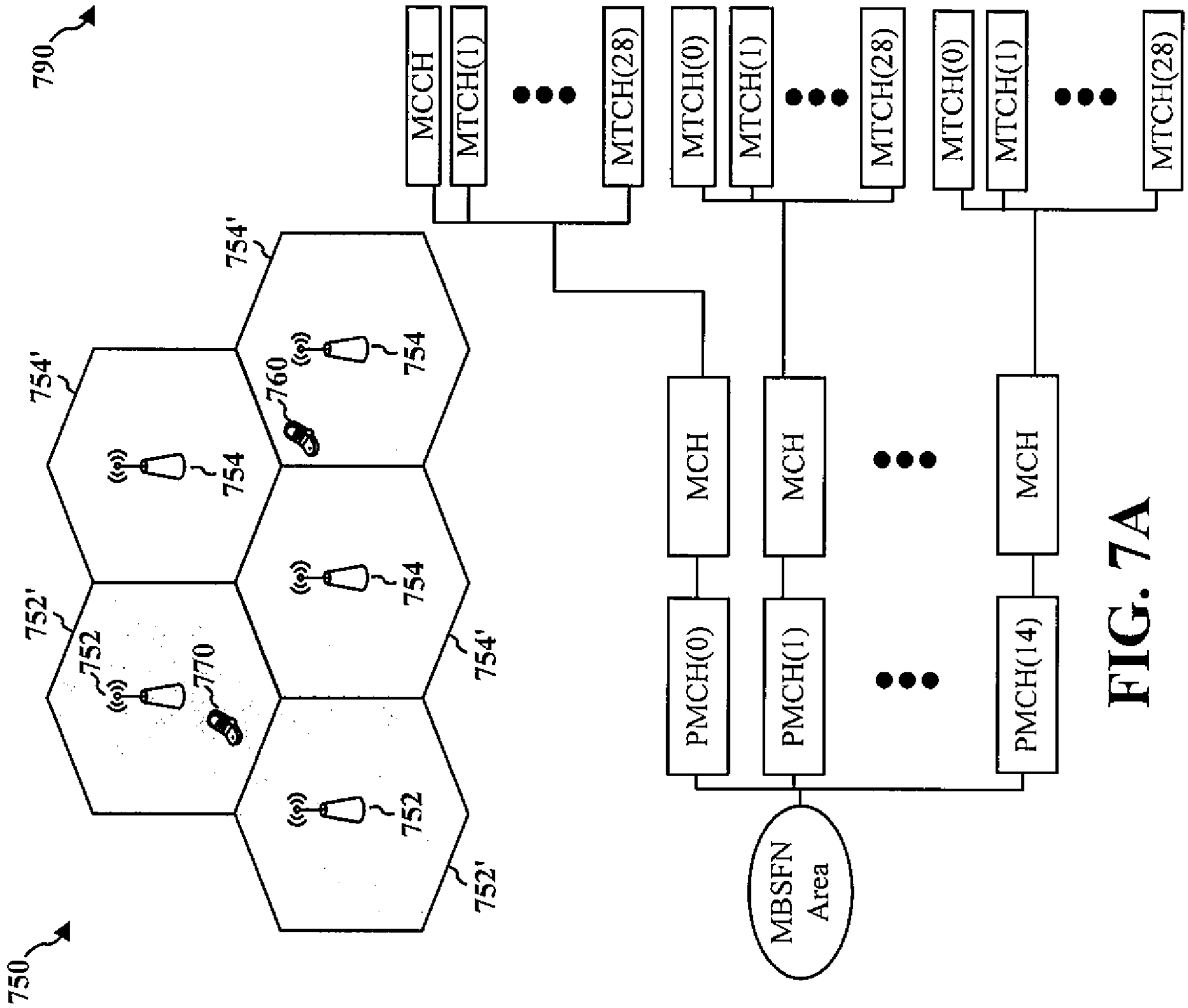

790
750
752
752'
754
754'
760
770
MBSFN Area
PMCH(0)
PMCH(1)
PMCH(14)
MCH
MCH
MCH
MCCH
MTCH(1)
MTCH(28)
MTCH(0)
MTCH(1)
MTCH(28)
MTCH(0)
MTCH(1)
MTCH(28)

FIG. 7A

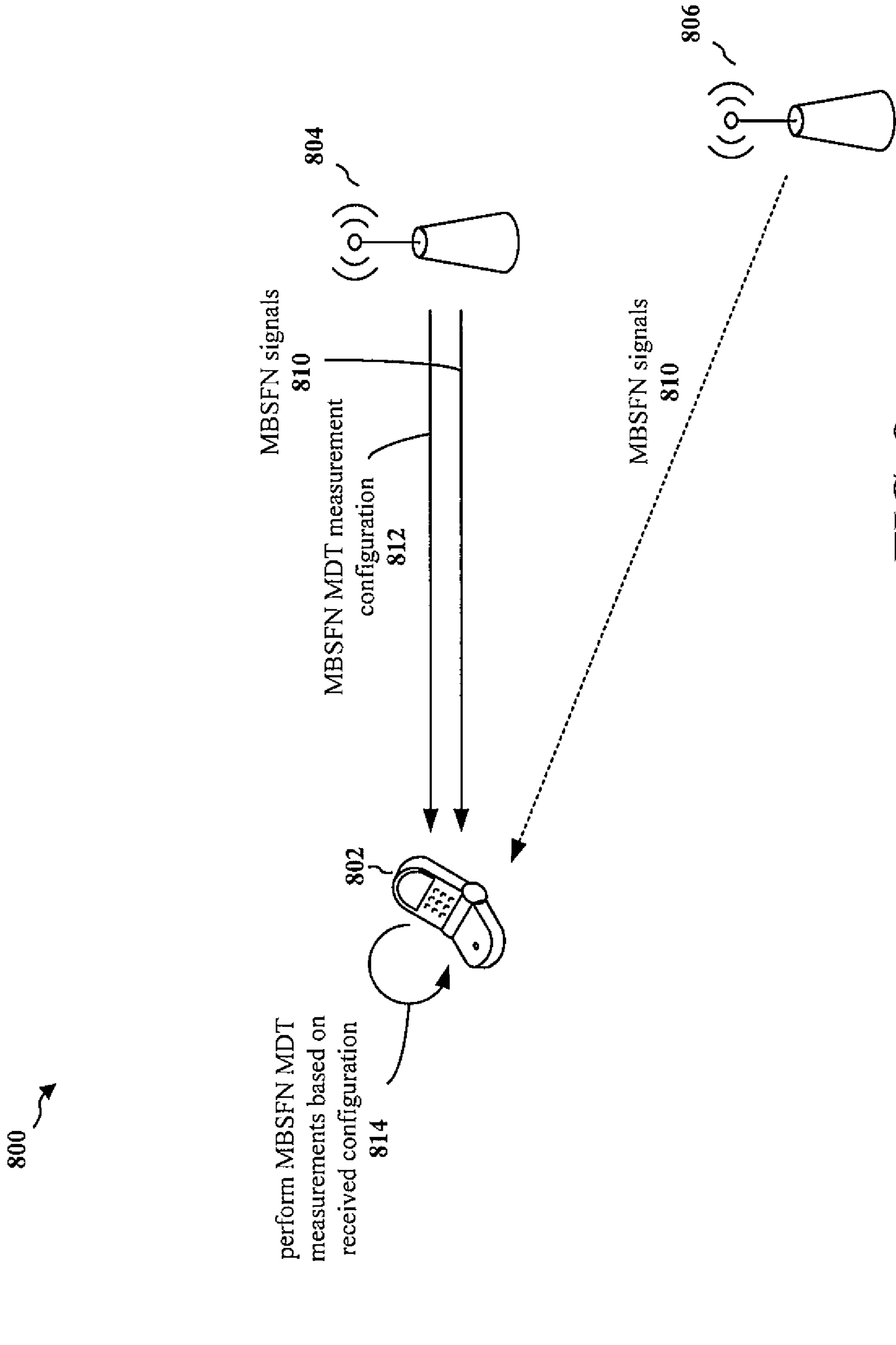

800
806
804
MBSFN signals
810
MBSFN MDT measurement
configuration
812
MBSFN signals
810
802
perform MBSFN MDT
measurements based on
received configuration
814

FIG. 8

900

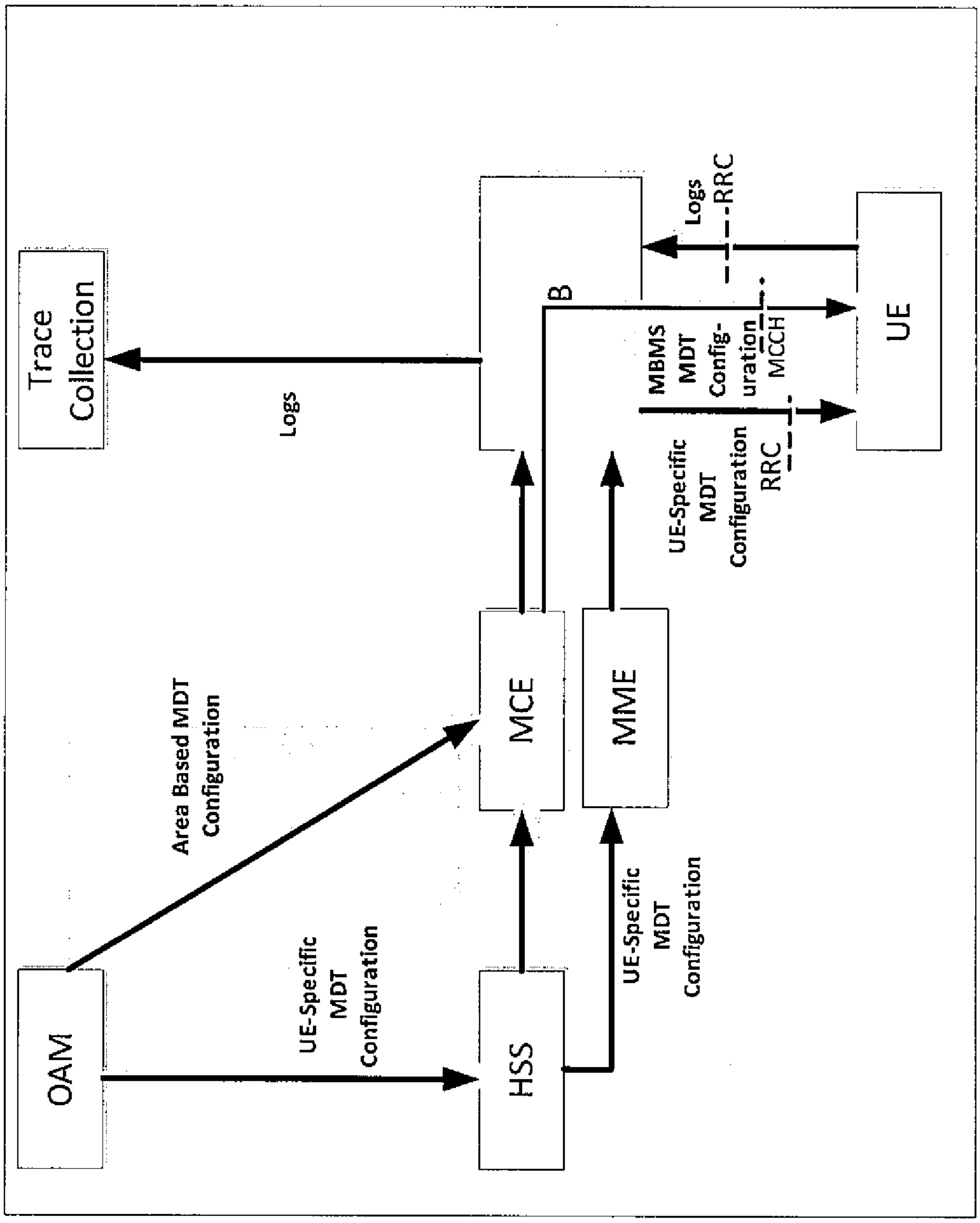

Trace Collection
Logs
OAM
UE-Specific MDT Configuration
HSS
Area Based MDT Configuration
MCE
MME
UE-Specific MDT Configuration
B
MBMS MDT Config-uration
MCCH
UE-Specific MDT Configuration
RRC
Logs
RRC
UE

FIG. 9

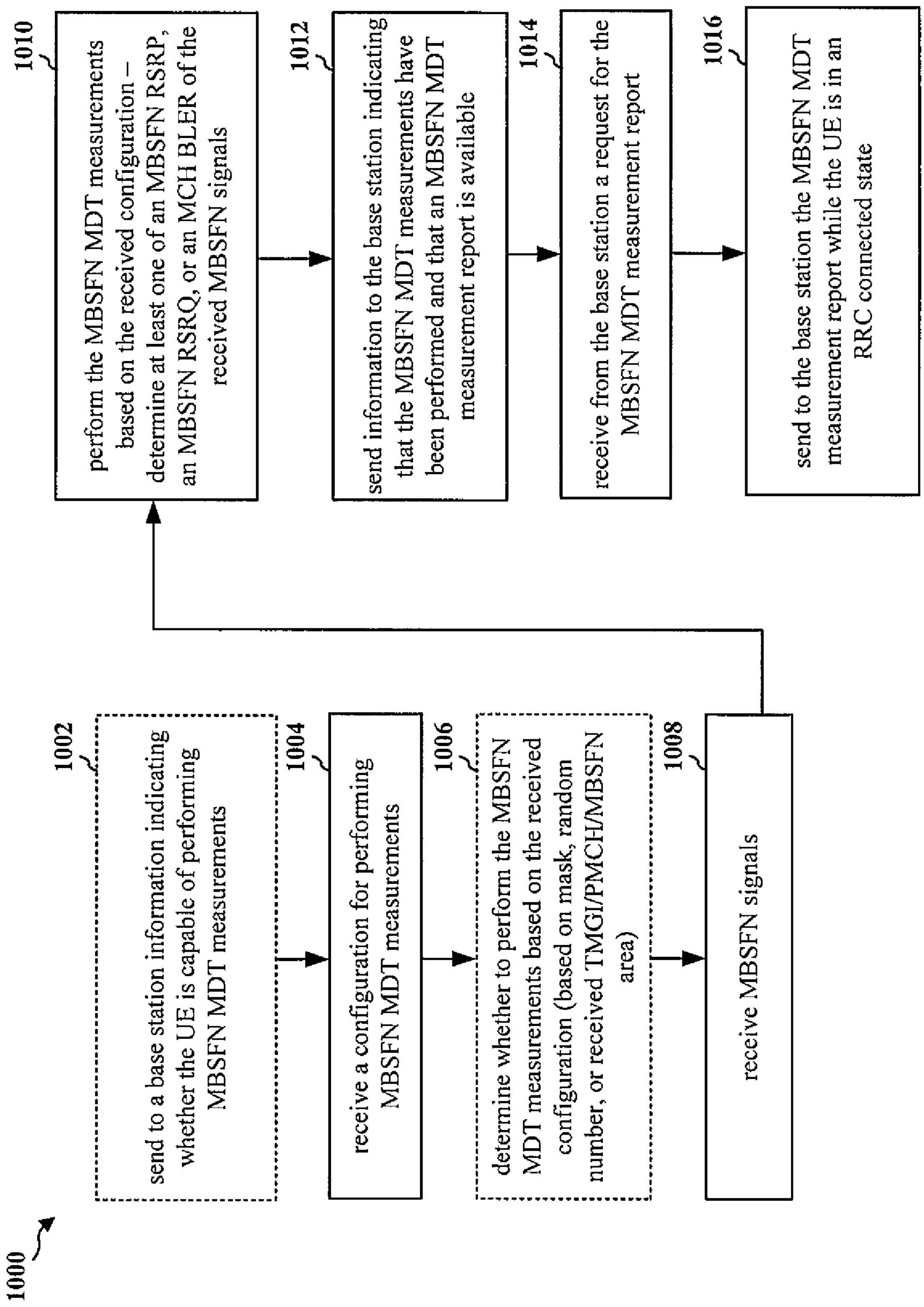

1000
1002
send to a base station information indicating whether the UE is capable of performing MBSFN MDT measurements
1004
receive a configuration for performing MBSFN MDT measurements
1006
determine whether to perform the MBSFN MDT measurements based on the received configuration (based on mask, random number, or received TMGI/PMCH/MBSFN area)
1008
receive MBSFN signals
1010
perform the MBSFN MDT measurements based on the received configuration – determine at least one of an MBSFN RSRP, an MBSFN RSRQ, or an MCH BLER of the received MBSFN signals
1012
send information to the base station indicating that the MBSFN MDT measurements have been performed and that an MBSFN MDT measurement report is available
1014
receive from the base station a request for the MBSFN MDT measurement report
1016
send to the base station the MBSFN MDT measurement report while the UE is in an RRC connected state

FIG. 10

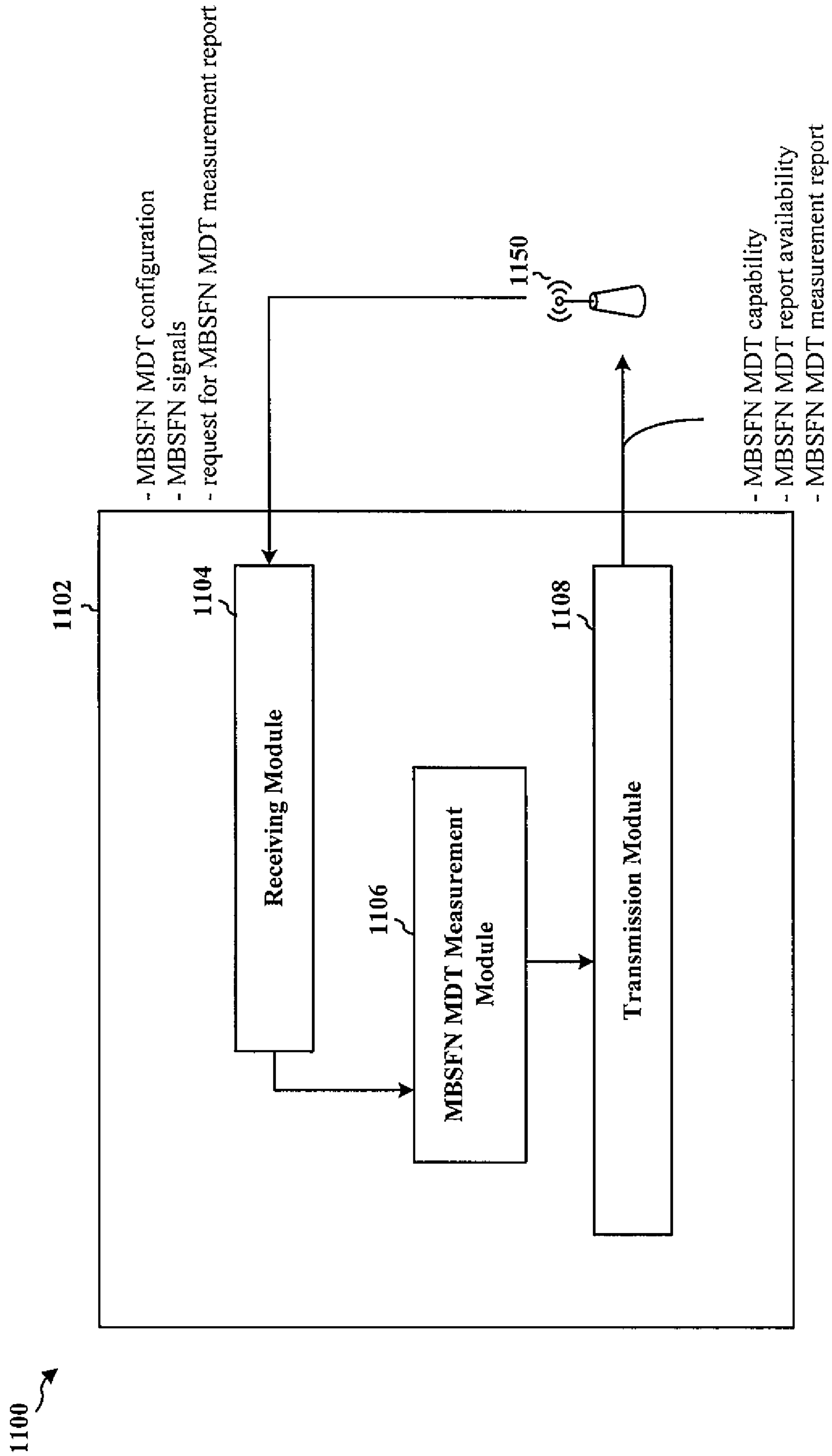

- MBSFN MDT configuration
- MBSFN signals
- request for MBSFN MDT measurement report
1150
- MBSFN MDT capability
- MBSFN MDT report availability
- MBSFN MDT measurement report
1102
1104
Receiving Module
1106
MBSFN MDT Measurement Module
1108
Transmission Module
1100

FIG. 11

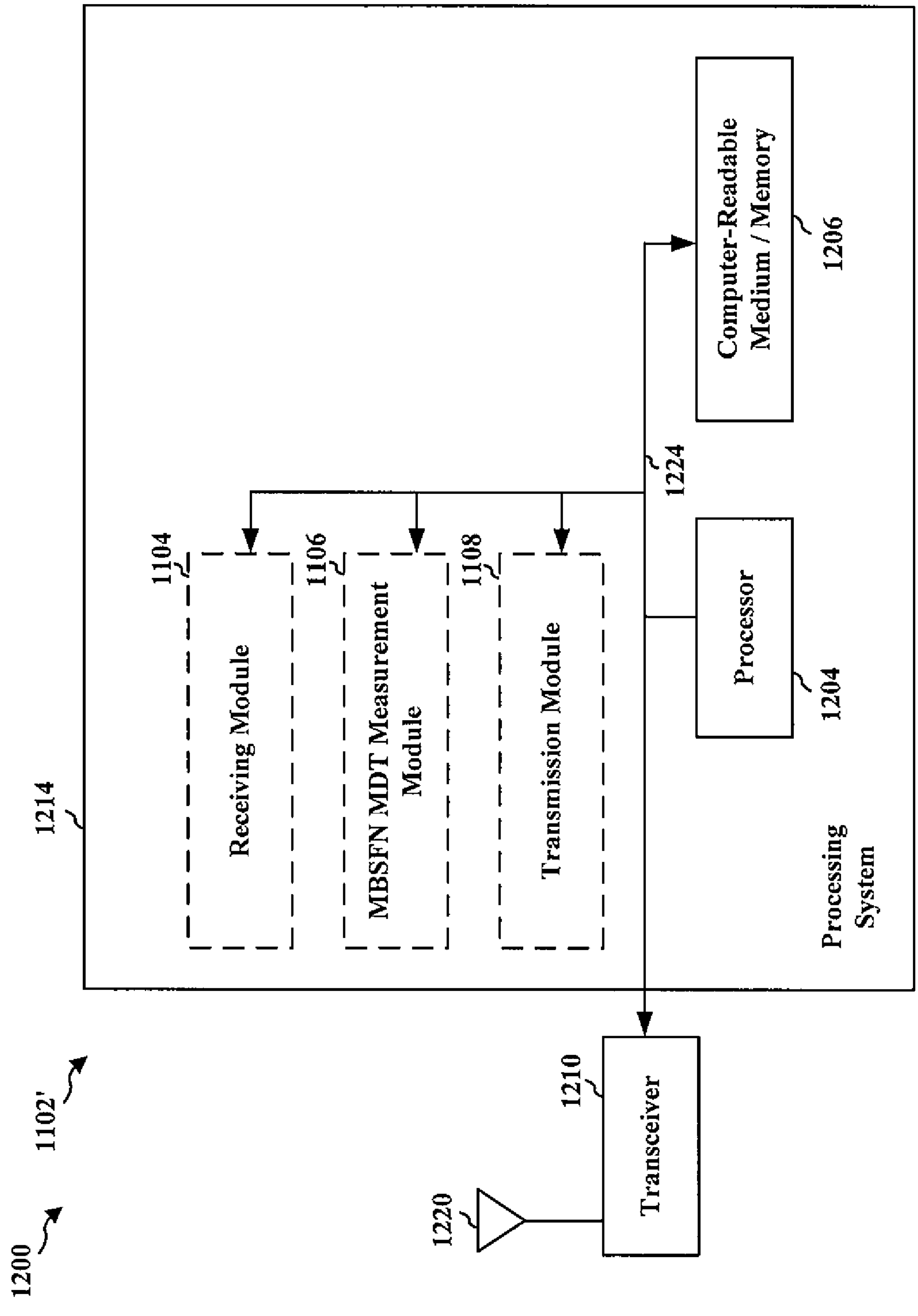

1200
1102'
1214
Receiving Module
1104
MBSFN MDT Measurement Module
1106
Transmission Module
1108
Processing System
1224
Processor
1204
Computer-Readable Medium / Memory
1206
Transceiver
1210
1220

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/071849

A. CLASSIFICATION OF SUBJECT MATTER

H04W 4/06(2009.01)i；H04W 24/10(2009.01)i

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)

CNABS,CNTXT,CNKI,VEN:MBSFN,MBMS,MDT,measur+,configuration,UE,user,terminal,wireless,communication,BS, base station,node?,eNB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 102215455 A (ZTE CORP.) 12 October 2011 (2011-10-12) description, paragraphs [0062]-[0066], [0076], [0088] and [0092]	1-45
Y	CN 102149106 A (INST. TELECOM. SCI&TECHNOLOGY MIN. O.) 10 August 2011 (2011-08-10) description, paragraphs [0057]-[0058]	1-45
A	CN 102083002 A (DATANG MOBILE COMMUNICATION EQUIP. CO., LTD.) 01 June 2011 (2011-06-01) the whole document	1-45
A	US 2013128756 A1 (QUALCOMM INC.) 23 May 2013 (2013-05-23) the whole document	1-45

☐ 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
25 October 2014	**04 November 2014**

Name and mailing address of the ISA/CN	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN) **6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China**	**LUO,Xinyao**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62089576**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/071849

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 102215455 A	12 October 2011	US 2013010624 A1	10 January 2013
		EP 2528270 A1	28 November 2012
		WO 2011120383 A1	06 October 2011
CN 102149106 A	10 August 2011	CN 102149106 B	29 January 2014
CN 102083002 A	01 June 2011	CN 102083002 B	02 April 2014
		WO 2011116692 A1	29 September 2011
US 2013128756 A1	23 May 2013	EP 2781114 A1	24 September 2014
		WO 2013074751 A1	23 May 2013
		KR 2014101813 A	20 August 2014