Certain aspects of the present disclosure relate to methods for PRS and eMBMS support under eMTA in LTE. The method generally includes receiving a subframe configuration, the subframe configuration being at least one of a positioning reference signal (PRS) configuration or an evolved multimedia services (eMBMS) configuration for at least one cell. For receiving the at least one cell, determining a reference uplink-downlink configuration for receiving the at least one cell for at least one of PRS or eMBMS from the at least one cell, determining a reference uplink-downlink configuration for receiving the at least one cell for at least one cell, where the reference uplink-downlink configuration defines one or more uplink subframes and one or more downlink subframes and the reference uplink-downlink configuration is separately determined from another uplink-downlink configuration based on a dynamic indication; and receiving the at least one of PRS or eMBMS based on the subframe configuration and the reference uplink-downlink configuration.
PRS AND eMBMS SUPPORT UNDER eMLTA IN LTE

BACKGROUND

Field

[0001] The present disclosure relates generally to wireless communication, and more particularly, to methods for PRS and eMBMS support under eMLTA in LTE.

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 divisional 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/LTE-Advanced is a set of enhancements to the Universal Mobile Telecommunications System (UMTS) mobile standard promulgated by Third Generation Partnership Project (3GPP). It is designed to better support mobile broadband Internet access by improving spectral efficiency, lower costs, improve services, make use of new spectrum, and better integrate 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
SUMMARY

[0004] Certain aspects of the present disclosure provide a method for wireless communications by a user equipment. The method generally includes receiving a subframe configuration, the subframe configuration being at least one of a positioning reference signal (PRS) configuration or an evolved multicast broadcast multimedia services (eMBMS) configuration for at least one cell for receiving at least one of PRS or eMBMS from the at least one cell; determining a reference uplink-downlink configuration for receiving the at least one of PRS or eMBMS from at least one cell, where the reference uplink-downlink configuration defines one or more uplink subframes and one or more downlink subframes and the reference uplink-downlink configuration is separately determined from a another uplink-downlink configuration based on a dynamic indication; and receiving the at least one of PRS or eMBMS based on the subframe configuration and the reference uplink-downlink configuration.

[0005] Aspects generally include methods, apparatus, systems, computer program products, and processing systems, as substantially described herein with reference to and as illustrated by the accompanying drawings. "LTE" refers generally to LTE and LTE-Advanced (LTE-A).

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a diagram illustrating an example of a network architecture.

[0007] FIG. 2 is a diagram illustrating an example of an access network.

[0008] FIG. 3 is a diagram illustrating an example of a DL frame structure in LTE.

[0009] FIG. 4 is a diagram illustrating an example of an UL frame structure in LTE.

[0010] FIG. 5 is a diagram illustrating an example of a radio protocol architecture for the user and control plane.

[0011] FIG. 6 is a diagram illustrating an example of an evolved Node B and user equipment in an access network, in accordance with certain aspects of the disclosure.

[0012] FIG. 7 illustrates a list of uplink/downlink subframe configurations.
FIG. 8 illustrates an example subframe frame format.

FIG. 9A illustrates legacy positioning reference signal (PRS) pattern for one and two cell-specific reference signal (CRS) ports, in accordance with certain aspects of the present disclosure.

FIG. 9B illustrates legacy PRS pattern for four CRS ports, in accordance with certain aspects of the present disclosure.

FIG. 10 illustrates example operations for wireless communications by a user equipment, in accordance with certain aspects of the present disclosure.

**DETAILED DESCRIPTION**

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.

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 hardware, software, or combinations thereof. Whether such elements are implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system.

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, firmware, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software/firmware, middleware, microcode, hardware description language, or otherwise.

[0020] Accordingly, in one or more exemplary embodiments, the functions described may be implemented in hardware, software, or combinations 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 RAM, ROM, EEPROM, PCM (phase change memory), flash memory, 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. 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 reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media.

[0021] 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, a Home Subscriber Server (HSS) 120, and an Operator's IP Services 122. The EPS can interconnect with other access networks, but for simplicity those entities/interfaces are not shown. Exemplary other access networks may include an IP Multimedia Subsystem (IMS) PDN, Internet PDN, Administrative PDN (e.g., Provisioning PDN), carrier-specific PDN, operator-specific PDN, and/or GPS PDN. 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.

[0022] The E-UTRAN includes the evolved Node B (eNB) 106 and other eNBs 108. The eNB 106 provides user and control plane protocol terminations toward the UE 102. The eNB 106 may be connected to the other eNBs 108 via an X2 interface (e.g., backhaul). The eNB 106 may also be referred to as a base station, a base transceiver station, a radio base station, a radio transceiver, a transceiver function, a basic service set (BSS), an extended service set (ESS), an access point, or some other suitable terminology. The eNB 106 may provide 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, a netbook, a smart book, an ultrabook, 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.

[0023] The eNB 106 is connected by an SI interface to the EPC 110. The EPC 110 includes a Mobility Management Entity (MME) 112, other MMEs 114, a Serving Gateway 116, 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. All user IP packets are 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 is connected to the Operator's IP Services 122. The Operator's IP Services 122 may include, for example, the Internet, the Intranet, an IP Multimedia Subsystem (IMS), and a PS (packet-switched) Streaming Service (PSS). In this manner, the UE102 may be coupled to the PDN through the LTE network.
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. A lower power class eNB 208 may be referred to as a remote radio head (RRH). The lower power class eNB 208 may be a femto cell (e.g., home eNB (HeNB)), pico cell, or micro cell. 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. The network 200 may also include one or more relays (not shown). According to one application, an UE may serve as a relay.

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 duplexing (FDD) and time division duplexing (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), Ultra Mobile Broadband (UMB), 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.

[0026] 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 (e.g., 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.

[0027] 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.

[0028] 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).
FIG. 3 is a diagram illustrating an example of a DL frame structure in LTE. A frame (10 ms) may be divided into 10 equally sized sub-frames with indices of 0 through 9. Each sub-frame 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, a resource block contains 12 consecutive subcarriers in the frequency domain and, for a normal cyclic prefix in each OFDM symbol, 7 consecutive OFDM symbols in the time domain, or 84 resource elements. For an extended cyclic prefix, a resource block contains 6 consecutive OFDM symbols in the time domain and has 72 resource elements. Some of the resource elements, as indicated as R 302, R 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 are 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.

In LTE, an eNB may send a primary synchronization signal (PSS) and a secondary synchronization signal (SSS) for each cell in the eNB. The primary and secondary synchronization signals may be sent in symbol periods 6 and 5, respectively, in each of subframes 0 and 5 of each radio frame with the normal cyclic prefix (CP). The synchronization signals may be used by UEs for cell detection and acquisition. The eNB may send a Physical Broadcast Channel (PBCH) in symbol periods 0 to 3 in slot 1 of subframe 0. The PBCH may carry certain system information.

The eNB may send a Physical Control Format Indicator Channel (PCFICH) in the first symbol period of each subframe. The PCFICH may convey the number of symbol periods (M) used for control channels, where M may be equal to 1, 2 or 3 and may change from subframe to subframe. M may also be equal to 4 for a small system bandwidth, e.g., with less than 10 resource blocks. The eNB may send a Physical HARQ Indicator Channel (PHICH) and a Physical Downlink Control Channel (PDCCH) in the first M symbol periods of each subframe. The PHICH may carry information to support hybrid automatic repeat request (HARQ). The PDCCH may carry information on resource allocation for UEs and control information for downlink channels. The
eNB may send a Physical Downlink Shared Channel (PDSCH) in the remaining symbol periods of each subframe. The PDSCH may carry data for UEs scheduled for data transmission on the downlink.

[0032] The eNB may send the PSS, SSS, and PBCH in the center 1.08 MHz of the system bandwidth used by the eNB. The eNB may send the PCFICH and PHICH across the entire system bandwidth in each symbol period in which these channels are sent. The eNB may send the PDCCH to groups of UEs in certain portions of the system bandwidth. The eNB may send the PDSCH to specific UEs in specific portions of the system bandwidth. The eNB may send the PSS, SSS, PBCH, PCFICH, and PHICH in a broadcast manner to all UEs, may send the PDCCH in a unicast manner to specific UEs, and may also send the PDSCH in a unicast manner to specific UEs.

[0033] A number of resource elements may be available in each symbol period. Each resource element (RE) may cover one subcarrier in one symbol period and may be used to send one modulation symbol, which may be a real or complex value. Resource elements not used for a reference signal in each symbol period may be arranged into resource element groups (REGs). Each REG may include four resource elements in one symbol period. The PCFICH may occupy four REGs, which may be spaced approximately equally across frequency, in symbol period 0. The PHICH may occupy three REGs, which may be spread across frequency, in one or more configurable symbol periods. For example, the three REGs for the PHICH may all belong in symbol period 0 or may be spread in symbol periods 0, 1, and 2. The PDCCH may occupy 9, 18, 36, or 72 REGs, which may be selected from the available REGs, in the first M symbol periods, for example. Only certain combinations of REGs may be allowed for the PDCCH. In aspects of the present methods and apparatus, a subframe may include more than one PDCCH.

[0034] A UE may know the specific REGs used for the PHICH and the PCFICH. The UE may search different combinations of REGs for the PDCCH. The number of combinations to search is typically less than the number of allowed combinations for the PDCCH. An eNB may send the PDCCH to the UE in any of the combinations that the UE will search.

[0035] 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.

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.

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).

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.
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.).

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.

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 (i.e., radio bearers) and for configuring the lower layers using RRC signaling between the eNB and the UE.

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.
The TX processor 616 implements various signal processing functions for the LI layer (i.e., physical layer). The signal processing functions includes 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 is then provided to a different antenna 620 via a separate transmitter 618TX. Each transmitter 618TX modulates an RF carrier with a respective spatial stream for transmission.

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 receiver (RX) processor 656. The RX processor 656 implements various signal processing functions of the LI layer. The RX processor 656 performs 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, is 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.
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 control/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.

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.

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 are provided to different antenna 652 via separate transmitters 654TX. Each transmitter 654TX modulates an RF carrier with a respective spatial stream for transmission.

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 LI layer.

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. The controllers/processors 675, 659 may direct the operation at the eNB 610 and the UE 650, respectively. The controller/processor 659 and/or other processors and modules at the UE 650 may perform or direct operations for example operations 1300 in FIG. 13, and/or other processes for the techniques described herein, for example. The controller/processor 675 and/or other processors and modules at the eNB 610 may perform or direct operations for example operations 1100 in FIG 11, and/or other processes for the techniques described herein, for example. In aspects, one or more of any of the components shown in FIG. 6 may be employed to perform example operations 1100 and 1200 and/or other processes for the techniques described herein.

**PRS AND eMBMS SUPPORT UNDER eMTA IN LTE**

[0050] Aspects of the present disclosure provide techniques that may allow for PRS and/or eMBMS processing in scenarios where a reference (PRS or eMBMS) configuration indicates a subframe as being for PRS and/or eMBMS, while detecting that one or more subframes indicated as downlink subframes by the reference uplink-downlink configuration are designated as uplink subframes by the at least one cell.

[0051] According to certain aspects, the dynamic indication may be handled in a manner that not impact the PRS/eMBMS configuration. Rather, the PRS configuration may be associated with a reference configuration. The possibility of a downlink subframe in the reference configuration becoming an uplink subframe may be due to, for example, a difference in dynamic subframe indication, and/or a difference in a SIB1 indicated configuration, if the reference configuration is not the same as SIB1. The possibility of a downlink subframe in the reference configuration becoming an uplink subframe may happen to a serving cell that a UE is associated with, or a neighboring cell that also provides PRS/eMBMS service to the UE. The possibility of a downlink
subframe in the reference configuration becoming an uplink subframe may happen to a
carrier frequency of a serving cell that a UE is associated with, or a different carrier
frequency that also provides PRS/eMBMS service to the UE.

[0052] In LTE, both frequency division duplexing (FDD) and time division
duplexing (TDD) frame structures are supported. Figure 8 illustrates that in TDD, one
radio frame consists of ten subframes, and has a length of ten milliseconds. As can be
seen, Fig. 7 shows seven possible downlink (DL) and uplink (UL) subframe
configurations supported for TDD. Each DL/UL subframe configuration may have an
associated switch-point periodicity, which may be either five or ten milliseconds. Each
subframe may either be an uplink, downlink, or special subframe. Referring back to Fig.
1, for a subframe configuration having a five millisecond switching periodicity, there
are two special subframes within one frame. For a subframe configuration having a ten
millisecond switching periodicity, there is one special subframe within one frame.

[0053] In LTE Rel-12, it may be possible to dynamically adapt TDD DL/UL
subframe configurations based on the actual traffic needs, which is also known as
evolved interference management for traffic adaptation (eMTA). For example,
according to certain aspects, if during a short duration a large data burst on downlink is
needed, the subframe configuration may be changed from, for example, configuration
#1, which has six DL subframes and four UL subframes, to configuration #5, which has
nine DL subframes and one UL subframe. According to certain aspects, the adaptation
of a TDD configuration is expected to be no slower than 640ms. In an extreme case, the
adaptation may be as fast as 10ms. Additionally, dynamic indication of a TDD DL/UL
subframe configuration may be done by explicit layer 1 signaling of reconfiguration by
UE-group-common (e)PDCCH (physical downlink control channel).

[0054] Additionally, the adaptation may cause some complexity in DL and UL
hybrid automatic repeat request (HARQ) timing management. To simplify HARQ
management, a reference DL/UL subframe configuration may be used. For example, for
UL HARQ, scheduling and HARQ timing may be based on the DL/UL subframe as
indicated in system information block 1 (SIB1). For DL HARQ, a UE may be indicated
to use one reference configuration, taken from configuration #2, #4, or #5.

[0055] In eMTA, some subframes may not be subject to dynamic change of
transmission directions, while other subframe may be subject to dynamic adaptations. It is generally understood that DL subframes in the TDD DL/UL subframe configuration in SIB1 may not be subject to dynamic adaptation, while UL subframes in the DL HARQ reference configuration may not be subject to dynamic adaptation.

[0056] In LTE Release 9 and later, positioning reference signals (PRS) are supported. PRS may be used for estimating the position of a UE (e.g., as a distance from a transmitting base station). The estimated position may be used for various purposes, for example, location services usage. PRS, along with other reference signals, such as cell-specific reference signals (CRS), may be used for various purposes such as channel estimation, channel measurement, channel feedback reporting, etc. A cell may transmit PRS and/or CRS in certain symbol periods of each subframe. The CRS and PRS may be specific for the cell and may be generated based on a cell identity (ID) of the cell.

[0057] FIGs. 9A-9B illustrate a legacy PRS pattern for one and two CRS ports and four CRS ports, in accordance with certain aspects of the present disclosure. In certain aspects, for both normal cyclic prefix (CP) and extended CP types, PRS is present in all symbols except those for legacy control and common reference signal (CRS). The pattern of PRS generally exhibits a "diagonal" property, but omits the symbols containing CRS. For example, as shown in FIG. 9A, for the one and two CRS ports case, PRS is not present in symbol 4 of the first slot and symbols 0 and 4 in the second slot. As another example, as shown in FIG. 9B, for the four CRS ports case, PRS is not present in symbol 1 of the second slot.

[0058] PRS may only transmitted in resource blocks (RB) in downlink subframes configured for PRS transmission. The periodicity $T_{PRS} (160, 320, 640, or 1280ms)$ and subframe offset $APRS$ for PRS subframes may be configurable on a per cell basis. Positioning reference signals may be transmitted in $NPRS$ consecutive downlink subframes, where $NPRS$ is configured by higher layers (1, 2, 4 or 6 subframes). The first subframe of the $NPRS$ downlink subframes for PRS transmission instances may satisfy the following equation:

$$(10xH_f + \lfloor n_f/2 \rfloor - A_{PRS}) \mod r_{PRS} = 0$$

[0059] where $n_f$ is the frame index, and $n_s$ is the slot index. PRS may be in both
multicast-broadcast single-frequency network (MBSFN) and/or non-MBSFN (normal) subframes. PRS may not be transmitted in special subframes in TDD. Additionally, PRS may not be mapped to resource elements allocated to the physical broadcast channel (PBCH), the primary synchronization signal (PSS) or the secondary synchronization signal (SSS).

[0060] Bandwidth for PRS may be configurable, and may be the same or less than downlink system bandwidth. According to certain aspects, if both normal and MBSFN subframes are configured as positioning subframes within a cell, the OFDM symbols in a MBSFN subframe configured for positioning reference signal transmission may use the same cyclic prefix as used for subframe #0. If only MBSFN subframes are configured as positioning subframes within a cell, the OFDM symbols configured for positioning reference signals in the MBSFN region of these subframes shall use extended cyclic prefix length.

[0061] According to certain aspects it may be possible to enable PRS in a set of common subframes, or adapt the PRS configuration or CP based on TDD DL/UL subframe configurations.

[0062] According to certain aspects, it may be possible to have different serving cell PRS configurations. For example, if PRS is transmitted from the serving cell, the PRS configuration may be based on an indication of a reference configuration. For example, the PRS configuration may be based on a SIB1 indicated TDD DL/UL subframe configuration or some other dedicated signaling. If a UE receives a PRS configuration with PRS subframes falling into a UL subframe indicated in the reference uplink-downlink configuration, the UE may interpret this as a misconfiguration. According to certain aspects, PRS may only be transmitted in DL subframes indicated by the reference uplink-downlink configuration. According to further aspects, if the number of consecutive downlink subframes $N_{PRS}$ for transmitting positioning reference signals is greater than 1 (e.g., 2, 4, or 6), the UE may assume that these subframes are counted within the regular downlink subframes indicated in the reference uplink-downlink configuration.

[0063] According to certain aspects, another possible configuration is to have the PRS configuration be irrespective of SIB1 or the dynamic subframe configuration
indication. In this configuration, the UE may always assume availability of DL subframes for PRS as long as it is configured as PRS subframes. This may imply that the serving cell has to enable a UL subframe as a PRS subframe if a PRS subframe happens to fall into the UL subframe.

[0064] According to certain aspects, another possible configuration is to place a PRS in a flexible DL subframe. In this configuration, the UE may assume unavailability of PRS if the PRS subframe is indicated as an UL subframe by a dynamic subframe configuration indication.

[0065] According to certain aspects, it may be possible to have different neighboring cell PRS configurations. For a neighboring cell(s), the PRS UE may be transparent to a dynamic TDD DL/UL subframe configuration that may be performed by neighboring cell(s) with respect to PRS configuration(s) for the neighboring cell(s). According to certain aspects, the UE may always assume that the PRS subframes are available from the neighboring cell based on the neighboring cell's PRS configuration. According to certain aspects, it may be up to neighboring eNBs to ensure availability of DL subframes to transmit PRS. According to certain aspects, if a neighboring eNB happens to have a UL subframe colliding with a PRS subframe, it may be preferable to have the eNB transmit the PRS instead. Alternatively, according to other aspects, the UE may be signaled or may detect whether a PRS is available in a subframe even if the UE is configured to receive PRS in the subframe.

[0066] According to certain aspects, in order to address potential PRS and UL subframe collision, an eNB may always treat a set of subframes as DL subframes regardless of whether these subframes are indicated by SIB1 or the dynamic subframe configuration indication as DL or UL subframes.

[0067] Additionally, the eNB may inform one or more UEs that a set of subframes should always be treated by the one or more UEs as DL subframes regardless of whether these subframes are indicated by SIB1 or the dynamic subframe configuration indication as DL or UL subframes. According to certain aspects, the one or more UEs may suspend UL transmissions in the subframes indicated by the eNB. Additionally, the one or more UEs may be required to monitor DL traffic. According to certain aspects, these subframes may be used for PRS or eMBMS services. According to further aspects,
these subframes may come from only the subframes that can be potentially configured as MBSFN subframes or from only the subframes that are not subject to dynamic adaptation (e.g., only from subframes \{3, 4, 7, 8, 9\}, but not from subframes \{0, 1, 5, 6\})

[0068] According to certain aspects, an elMTA-capable UE may assume that PRS management (e.g., availability, processing, etc.) is independent of whether elMTA is enabled or not. In other words, it may not be preferable for the elMTA UEs to handle a dynamic set of cells involved in PRS measurement. According to certain aspects, if a cell involved in PRS operation has non-guaranteed availability of PRS subframes, the relevant PRS processing may take into account whether the PRS is available or not. For example, according to certain aspects, for a reference signal timing difference (RSTD) report, the UE may exclude these non-available PRS subframes from RSTD measurement averaging, and may reflect the non-availability of PRS subframes in the RSTD measurement quality report.

[0069] According to certain aspects, a UE may be explicitly indicated whether a PRS subframe is guaranteed or not for a cell. The UE may also blindly detect whether PRS is present in a subframe of a cell or not. For example, for a serving cell, the UE may determine whether PRS is available or not in a subframe it is configured to receive PRS based on the dynamic indication; while for neighboring cells, the UE may use blind detection to determine PRS is available or not in a subframe it is configured to receive PRS.

[0070] According to certain aspects, the above teachings may be applied to eMBMS services as well. According to certain aspects, an elMTA-capable UE may assume that eMBMS (e.g., availability, processing, etc.) is independent of whether elMTA is enabled or not. In other words, it may not be preferable for the elMTA UEs to handle a dynamic set of cells involved in eMBMS service.

[0071] According to certain aspects, if a cell involved in eMBMS has non-guaranteed availability of eMBMS subframes, the relevant eMBMS processing may take into account whether the eMBMS is available or not. According to further aspects, a UE may be explicitly indicated that availability of eMBMS subframes is not guaranteed for all cells, such that the set of cells involved in eMBMS is dynamic. For example, one bit set to 0 may indicate that the set of eMBMS cells is (semi)-static,
whereas 1 may indicate the set of eMBMS cells is dynamic. According to certain aspects, a first set of subframes where the set of cells involved in eMBMS may be (semi) static; a second set of subframes where the set of cells involved in eMBMS may be dynamic. Consequently, for channel measurement and other relevant eMBMS processing, the UE may perform appropriately. For example, the UE may not perform filtering of channel estimations over subframes with different sets of cells involving in eMBMS services. As another example, for eMBMS reference signal received power (RSRP) reporting, reference signal received quality (RSRQ) reporting, or eMBMS error rate reporting, the UE may exclude the subframes where the set of cells involved in eMBMS is dynamic. Alternatively, the UE may report RSRP, RSRQ, or error rate separately for subframes associated with a semi-static set of cells and for subframes associated with a dynamic set of cells.

[0072] FIG. 10 illustrates example operations 1000 for wireless communications, in accordance with aspects of the present disclosure. The operations 1000 may be performed, for example, by an eMTA-capable UE.

[0073] The operations 1000 begin, at 1002, by receiving a subframe configuration, the subframe configuration being at least one of a positioning reference signal (PRS) configuration or an evolved multicast broadcast multimedia services (eMBMS) configuration for at least one cell for receiving at least one of PRS or eMBMS from the at least one cell. At 1004, operations continue by determining a reference uplink-downlink configuration for receiving the at least one of PRS or eMBMS from at least one cell, where the reference uplink-downlink configuration defines one or more uplink subframes and one or more downlink subframes and the reference uplink-downlink configuration is separately determined from a another uplink-downlink configuration based on a dynamic indication. At 1006, operations continue by receiving the at least one of PRS or eMBMS based on the subframe configuration and the reference uplink-downlink configuration.

[0074] It is understood that the specific order or hierarchy of steps in the processes 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 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.

[0075] Moreover, the term "or" is intended to mean an inclusive "or" rather than an exclusive "or." That is, unless specified otherwise, or clear from the context, the phrase, for example, "X employs A or B" is intended to mean any of the natural inclusive permutations. That is, for example the phrase "X employs A or B" is satisfied by any of the following instances: X employs A; X employs B; or X employs both A and B. In addition, the articles "a" and "an" as used in this application and the appended claims should generally be construed to mean "one or more" unless specified otherwise or clear from the context to be directed to a singular form. A phrase referring to "at least one of a list of items refers to any combination of those items, including single members. As an example, "at least one of: a, b, or c" is intended to cover: a, b, c, a-b, a-c, b-c, and a-b-c.

[0076] 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." Unless specifically stated otherwise, the term "some" refers to one or more. 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:

1. A method for wireless communications by a user equipment (UE) capable of supporting dynamic uplink-downlink configurations, comprising:
   - receiving a subframe configuration, the subframe configuration being at least one of a positioning reference signal (PRS) configuration or an evolved multicast broadcast multimedia services (eMBMS) configuration for at least one cell for receiving at least one of PRS or eMBMS from the at least one cell;
   - determining a reference uplink-downlink configuration for receiving the at least one of PRS or eMBMS from at least one cell, where the reference uplink-downlink configuration defines one or more uplink subframes and one or more downlink subframes and the reference uplink-downlink configuration is separately determined from another uplink-downlink configuration based on a dynamic indication;
   - receiving the at least one of PRS or eMBMS based on the subframe configuration and the reference uplink-downlink configuration.

2. The method of claim 1, further comprising:
   - detecting that one or more subframes indicated as downlink subframes by the reference uplink-downlink configuration are designated as uplink subframes by the at least one cell; and
   - taking the detection into consideration when measuring and reporting the at least one of PRS or eMBMS.

3. The method of claim 2, wherein taking the detection into consideration when measuring and reporting the at least one of PRS or eMBMS comprises:
   - excluding, from the at least one of PRS or eMBMS measurements, subframes indicated as uplink subframes.

4. The method of claim 3, further comprising providing, when reporting the at least one of PRS or eMBMS measurements, a quality indication that reflects the exclusion of subframes from the at least one of PRS or eMBMS measurements.
5. The method of claim 2, wherein taking the detection into consideration when measuring and reporting the at least one of PRS or eMBMS comprises:
   determining whether or not the at least one of PRS or eMBMS is transmitted in the subframes indicated as uplink subframes.

6. The method of claim 5, wherein the determining comprises:
   blind detection of the at least one of PRS or eMBMS.

7. The method of claim 5, wherein the determining comprises:
   receiving signaling indicating whether or not the at least one of PRS or eMBMS is transmitted in the subframes indicated as uplink subframes.

8. The method of claim 2, wherein taking the detection into consideration when measuring and reporting the at least one of PRS or eMBMS comprises:
   assuming the at least one of PRS or eMBMS is transmitted in the subframes indicated as uplink subframes by the first subframe configuration, regardless of the detection.

9. The method of claim 2, wherein:
   multiple cells are involved in the at least one of PRS or eMBMS operations with the UE; and
   taking the detection into consideration when measuring and reporting the at least one of PRS or eMBMS comprises determining which of the multiple cells transmit the at least one of PRS or eMBMS in the subframes indicated as uplink subframes.

10. The method of claim 9, wherein:
   the multiple cells comprise at least one serving cell and at least one neighbor cell;
   the at least one of PRS or eMBMS is transmitted from the serving cell; and
   the reference uplink-downlink subframe configuration is based on a subframe configuration consistent with a system information block in the at least one serving cell.
11. The method of claim 9, wherein taking the detection into consideration when measuring and reporting the at least one of PRS or eMBMS further comprises excluding from the at least one of PRS or eMBMS measurements, cells determined not to transmit the at least one of PRS or eMBMS in the subframes indicated as uplink subframes.

12. The method of claim 11, further comprising providing, when reporting the at least one of PRS or eMBMS measurements, a quality indication that reflects the exclusion of cells from the at least one of PRS or eMBMS measurements.

13. The method of claim 1, wherein the reference uplink-downlink subframe configuration is received via dedicated signaling.

14. The method of claim 1, wherein the reference uplink-downlink subframe configuration is received via a system information block (SIB).
FIG. 5
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<th>Uplink-downlink configuration</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<td>5 ms</td>
<td>5 ms</td>
<td>5 ms</td>
<td>10 ms</td>
<td>10 ms</td>
<td>5 ms</td>
<td></td>
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</table>
One radio frame, $T_R = 307200\, T_s = 10\, ms$

One half-frame, $153600\, T_s = 5\, ms$

One slot, $15360 T_s$

Subframe #0 - Subframe #9

DwPTS - GP - UpPTS

FIG. 8
Four PBCCH antenna ports

One and two PBCCH antenna ports

FIG. 9A

FIG. 9B
1000

RECEIVE A SUBFRAME CONFIGURATION, THE SUBFRAME CONFIGURATION BEING AT LEAST ONE OF A POSITIONING REFERENCE SIGNAL (PRS) OR AN EVOLVED MULTICAST BROADCAST MULTIMEDIA SERVICES (eMBMS) CONFIGURATION FOR AT LEAST ONE CELL FOR RECEIVING AT LEAST ONE OF PRS OR eMBMS FROM THE AT LEAST ONE CELL

1004

DETERMINE A REFERENCE UPLINK-DOWNLINK CONFIGURATION FOR RECEIVING THE AT LEAST ONE OF PRS OR eMBMS FROM THE AT LEAST ONE CELL, WHERE THE REFERENCE UPLINK-DOWNLINK CONFIGURATION DEFINES ONE OR MORE UPLINK SUBFRAMES AND ONE OR MORE DOWNLINK SUBFRAMES AND THE REFERENCE UPLINK-DOWNLINK CONFIGURATION IS SEPARATELY DETERMINED FROM A ANOTHER UPLINK-DOWNLINK CONFIGURATION BASED ON A DYNAMIC INDICATION

1006

RECEIVE THE AT LEAST ONE OF PRS OR eMBMS BASED ON THE SUBFRAME CONFIGURATION AND THE REFERENCE UPLINK-DOWNLINK CONFIGURATION

FIG. 10
A. Classification of Subject Matter

H04W 4/00(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; H04Q; H04L

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

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

CNPAT,CNTXT,WP,LEPODOC,3GPP,GOOGLE:PRS,embms , e-embms , UL,DL,etIMTA,configuration, uplink, downlink, subframe, frame, dynamic

C. Documents Considered to be Relevant

<table>
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<td>A</td>
<td>US 2012027110 A1 (HAN, SEUNG HEE ET AL.) 02 February 2012 (2012-02-02) description, paragraphs [0079]-[0121], claims 14-27</td>
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<tr>
<td>A</td>
<td>CN 102265687 A (MEDIATEK INC.) 30 November 2011 (2011-11-30) the whole document</td>
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<td>A</td>
<td>CN 101616360 A (ZTE CORPORATION) 30 December 2009 (2009-12-30) the whole document</td>
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<td>A</td>
<td>US 2012122440 A1 (MOTOROLA MOBILITY, INC.) 17 May 2012 (2012-05-17) the whole document</td>
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<tr>
<td>A</td>
<td>US 20131904931 A1 (INTERDIGITAL PATENT HOLDINGS, INC.) 01 August 2013 (2013-08-01) the whole document</td>
<td>1-14</td>
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<td>A</td>
<td>WO 2012142436 A1 (INTERDIGITAL PATENT HOLDINGS, INC. ET AL.) 18 October 2012 (2012-10-18) the whole document</td>
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Further documents are listed in the continuation of Box C.

Date of the actual completion of the international search: 11 September 2014

Date of mailing of the international search report: 02 November 2014

Name and mailing address of the ISA/CN

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<td>A</td>
<td>WO 2012044246 A1 (TELEFONAKTIEBOLAGET LMERICSSON PUBL) 05 April 2012 (2012-04-05) the whole document</td>
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<td>CN 102265687 A</td>
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<td>US 2011117926 A1</td>
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<td>JP 20135111233 A</td>
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<td>EP 2502454 A1</td>
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<td>US 2012093101 A1</td>
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Form PCT/ISA/210 (patent family annex) (July 2009)