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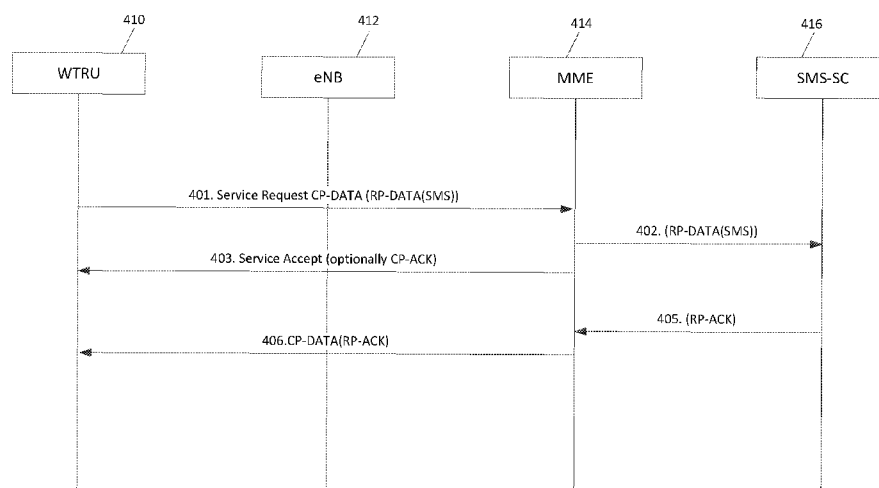


FIG. 4

(57) Abstract: Systems, methods, and instrumentalities are disclosed for using a short message service (SMS). An indication that a wireless transmit/receive unit (WTRU) may be operating in an optimized transmission mode for SMS may be sent to a mobility management entity (MME). The WTRU may communicate with the MME using fewer messages in the optimized transmission mode for SMS than in a normal mode for SMS. A data service request may be sent to the MME via a control protocol (CP). The data service request may include CP-DATA and/or the data service request may include relay protocol (RP)-DATA. A service accept message may be received from the MME, via the CP. Based on receiving the service accept message from the MME, the WTRU may implicitly determine that the CP-DATA has been successfully acknowledged. SMS protocols may be used for Cellular Internet of Things (CIoT).



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SHORT MESSAGE SERVICES IN THE CELLULAR INTERNET OF THINGS

CROSS-REFERENCE

[0001] This application claims the benefit of U.S. Provisional Application No. 62/335,608 filed on May 12, 2016, which is incorporated herein by reference as if fully set forth.

BACKGROUND

[0002] Short Message Service (SMS) has been used in 3GPP and may be used with the Cellular Internet of Things (CIoT). For example, a CIoT device may use SMS to communicate with a server. Previously utilized SMS protocols may have been designed to support the types of signaling and data transfer scenarios than may be present in a CIoT deployment, which may lead to wasted power and decreased battery life.

SUMMARY

[0003] Disclosed herein are methods and apparatus for providing short message service (SMS) protocols, for example, for Cellular Internet of Thing (CIoT) type applications. The SMS protocols described herein may reduce a number of packets or signaling messages used by one or more devices. As described herein, a wireless transmit/receive unit (WTRU) and a network (NW) may negotiate the level of support for SMS protocols that may be used for CIoT.

[0004] A control protocol (CP) may be used by a WTRU in order to perform an SMS transmission and/or reception. For example, messages between the WTRU and an anchor point in the core network (e.g., mobile switching center (MSC)/ Serving General Packet Radio Service (GPRS) Support Node (SGSN)/Mobility Management Entity (MME)) may be exchanged using the CP. The WTRU may transmit an SMS message, which may include CP-DATA, using a Service Request message in CIoT. The network may return a Service Accept message, which may act as a CP-ACK. The network may include the CP-ACK in a Service Accept message.

[0005] A relay protocol (RP) may be used by a WTRU in order to perform an SMS transmission and/or reception. For example, messages exchanged between a WTRU and a service center (SC) may use an RP. An acknowledgement, such as a RP-ACK, from the SMS Service Center (SC) may be sent to the WTRU by the network in a CP-DATA. The WTRU may be informed that there may not be a need to send a CP-ACK to the network. The RAN may send an indication to a core network (CN) node that the RAN has received a lower layer acknowledgement from the WTRU. This indication may serve the same functionality as a CP-ACK.

[0006] To provide an SMS protocol for the CIoT, a WTRU may start a timer to allow the MME to receive an RP-ACK from the Service Center and send it back to the WTRU. The network (MME/SGSN) may transmit RP-ACK and/or CP-ACK in a Service Accept message.

[0007] Systems, methods, and instrumentalities are disclosed for using an SMS. An indication that a WTRU may be operating in a reduced (e.g., optimized) transmission mode for SMS may be sent to a MME. The WTRU may communicate with the MME using fewer messages in the reduced (e.g., optimized) transmission mode for SMS than in a normal mode for SMS. A data service request may be sent to the MME via a CP. The data service request may include CP-DATA and/or the data service request may include RP-DATA. A service accept message may be received from the MME, via the CP. Based on receiving the service accept message from the MME, the WTRU may implicitly determine that the CP-DATA has been successfully acknowledged.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1A is a system diagram of an example communications system in which one or more disclosed embodiments may be implemented.

[0009] FIG. 1B is a system diagram of an example wireless transmit/receive unit (WTRU) that may be used within the communications system illustrated in FIG. 1A.

[0010] FIG. 1C is a system diagram of an example radio access network and an example core network that may be used within the communications system illustrated in FIG. 1A.

[0011] FIG. 1D is a system diagram of another example radio access network and another example core network that may be used within the communications system illustrated in FIG. 1A.

[0012] FIG. 1E is a system diagram of another example radio access network and another example core network that may be used within the communications system illustrated in FIG. 1A.

[0013] FIG. 2 shows an example short message services (SMS) signaling exchange for a mobile originating (MO) signaling, for example, when the device is in connected mode.

[0014] FIG. 3 shows an example SMS signaling exchange for a MO signaling, for example, when the WTRU is in idle mode.

[0015] FIG. 4 shows an example message flow for SMS communications that may be used when transitioning from an idle mode to a connected, for example, for signaling associated with CIoT devices.

[0016] FIG. 5 shows an example message flow that may use a Service Accept message indicate one or more SMS communication messages.

[0017] FIG. 6 shows an example message flow that may be used to negotiate capabilities for SMS procedures and/or timers between a WTRU and a Mobility Management Entity (MME).

[0018] FIG. 7 shows an example message flow for SMS communications that may be used in connected mode.

DETAILED DESCRIPTION

[0019] A detailed description of illustrative embodiments will now be described with reference to the various figures. Although this description provides a detailed example of possible implementations, it should be noted that the details are intended to be exemplary and in no way limit the scope of the application.

[0020] FIG. 1A is a diagram of an example communications system 100 in which one or more disclosed embodiments may be implemented. The communications system 100 may be a multiple access system that provides content, such as voice, data, video, messaging, broadcast, etc., to multiple wireless users. The communications system 100 may enable multiple wireless users to access such content through the sharing of system resources, including wireless bandwidth. For example, the communications systems 100 may employ one or more channel access methods, such as code division multiple access (CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal FDMA (OFDMA), single-carrier FDMA (SC-FDMA), and/or the like.

[0021] As shown in FIG. 1A, the communications system 100 may include wireless transmit/receive units (WTRUs) 102a, 102b, 102c, and/or 102d (which generally or collectively may be referred to as WTRU 102), a radio access network (RAN) 103/104/105, a core network 106/107/109, a public switched telephone network (PSTN) 108, the Internet 110, and other networks 112, though it will be appreciated that the disclosed embodiments contemplate any number of WTRUs, base stations, networks, and/or network elements. Each of the WTRUs 102a, 102b, 102c, 102d may be any type of device configured to operate and/or communicate in a wireless environment. By way of example, the WTRUs 102a, 102b, 102c, 102d may be configured to transmit and/or receive wireless signals and may include user equipment (WTRU), a mobile station, a fixed or mobile subscriber unit, a pager, a cellular telephone, a personal digital assistant (PDA), a smartphone, a laptop, a netbook, a personal computer, a wireless sensor, consumer electronics, and/or the like.

[0022] The communications systems 100 may also include a base station 114a and a base station 114b. Each of the base stations 114a, 114b may be any type of device configured to wirelessly interface with at least one of the WTRUs 102a, 102b, 102c, 102d to facilitate access to one or more communication networks, such as the core network 106/107/109, the Internet 110, and/or the networks 112. By way of example, the base stations 114a, 114b may be a base transceiver station (BTS), a Node-B, an eNode B, a Home Node B, a Home eNode B, a site controller, an access point (AP), a wireless router, and/or the like. While the base stations 114a, 114b are each depicted as a single element, it will be appreciated that the base stations 114a, 114b may include any number of interconnected base stations and/or network elements.

[0023] The base station 114a may be part of the RAN 103/104/105, which may also include other base stations and/or network elements (not shown), such as a base station controller (BSC), a radio network controller (RNC), relay nodes, *etc.* The base station 114a and/or the base station 114b may be configured to transmit and/or receive wireless signals within a particular geographic region, which may be referred to as a cell (not shown). The cell may further be divided into cell sectors. For example, the cell associated with the base station 114a may be divided into three sectors. Thus, in one embodiment, the base station 114a may include three transceivers, *e.g.*, one for each sector of the cell. In another embodiment, the base station 114a may employ multiple-input multiple output (MIMO) technology and, therefore, may utilize multiple transceivers for each sector of the cell.

[0024] The base stations 114a, 114b may communicate with one or more of the WTRUs 102a, 102b, 102c, 102d over an air interface 115/116/117, which may be any suitable wireless communication link (*e.g.*, radio frequency (RF), microwave, infrared (IR), ultraviolet (UV),

visible light, *etc.*). The air interface 115/116/117 may be established using any suitable radio access technology (RAT).

[0025] More specifically, as noted above, the communications system 100 may be a multiple access system and may employ one or more channel access schemes, such as CDMA, TDMA, FDMA, OFDMA, SC-FDMA, and/or the like. For example, the base station 114a in the RAN 103/104/105 and the WTRUs 102a, 102b, 102c may implement a radio technology such as Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access (UTRA), which may establish the air interface 115/116/117 using wideband CDMA (WCDMA).

WCDMA may include communication protocols such as High-Speed Packet Access (HSPA) and/or Evolved HSPA (HSPA+). HSPA may include High-Speed Downlink Packet Access (HSDPA) and/or High-Speed Uplink Packet Access (HSUPA).

[0026] In another embodiment, the base station 114a and the WTRUs 102a, 102b, 102c may implement a radio technology such as Evolved UMTS Terrestrial Radio Access (E-UTRA), which may establish the air interface 115/116/117 using Long Term Evolution (LTE) and/or LTE-Advanced (LTE-A).

[0027] In other embodiments, the base station 114a and the WTRUs 102a, 102b, 102c may implement radio technologies such as IEEE 802.16 (*e.g.*, Worldwide Interoperability for Microwave Access (WiMAX)), CDMA2000, CDMA2000 1X, CDMA2000 EV-DO, Interim Standard 2000 (IS-2000), Interim Standard 95 (IS-95), Interim Standard 856 (IS-856), Global System for Mobile communications (GSM), Enhanced Data rates for GSM Evolution (EDGE), GSM EDGE (GERAN), and/or the like.

[0028] The base station 114b in FIG. 1A may be a wireless router, Home Node B, Home eNode B, or access point, for example, and may utilize any suitable RAT for facilitating wireless connectivity in a localized area, such as a place of business, a home, a vehicle, a campus, and/or the like. In one embodiment, the base station 114b and the WTRUs 102c, 102d may implement a radio technology such as IEEE 802.11 to establish a wireless local area network (WLAN). In another embodiment, the base station 114b and the WTRUs 102c, 102d may implement a radio technology such as IEEE 802.15 to establish a wireless personal area network (WPAN). In yet another embodiment, the base station 114b and the WTRUs 102c, 102d may utilize a cellular-based RAT (*e.g.*, WCDMA, CDMA2000, GSM, LTE, LTE-A, *etc.*) to establish a picocell or femtocell. As shown in FIG. 1A, the base station 114b may have a direct connection to the Internet 110. Thus, the base station 114b may not be used to access the Internet 110 via the core network 106/107/109.

[0029] The RAN 103/104/105 may be in communication with the core network 106/107/109, which may be any type of network configured to provide voice, data, applications, and/or voice over internet protocol (VoIP) services to one or more of the WTRUs 102a, 102b, 102c, 102d. For example, the core network 106/107/109 may provide call control, billing services, mobile location-based services, pre-paid calling, Internet connectivity, video distribution, *etc.*, and/or perform high-level security functions, such as user authentication. Although not shown in FIG. 1A, it will be appreciated that the RAN 103/104/105 and/or the core network 106/107/109 may be in direct or indirect communication with other RANs that employ the same RAT as the RAN 103/104/105 or a different RAT. For example, in addition to being connected to the RAN 103/104/105, which may be utilizing an E-UTRA radio technology, the core network 106/107/109 may also be in communication with another RAN (not shown) employing a GSM radio technology.

[0030] The core network 106/107/109 may also serve as a gateway for the WTRUs 102a, 102b, 102c, 102d to access the PSTN 108, the Internet 110, and/or other networks 112. The PSTN 108 may include circuit-switched telephone networks that provide plain old telephone service (POTS). The Internet 110 may include a global system of interconnected computer networks and devices that use common communication protocols, such as the transmission control protocol (TCP), user datagram protocol (UDP) and the internet protocol (IP) in the TCP/IP internet protocol suite. The networks 112 may include wired or wireless communications networks owned and/or operated by other service providers. For example, the networks 112 may include another core network connected to one or more RANs, which may employ the same RAT as the RAN 103/104/105 or a different RAT.

[0031] One or more of the WTRUs 102a, 102b, 102c, 102d in the communications system 100 may include multi-mode capabilities, *e.g.*, the WTRUs 102a, 102b, 102c, 102d may include multiple transceivers for communicating with different wireless networks over different wireless links. For example, the WTRU 102c shown in FIG. 1A may be configured to communicate with the base station 114a, which may employ a cellular-based radio technology, and with the base station 114b, which may employ an IEEE 802 radio technology.

[0032] FIG. 1B is a system diagram of an example WTRU 102. As shown in FIG. 1B, the WTRU 102 may include a processor 118, a transceiver 120, a transmit/receive element 122, a speaker/microphone 124, a keypad 126, a display/touchpad 128, non-removable memory 130, removable memory 132, a power source 134, a global positioning system (GPS) chipset 136, and other peripherals 138. It will be appreciated that the WTRU 102 may include any sub-combination of the foregoing elements while remaining consistent with an embodiment. Also,

embodiments contemplate that the base stations 114a and 114b, and/or the nodes that base stations 114a and 114b may represent, such as but not limited to transceiver station (BTS), a Node-B, a site controller, an access point (AP), a home node-B, an evolved node-B (eNodeB or eNB), a home evolved node-B (HeNB), a home evolved node-B gateway, and proxy nodes, among others, may include one or more of the elements depicted in FIG. 1B and described herein.

[0033] The processor 118 may be a general purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Array (FPGAs) circuits, any other type of integrated circuit (IC), a state machine, and/or the like. The processor 118 may perform signal coding, data processing, power control, input/output processing, and/or any other functionality that enables the WTRU 102 to operate in a wireless environment. The processor 118 may be coupled to the transceiver 120, which may be coupled to the transmit/receive element 122. While FIG. 1B depicts the processor 118 and the transceiver 120 as separate components, it will be appreciated that the processor 118 and the transceiver 120 may be integrated together in an electronic package or chip.

[0034] The transmit/receive element 122 may be configured to transmit signals to, or receive signals from, a base station (*e.g.*, the base station 114a) over the air interface 115/116/117. For example, in one embodiment, the transmit/receive element 122 may be an antenna configured to transmit and/or receive RF signals. In another embodiment, the transmit/receive element 122 may be an emitter/detector configured to transmit and/or receive IR, UV, or visible light signals, for example. In yet another embodiment, the transmit/receive element 122 may be configured to transmit and receive both RF and light signals. It will be appreciated that the transmit/receive element 122 may be configured to transmit and/or receive any combination of wireless signals.

[0035] In addition, although the transmit/receive element 122 is depicted in FIG. 1B as a single element, the WTRU 102 may include any number of transmit/receive elements 122. More specifically, the WTRU 102 may employ MIMO technology. Thus, in one embodiment, the WTRU 102 may include two or more transmit/receive elements 122 (*e.g.*, multiple antennas) for transmitting and receiving wireless signals over the air interface 115/116/117.

[0036] The transceiver 120 may be configured to modulate the signals that are to be transmitted by the transmit/receive element 122 and to demodulate the signals that are received by the transmit/receive element 122. As noted above, the WTRU 102 may have multi-mode

capabilities. Thus, the transceiver 120 may include multiple transceivers for enabling the WTRU 102 to communicate via multiple RATs, such as UTRA and IEEE 802.11, for example.

[0037] The processor 118 of the WTRU 102 may be coupled to, and may receive user input data from, the speaker/microphone 124, the keypad 126, and/or the display/touchpad 128 (*e.g.*, a liquid crystal display (LCD) display unit or organic light-emitting diode (OLED) display unit). The processor 118 may also output user data to the speaker/microphone 124, the keypad 126, and/or the display/touchpad 128. In addition, the processor 118 may access information from, and store data in, any type of suitable memory, such as the non-removable memory 130 and/or the removable memory 132. The non-removable memory 130 may include random-access memory (RAM), read-only memory (ROM), a hard disk, or any other type of memory storage device. The removable memory 132 may include a subscriber identity module (SIM) card, a memory stick, a secure digital (SD) memory card, and/or the like. In other embodiments, the processor 118 may access information from, and store data in, memory that is not physically located on the WTRU 102, such as on a server or a home computer (not shown).

[0038] The processor 118 may receive power from the power source 134, and may be configured to distribute and/or control the power to the other components in the WTRU 102. The power source 134 may be any suitable device for powering the WTRU 102. For example, the power source 134 may include one or more dry cell batteries (*e.g.*, nickel-cadmium (NiCd), nickel-zinc (NiZn), nickel metal hydride (NiMH), lithium-ion (Li-ion), *etc.*), solar cells, fuel cells, and/or the like.

[0039] The processor 118 may also be coupled to the GPS chipset 136, which may be configured to provide location information (*e.g.*, longitude and latitude) regarding the current location of the WTRU 102. In addition to, or in lieu of, the information from the GPS chipset 136, the WTRU 102 may receive location information over the air interface 115/116/117 from a base station (*e.g.*, base stations 114a, 114b) and/or determine its location based on the timing of the signals being received from two or more nearby base stations. It will be appreciated that the WTRU 102 may acquire location information by way of any suitable location-determination method while remaining consistent with an embodiment.

[0040] The processor 118 may further be coupled to other peripherals 138, which may include one or more software and/or hardware modules that provide additional features, functionality and/or wired or wireless connectivity. For example, the peripherals 138 may include an accelerometer, an e-compass, a satellite transceiver, a digital camera (for photographs or video), a universal serial bus (USB) port, a vibration device, a television transceiver, a hands free

headset, a Bluetooth® module, a frequency modulated (FM) radio unit, a digital music player, a media player, a video game player module, an Internet browser, and/or the like.

[0041] FIG. 1C is a system diagram of the RAN 103 and the core network 106 according to an embodiment. As noted above, the RAN 103 may employ a UTRA radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 115. The RAN 103 may also be in communication with the core network 106. As shown in FIG. 1C, the RAN 103 may include Node-Bs 140a, 140b, 140c, which may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 115. The Node-Bs 140a, 140b, 140c may each be associated with a particular cell (not shown) within the RAN 103. The RAN 103 may also include RNCs 142a, 142b. It will be appreciated that the RAN 103 may include any number of Node-Bs and RNCs while remaining consistent with an embodiment.

[0042] As shown in FIG. 1C, the Node-Bs 140a, 140b may be in communication with the RNC 142a. Additionally, the Node-B 140c may be in communication with the RNC 142b. The Node-Bs 140a, 140b, 140c may communicate with the respective RNCs 142a, 142b via an Iub interface. The RNCs 142a, 142b may be in communication with one another via an Iur interface. Each of the RNCs 142a, 142b may be configured to control the respective Node-Bs 140a, 140b, 140c to which it is connected. In addition, each of the RNCs 142a, 142b may be configured to carry out or support other functionality, such as outer loop power control, load control, admission control, packet scheduling, handover control, macrodiversity, security functions, data encryption, and/or the like.

[0043] The core network 106 shown in FIG. 1C may include a media gateway (MGW) 144, a mobile switching center (MSC) 146, a serving GPRS support node (SGSN) 148, and/or a gateway GPRS support node (GGSN) 150. While each of the foregoing elements are depicted as part of the core network 106, it will be appreciated that any one of these elements may be owned and/or operated by an entity other than the core network operator.

[0044] The RNC 142a in the RAN 103 may be connected to the MSC 146 in the core network 106 via an IuCS interface. The MSC 146 may be connected to the MGW 144. The MSC 146 and the MGW 144 may provide the WTRUs 102a, 102b, 102c with access to circuit-switched networks, such as the PSTN 108, to facilitate communications between the WTRUs 102a, 102b, 102c and land-line communications devices.

[0045] The RNC 142a in the RAN 103 may also be connected to the SGSN 148 in the core network 106 via an IuPS interface. The SGSN 148 may be connected to the GGSN 150. The SGSN 148 and the GGSN 150 may provide the WTRUs 102a, 102b, 102c with access to packet-

switched networks, such as the Internet 110, to facilitate communications between and the WTRUs 102a, 102b, 102c and IP-enabled devices.

[0046] As noted above, the core network 106 may also be connected to the networks 112, which may include other wired or wireless networks that are owned and/or operated by other service providers.

[0047] FIG. 1D is a system diagram of the RAN 104 and the core network 107 according to an embodiment. As noted above, the RAN 104 may employ an E-UTRA radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 116. The RAN 104 may also be in communication with the core network 107.

[0048] The RAN 104 may include eNode-Bs 160a, 160b, 160c, though it will be appreciated that the RAN 104 may include any number of eNode-Bs while remaining consistent with an embodiment. The eNode-Bs 160a, 160b, 160c may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 116. In one embodiment, the eNode-Bs 160a, 160b, 160c may implement MIMO technology. Thus, the eNode-B 160a, for example, may use multiple antennas to transmit wireless signals to, and receive wireless signals from, the WTRU 102a.

[0049] Each of the eNode-Bs 160a, 160b, 160c may be associated with a particular cell (not shown) and may be configured to handle radio resource management decisions, handover decisions, scheduling of users in the uplink and/or downlink, and/or the like. As shown in FIG. 1D, the eNode-Bs 160a, 160b, 160c may communicate with one another over an X2 interface.

[0050] The core network 107 shown in FIG. 1D may include a mobility management entity (e.g., gateway) (MME) 162, a serving gateway 164, and a packet data network (PDN) gateway 166. While each of the foregoing elements are depicted as part of the core network 107, it will be appreciated that any one of these elements may be owned and/or operated by an entity other than the core network operator.

[0051] The MME 162 may be connected to each of the eNode-Bs 160a, 160b, 160c in the RAN 104 via an S1 interface and may serve as a control node. For example, the MME 162 may be responsible for authenticating users of the WTRUs 102a, 102b, 102c, bearer activation/deactivation, selecting a particular serving gateway during an initial attach of the WTRUs 102a, 102b, 102c, and/or the like. The MME 162 may also provide a control plane function for switching between the RAN 104 and other RANs (not shown) that employ other radio technologies, such as GSM or WCDMA.

[0052] The serving gateway 164 may be connected to each of the eNode-Bs 160a, 160b, 160c in the RAN 104 via the S1 interface. The serving gateway 164 may generally route and forward

user data packets to/from the WTRUs 102a, 102b, 102c. The serving gateway 164 may also perform other functions, such as anchoring user planes during inter-eNode B handovers, triggering paging when downlink data is available for the WTRUs 102a, 102b, 102c, managing and storing contexts of the WTRUs 102a, 102b, 102c, and/or the like.

[0053] The serving gateway 164 may also be connected to the PDN gateway 166, which may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, to facilitate communications between the WTRUs 102a, 102b, 102c and IP-enabled devices.

[0054] The core network 107 may facilitate communications with other networks. For example, the core network 107 may provide the WTRUs 102a, 102b, 102c with access to circuit-switched networks, such as the PSTN 108, to facilitate communications between the WTRUs 102a, 102b, 102c and land-line communications devices. For example, the core network 107 may include, or may communicate with, an IP gateway (*e.g.*, an IP multimedia subsystem (IMS) server) that serves as an interface between the core network 107 and the PSTN 108. In addition, the core network 107 may provide the WTRUs 102a, 102b, 102c with access to the networks 112, which may include other wired or wireless networks that are owned and/or operated by other service providers.

[0055] FIG. 1E is a system diagram of the RAN 105 and the core network 109 according to an embodiment. The RAN 105 may be an access service network (ASN) that employs IEEE 802.16 radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 117. As will be further discussed below, the communication links between the different functional entities of the WTRUs 102a, 102b, 102c, the RAN 105, and the core network 109 may be defined as reference points.

[0056] As shown in FIG. 1E, the RAN 105 may include base stations 180a, 180b, 180c, and an ASN gateway 182, though it will be appreciated that the RAN 105 may include any number of base stations and ASN gateways while remaining consistent with an embodiment. The base stations 180a, 180b, 180c may each be associated with a particular cell (not shown) in the RAN 105 and may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 117. In one embodiment, the base stations 180a, 180b, 180c may implement MIMO technology. Thus, the base station 180a, for example, may use multiple antennas to transmit wireless signals to, and receive wireless signals from, the WTRU 102a. The base stations 180a, 180b, 180c may also provide mobility management functions, such as handoff triggering, tunnel establishment, radio resource management, traffic classification, quality of service (QoS) policy enforcement, and/or the like. The ASN gateway 182 may serve

as a traffic aggregation point and may be responsible for paging, caching of subscriber profiles, routing to the core network 109, and/or the like.

[0057] The air interface 117 between the WTRUs 102a, 102b, 102c and the RAN 105 may be defined as an R1 reference point that implements the IEEE 802.16 specification. In addition, each of the WTRUs 102a, 102b, 102c may establish a logical interface (not shown) with the core network 109. The logical interface between the WTRUs 102a, 102b, 102c and the core network 109 may be defined as an R2 reference point, which may be used for authentication, authorization, IP host configuration management, and/or mobility management.

[0058] The communication link between each of the base stations 180a, 180b, 180c may be defined as an R8 reference point that includes protocols for facilitating WTRU handovers and the transfer of data between base stations. The communication link between the base stations 180a, 180b, 180c and the ASN gateway 182 may be defined as an R6 reference point. The R6 reference point may include protocols for facilitating mobility management based on mobility events associated with each of the WTRUs 102a, 102b, 102c.

[0059] As shown in FIG. 1E, the RAN 105 may be connected to the core network 109. The communication link between the RAN 105 and the core network 109 may be defined as an R3 reference point that includes protocols for facilitating data transfer and mobility management capabilities, for example. The core network 109 may include a mobile IP home agent (MIP-HA) 184, an authentication, authorization, accounting (AAA) server 186, and a gateway 188. While each of the foregoing elements are depicted as part of the core network 109, it will be appreciated that any one of these elements may be owned and/or operated by an entity other than the core network operator.

[0060] The MIP-HA may be responsible for IP address management, and may enable the WTRUs 102a, 102b, 102c to roam between different ASNs and/or different core networks. The MIP-HA 184 may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, to facilitate communications between the WTRUs 102a, 102b, 102c and IP-enabled devices. The AAA server 186 may be responsible for user authentication and for supporting user services. The gateway 188 may facilitate interworking with other networks. For example, the gateway 188 may provide the WTRUs 102a, 102b, 102c with access to circuit-switched networks, such as the PSTN 108, to facilitate communications between the WTRUs 102a, 102b, 102c and land-line communications devices. In addition, the gateway 188 may provide the WTRUs 102a, 102b, 102c with access to the networks 112, which may include other wired or wireless networks that are owned and/or operated by other service providers.

[0061] Although not shown in FIG. 1E, it will be appreciated that the RAN 105 may be connected to other ASNs and the core network 109 may be connected to other core networks. The communication link between the RAN 105 and the other ASNs may be defined as an R4 reference point, which may include protocols for coordinating the mobility of the WTRUs 102a, 102b, 102c between the RAN 105 and the other ASNs. The communication link between the core network 109 and the other core networks may be defined as an R5 reference, which may include protocols for facilitating interworking between home core networks and visited core networks.

[0062] A WTRU and/or network device (e.g., MME, eNodeB, gNodeB, transmission/reception point (TRP), and/or the like) may utilize a modified Short Message Service (SMS) signaling procedure, for example, to reduce the total number of messages exchanged while ensuring proper data delivery and/or enabling backwards compatibility. For example, devices (e.g., a WTRU, such as a CIoT WTRU) operating in the context of Cellular Internet of Things (CIoT) may communicate using the modified Short Message Service (SMS) signaling. CIoT devices (e.g., CIoT WTRUs) may include low power and/or low cost devices that communicate in one or more contexts, such as sensors, vehicles, buildings, embedded electronics, actuators, etc. CIoT communications may provide network connectivity that may enable WTRUs to collect and/or exchange data. Such connectivity may implement one or more technologies, such as smart grids, virtual power plants, smart homes, intelligent transportation, smart cities, and/or the like.

[0063] The signaling associated with CIoT devices (e.g., the WTRUs) may be infrequent and/or may be small in terms of payload size. CIoT devices may be power-constrained, for example, when operating on a battery that may not be rechargeable or in a deployment that may make it difficult to obtain power. Reducing the amount of control signaling utilized for data transfer by CIoT devices may increase the efficiency (e.g., overall efficiency) and/or operating life associated with the CIoT devices. Reducing network-side signaling that supports CIoT device data transfer may increase a network's ability to support a large number of CIoT devices.

[0064] SMS procedures, including reduced transmission SMS procedures that may eliminate one or more types of control signaling, may allow CIoT devices to communicate in an efficient manner and/or may allow networks to support large numbers of CIoT devices. For example, CIoT devices may use SMS to communicate with one or more other devices (e.g., a server). For CIoT devices, the number of packets/signaling messages used for communicating with the network may be decreased. Decreasing the number of packets/signaling messages used by the CIoT devices and network when communicating may save power of the CIoT devices

and/or may result in a longer battery life of the CIoT devices. A CIoT device (e.g., a WTRU) and/or network may exchange a Service Request message. For example, the CIoT device may send the network the Service Request message. The Service Request message may include an indication that the WTRU is able to support and/or is using a reduced transmission SMS data exchange. For example, a Data Service Request may be used by a CIoT device (e.g., a WTRU) to transition from Idle Mode to Connected Mode, and/or may send data/messages to the network. [0065] FIG. 2 illustrates an example SMS signaling exchange for a mobile originating (MO) case, for example, where the CIoT device (e.g., WTRU) is in connected mode. FIG. 3 shows an example SMS signaling exchange for a MO case, for example, when the CIoT (e.g., WTRU) begins in IDLE mode and transitions to connected mode. The example illustrated in FIG. 3 may be an example of a reduced transmission SMS procedure that may reduce control plane signaling, and/or which may be used by CIoT device. Although many examples here may be described with respect to CIoT WTRUs or CIoT devices, the examples may be applicable to any type of device or WTRU and this description is not meant to be limited to a certain type of device.

[0066] FIG. 2 and FIG. 3 illustrate examples of how MO SMS traffic may work in a connected mode and/or idle mode. The SMS transmission procedure may utilize a first protocol for communications between a WTRU and an SMS Service Center (SMS-SC, which may be referred to as an SC). For example, as shown on FIG. 2, the SMS transmission procedure may utilize a first protocol for communications between a WTRU 210 and an SMS-SC 216. The protocol for communications between a WTRU (e.g., WTRU 210) and an SMS Service Center (e.g., SMS-SC 216) may be referred to as a Relay Protocol (RP). At the RP level, an SMS-SC (e.g., SMS-SC 216) may send data to a WTRU (e.g., WTRU 210) and/or a WTRU (e.g., WTRU 210) may send data to an SMS-SC (e.g., SMS-SC 216). The data sent corresponding to the RP level may be referred to as RP-DATA. The receiver (e.g., SMS-SC or WTRU) of the RP data may reply using an acknowledgement, which may be referred to as an RP-ACK. If an RP-ACK is not received within a predefined time of receipt of the RP data, a retransmission may be performed by the transmitter of the RP data.

[0067] At the Non-Access Stratum (NAS) level, there may be a protocol defined between the WTRU and the network (e.g., one or more network entities, such as an MME), which may be referred to as the Control Protocol (CP). The CP protocol may be used by an entity (e.g., a WTRU or MME) to send information to another entity. For example, as shown in FIG. 2, a WTRU (e.g., WTRU 210) may send information to an MME (e.g., MME 214) and/or the MME

(e.g., MME 214) may send information to the WTRU (e.g., WTRU 210) using the CP. The CP may carry RP data to and/or from an SMS-SC (e.g., SMS-SC 216). The data transferred via the CP may be referred to as CP-DATA. The receiver (e.g., WTRU or MME) may reply to CP-DATA using a CP-ACK. The CP-ACK message may be an acknowledgement at the CP layer and may contain information. The sending entity may retransmit the CP-DATA. For example, if the sending entity does not receive a CP-ACK from another entity, the sending entity may start a retransmission of the CP-DATA.

[0068] SMS may be used with various types of cellular communication systems, for example, Global System for Mobile communication (GSM), General Packet Radio Service (GPRS), Universal Mobile Telecommunications Service (UMTS), Evolved Packet System (EPS) (e.g., LTE), and/or 5G protocols. When using SMS, there may be one or more acknowledgements exchanged between communication entities, such as acknowledgements between a mobile device (e.g., WTRU) and on more core network entities. The acknowledgement(s) may be exchanged using one or more protocol layers. For example, the WTRU and the core network entity may send and/or receive acknowledgements at the Control Protocol (CP) layer when sending and/or receiving SMS messages. The WTRU and/or the SMS Service Center (SC) may send and/or receive acknowledgements at a protocol layer called Relay Protocol (RP). Using one or more types of acknowledgements may increase the total signaling level (e.g., may increase total traffic) in SMS. For example, using one or more types of acknowledgements may cause traffic in SMS, whether the acknowledgements are mobile originated (MO) or mobile terminated (MT). For example, if a WTRU sends an SMS message, there may be one or more (e.g., four) messages exchanged over the air.

[0069] The example shown in FIG. 2 includes WTRU 210, eNB 212, MME 214, and SMS-SC 216. As shown in FIG. 2, at 201 WTRU 210 sends a CP-DATA to MME 214. The CP-DATA may contain an RP-DATA intended for an SMS-SC, for example, at 202. At 203, the MME 214 acknowledges the reception of the CP-DATA, for example, by a CP-ACK. At 204, the MME 214 receives an RP-ACK from the SMS-SC 216, which may be intended for the WTRU 210. The MME 214 may insert the RP-ACK in a CP-DATA and/or the MME 214 may send the RP-ACK to the WTRU 210, at 205. At 206, the WTRU 210 sends a CP-ACK to the MME 214. For example, the WTRU 210 may send a CP-ACK to the MME 214 to acknowledge the reception of the CP-DATA.

[0070] The example shown in FIG. 3 includes WTRU 310, eNB 312, MME 314, and SMS-SC 316. As shown in FIG. 3, at 301 WTRU 310 sends a Service Request message to MME 314. The Service Request message may contain an RP-DATA intended for an SMS-SC 316, for

example, at 302. At 303, the MME 314 sends a Service Accept message to WTRU 310. The MME 314 may acknowledge the reception of the CP-DATA, for example, by a CP-ACK, at 304. At 305, the MME 314 receives an RP-ACK from the SMS-SC 316, which may be intended for the WTRU 310. The MME 314 may insert the RP-ACK in a CP-DATA and/or the MME 314 may send the RP-ACK to the WTRU 310, at 306. At 307, the WTRU 310 sends a CP-ACK to the MME 314. For example, the WTRU 310 may send a CP-ACK to the MME 314 to acknowledge the reception of the CP-DATA.

[0071] By modifying the SMS signaling procedures, the efficiency of SMS signaling and/or traffic may be increased. For example, Cellular Internet of Things (CIoT) applications may utilize a reduced transmission SMS procedure to transmit and/or receive data using less control signaling overhead and/or fewer messages. For example, the number of signaling messages exchanged between the CIoT device (e.g., WTRU) and/or the network may be reduced. The number of signaling messages exchanged between the CIoT device and/or the network may be reduced, for example, by transmitting and/or receiving user data, signaling information (e.g., from the Session Management (SM) layer), and/or an SMS message in fewer messages. The use of fewer messages may be achieved by including some types of signaling messages (e.g., such as a CP-ACK) in other messages of the procedure (e.g., a service accept message). The use of fewer messages may be achieved implicitly determining that a message has been provided (e.g., such as a CP-ACK) based on the presence or reception of another message of the procedure (e.g., a service accept message). For example, a WTRU may be configured to treat reception of a first message (e.g., a service accept message) as if two messages had been received (e.g., a CP-ACK and a service accept message).

[0072] The user data, signaling information, and/or an SMS message may be transmitted and/or received in fewer messages when a CIoT device transitions from an idle mode to a connected mode. For example, user data, signaling information, and/or an SMS message may be transmitted and/or received in fewer messages by transmitting and/or receiving the user data, signaling information, and/or an SMS message in a Service Request Message (e.g., Service Request CP-DATA 301, as shown in FIG. 3). User data, signaling information, and/or an SMS message may be transmitted and/or received in fewer messages when the WTRU is in a connected mode by using an EMM message. A WTRU may transition from an idle mode to a connected mode upon request from an SMS protocol entity to send an SMS message.

[0073] The WTRU and the network may negotiate a level of support. For example, the WTRU and the network may negotiate SMS capabilities of the WTRU and the network. The SMS capabilities may relate to whether the WTRU and/or the network supports legacy SMS signaling

and/or reduced transmission SMS signaling. For example, when the WTRU registers in a network (e.g., through an Attach procedure or a Tracking Area Update procedure), the WTRU may inform the network that the WTRU may have capabilities related to handling SMS messages. For example the WTRU may indicate whether the WTRU supports legacy SMS signaling and/or reduced transmission SMS signaling. In response, the network (e.g., MME) may inform the WTRU of the network's level of support (e.g. legacy SMS protocol handling vs. a reduced transmission/optimized handling) for the SMS traffic. The WTRU may inform the network of the WTRU's level of support by adding information elements in the Request message (e.g., Service Request message 301, shown in FIG. 3). The network (MME) may inform the WTRU of the network's level of support by adding information elements in the Accept message (e.g., Service Accept message 303, shown in FIG. 3). The WTRU and/or the network may inform the other entity the respective levels of support by modifying existing information elements, such as a WTRU Network Capability, an EPS Feature Support, or the like.

[0074] If the WTRU and the network support a reduced transmission SMS protocol (e.g., an optimized transmission mode, as further described herein), the WTRU may use a timer (e.g., an extended timer) that may be associated with a Service Request message (e.g., Service Request message 301, shown in FIG. 3). For example, the timer (e.g., the extended timer) may start based on the transmitting and/or receiving of the Service Request message 301. The timer may be referred to as a Service Request timer or a Service Request timer associated with a reduced transmission SMS transfer (e.g., an optimized transmission mode). The timer may be a T3417ext timer. The Service Request message may be a Data Service Request message. A Data Service Request message may be a type of Service Request message used for requesting service when the WTRU attempts to transmit/receive SMS data using a modified (e.g., reduced) SMS procedure.

[0075] The WTRU may use a timer (e.g., the Service Request timer) when it is determined that the WTRU and the network support a reduced transmission SMS protocol, and/or when the network indicates that the network uses a reduced transmission SMS protocol for the WTRU. The Service Request timer, which may be the T3417ext timer, may have a longer timeout value than a T3417 timer. If the network does not support a reduced transmission SMS protocol, such as those described herein, and/or if the network determines not to use the reduced transmission SMS protocol for the WTRU, the WTRU may use timer T3417 to guard the completion of the service request.

[0076] The WTRU and the network (e.g. MME/SGSN/CSGSN) may identify a timer that may guard a wait period within which an RP-ACK may be received (e.g., received by the WTRU)

before the CP-DATA is re-transmitted (e.g., re-transmitted by the WTRU). For example, if a predetermined amount of time passes and the WTRU does not receive an RP-ACK, the WTRU may retransmit a CP-DATA. The WTRU and/or the network may identify a timer that may provide an indication that a predefined time interval, such as $T_{SMS_extended}$, has passed. The timer (e.g., the time interval, $T_{SMS_extended}$) may guard a period of SMS re-transmission (e.g., retransmission of a CP-DATA). For example, if the WTRU receives the RP-ACK before the timer expires, the WTRU may not re-transmit CP-DATA. If the WTRU fails to receive the RP-ACK before the timer expires, the WTRU may re-transmit CP-DATA. Use of the timer, as described herein, may reduce associated signaling between the WTRU and the network and make transmitting an SMS more efficient.

[0077] The WTRU and the network may determine a timer as part of an Attach or a Tracking/Routing Area Update. In determining a timer, the WTRU and/or the network may use indications, information elements, and/or capability indications (e.g., separate indications, information elements, and/or capability indications).

[0078] In the reduced transmission SMS protocol, one or more (e.g., all) acknowledgement messages may be eliminated and/or acknowledgments may be indicated implicitly rather than explicitly. For example, predefined explicit acknowledgement messages in a mobile originated case may be eliminated.

[0079] FIG. 4 illustrates an example message flow for SMS communications that may be used, for example when the WTRU transitions from an idle mode to a connected mode. When transitioning from idle mode to a connected mode, one or more predefined acknowledgement messages may be eliminated and/or acknowledgments may be indicated implicitly rather than explicitly. Eliminating CP-ACK messages, including the CP-ACK in other service request procedure messages, and/or implicitly indicating CP-ACK messages, may reduce SMS communications.

[0080] An RP-ACK may be utilized. For example, an RP-ACK may be used by a device (e.g., WTRU) in order to determine whether to attempt to resend an SMS (RP-DATA) message if the device does not receive the RP-ACK with a time window.

[0081] The example shown in FIG. 4 includes WTRU 410, eNB 412, MME 414, and SMS-SC 416. As shown in FIG. 4, at 401 WTRU 410 sends a Service Request message to MME 414. The Service Request message may contain an RP-DATA intended for an SMS-SC 416, for example, at 402. At 403, the MME 414 sends an EPS Mobility Management (EMM) Service Accept message to WTRU 410. The EMM Service Accept message may be used (e.g., transmitted) in response to a Service Request, such as a Data Service Request. Receiving the

EMM Service Accept message may indicate (e.g., implicitly indicate) to the WTRU that the service request may be finalized. An EMM layer in the WTRU may send an indication to an SMS protocol entity, which may be in the WTRU, that the network may have sent a positive response. The indication may be interpreted by the WTRU, which may be the EMM entity in the WTRU and/or the SMS entity in the WTRU, as a CP-ACK.

[0082] The MME 414 may transmit the CP-ACK in the Service Accept message and/or the EMM layer in the device. Transmitting the CP-ACK in the Service Accept message may indicate (e.g., explicitly indicate) to the WTRU that the service request may be finalized. The EMM entity in the WTRU may provide the CP-ACK to the SMS entity. For example, the MME 414 may include the CP-ACK in the Service Accept message and/or the EMM in the WTRU may send the CP-ACK to the SMS entity.

[0083] FIG. 5 shows an example message flow that may use a Service Accept message to reduce SMS communications. For example, FIG. 5 shows messages between an EMM entity 512 and an SMS entity 510 that may be in WTRU.

[0084] As shown in FIG. 5, the EMS entity 512 may send a Data Service Request, at 501, and may receive a Service Accept message, at 502. The Service Accept message may include a CP-ACK. If the EMM entity 512 receives a CP-ACK in the Service Accept message, the EMM entity 512 may, at 503A, forward the CP-ACK to the SMS entity 510. If the EMM entity 512 does not receive a CP-ACK in the Service Accept message, the EMM entity 512 may, at 503B, send an implicit CP-ACK indicator to the SMS entity 510. The SMS entity 510 may consider the implicit CP-ACK as an equivalent to the reception of a CP-ACK.

[0085] SMS (or CP-DATA) re-transmissions by the WTRU may be reduced. For example, unnecessary SMS (or CP-DATA) re-transmissions by the WTRU may be reduced. To discourage one or more SMS (or CP-DATA) re-transmissions by the WTRU, such as due to a delayed CP-ACK and/or RP-ACK, the WTRU may start a timer, such as a T3417ext timer. For example, the WTRU may start a timer when the WTRU sends the Data Service Request. The WTRU may include a time period in the Data Service Request. The WTRU may include a time period in the Data Service Request, for example, to inform the MME about the period of time that the WTRU may wait before re-transmitting a CP-DATA. The time period may be longer than the T3417ext timer and/or the time period may be the time that is associated with the Data Service Request. The time period may be used by the MME to send an RP-ACK, which may be embedded in a CP-DATA, to the WTRU after an RP-ACK is received by the MME from the SMS-SC. Before sending a CP-ACK to a WTRU, the MME may wait for a predetermined time in the Data Service Request, a time period that may be configured in the MME, and/or a

reception of the RP-ACK as indicated in the subscription profile of the WTRU. If the timer expires and the MME did not receive an RP-ACK from the SMS-SC, the MME may send a CP-ACK to the WTRU. If the MME receives an RP-ACK from the SMS-SC before the timer expires, the MME may send the CP-ACK and/or the RP-ACK to the WTRU. The CP-ACK and/or the RP-ACK may be sent in the Service Accept message. The RP-ACK may be embedded in a CP-DATA in the Service Accept message.

[0086] FIG. 6 shows an example message flow that may be used to negotiate SMS messages and/or timers between a WTRU and a MME. The example shown in FIG. 6 includes WTRU 610, MME 614, and SMS-SC 616. At 601, the WTRU 610 and MME 614 may determine (e.g., negotiate) a timer for CP-DATA Retransmission. The WTRU 610 and MME 614 may determine a timer as part of an Attach procedure and/or Tracking Area Update (TAU) and/or Routing Area Update (RAU). WTRU 610, at 602, sends a Service Request message to MME 614. The Service Request message may contain a timer for CP-DATA retransmission by the WTRU 610. The Service Request may contain an RP-DATA intended for an SMS-SC 616. The MME 614 sends an RP-DATA message to SMS-SC 616, at 603

[0087] As shown in FIG. 6, MME 614 may send a Service Accept message with CP-ACK and/or CP-DATA (with RP-ACK). At 606A, the MME 614 may send a Service Accept message with CP-ACK and/or CP-DATA (with RP-ACK) if a timer does not expire at the MME 614. At 606B, the MME 614 may send a Service Accept message with the CP-ACK if the timer expires.

[0088] The SMS-SC 616 sends an RP-ACK to the MME 614, at 605 (e.g., 605A, 605B). If, at 606A, the MME 614 sends the CP-ACK and/or the CP-DATA (which may include the RP-ACK) in the Service Accept message, the MME 614 may include the messages as one or more (e.g., two) separate components and/or information elements. For example, the MME 614 may use one or more (e.g., two, such as two different) information elements of TLV (e.g. Type, Length and Value) format to separate the CP-ACK from the CP-DATA, which may include the RP-ACK. The type field may be set to an SMS container and/or the length field may be set to the length of the CP-ACK and/or the CP-DATA, which may include the RP-ACK. When the WTRU 610 receives a Service Accept message (which may include two IEs of TLV format components and/or information elements, as described herein), the EMM entity (e.g., the EMM entity of the WTRU 610) may forward one or more of the components to the SMS entity (e.g., the SMS entity of the WTRU 610). The SMS entity may interpret one or more (e.g., both) components to determine that a first component may be a CP-ACK and/or the second component may be a CP-DATA (which may include the RP-ACK).

[0089] When the WTRU 610 sends a Data Service Request, at 602, the Data Service Request may indicate to the MME 614 that a CP-ACK may be omitted. The indication that the CP-ACK may be omitted may be performed using an indication and/or information element (IE) in the message. The WTRU 610 may rely on the lower layer acknowledgements, such as the Radio Link Control (RLC)-ACK at the RLC level, to determine that the message (*e.g.* CP-DATA) has been received in the MME. The lower layers, such as the RLC or PDCP, may inform the EMM entity that an acknowledgement has been received. For example, a lower layer may indicate to the EMM entity that an acknowledgment from the eNB at the peer RLC or PDCP entity has been received. As described herein, the EMM entity may identify the indication that the acknowledgement has been received as an implicit CP-ACK. The EMM entity may send an indication to the SMS entity that an implicit CP-ACK has been received. The WTRU 610 may wait for the Service Accept message. Waiting for the Service Accept message may give the MME 614 the option to wait for the RP-ACK from the SMS-SC before sending the Service Accept message to the WTRU 610. When the MME 614 receives the RP-ACK from the SMS-SC 616, the MME 614 may send a Service Accept message with the CP-DATA, which may include the RP-ACK. The MME 614 may send a Service Accept message with the CP-DATA to the WTRU 610. The WTRU 610 may determine the service request to have successfully completed, and/or the WTRU 610 may stop the associated timer, which may be a T3417ext timer. The EMM entity may forward the CP-DATA, which may include the RP-ACK, to the SMS entity.

[0090] The MME 614 may send CP-DATA in one or more NAS messages, at 607. If the MME 614 determines to send (*e.g.*, send separately) the CP-DATA (which may include an RP-ACK) in NAS messages, the MME 614 may indicate in the NAS message that a CP-ACK may not be needed. The NAS messages may not be the Service Accept message. Not needing a CP-ACK may save a transmission from the WTRU 610. The MME 614 may send the NAS message (which may include the CP-DATA) and/or may request the eNB to release the NAS connection of the WTRU 610. The eNB may send the NAS message embedded in an RRC Connection Release message. The WTRU 610 may receive a NAS message in the RRC Connection Release message. The NAS message may include an SMS container. The EMM entity may forward the SMS container to the SMS entity and/or may indicate that a CP-ACK may not be needed. The EMM may indicate whether the NAS message is received in the RRC Connection Release message and/or if the NAS message (which may be sent by the MME) includes an indication (*e.g.* set by the MME) that no CP-ACK may be needed and/or transmitted by the WTRU.

[0091] FIG. 7 shows an example message flow for SMS communications that may be used in a connected mode. The example shown in FIG. 7 includes WTRU 710, eNB 712, MME 714, and SMS-SC 716. An efficient (e.g., a more efficient) SMS protocol may be provided for a connected mode. For example, a reduced transmission SMS protocol may be used by a WTRU operating in connected mode. At 701, WTRU 710 may send a CP-DATA message. The WTRU 710 may be in connected mode. The CP-DATA message may contain an SMS message. The CP-DATA may not expect a CP-ACK message from the MME 714. At 702, the MME 714 may send RP-DATA to SMS-SC 716 and, at 704, the MME 714 may receive an RP-ACK from SMS-SC 716. At 705, MME 714 may send the CP-DATA with an RP-ACK to the WTRU 710. For example, MME 714 may send the CP-DATA with an RP-ACK to the WTRU 710 when MME 714 receives a RP-ACK from the SMS service center 716. Upon reception of the CP-DATA, which may include an RP-ACK at the WTRU 710, the MME 714 may send the CP-DATA to the SMS entity, which may determine the CP-DATA to be a CP-ACK.

[0092] When the Service Center sends the RP-ACK, at 704, the RP-ACK may arrive at the MME 714. The MME 714 may insert the RP-ACK in a CP-DATA and may send the RP-ACK to the WTRU 710, at 705. The reception of the RP-ACK at the WTRU 710 may indicate that the Mobile Originated SMS service may be successful. The WTRU 710 may send one or more CP-ACKs to the MME 714. The MME 714 may insert an indicator and/or an information element that may inform the WTRU 710 that sending a CP-ACK may be unnecessary. A mechanism other than the CP-ACK may be used to allow the MME 714 to ensure that the WTRU 710 received the CP-DATA that includes the RP-ACK. For example, the RAN may send an indication to the MME 714 upon receiving final acknowledgement at the Layer 2 (e.g. RLC) to indicate to the MME 714 that the WTRU received the CP-DATA with the RP-ACK. For example, the WTRU 710, at 706, may send an RLC-ACK to the eNB 712. At 707, the eNB 712 may send a CP-ACK to the MME 714.

[0093] A reduced transmission SMS protocol may be used by the network and/or WTRU for a mobile terminated SMS scenario. In the case of Mobile Terminated SMS traffic, a WTRU may be paged. When the WTRU decodes the paging message, the WTRU may respond to the network by using a Service Request message, which may be a Data Service Request message. The MME may send a CP-DATA, which may include RP-DATA. The MME may use an indicator and/or IE that may inform the WTRU that the MME may not have to reply to the CP-DATA using a CP-ACK. The WTRU may send a CP-DATA that may include an RP-ACK to the SMS-SC. The message may have an indicator and/or IE that may inform the MME that the WTRU received and/or decoded the CP-DATA from the MME. The WTRU may include an

information element (IE) and/or indicator that may inform the MME that there may not be a need to send back a CP-ACK.

[0094] Although features and elements are described above in particular combinations, one of ordinary skill in the art will appreciate that each feature or element can be used alone or in any combination with the other features and elements. In addition, the methods described herein may be implemented in a computer program, software, or firmware incorporated in a computer-readable medium for execution by a computer or processor. Examples of computer-readable media include computer-readable storage media. Examples of computer-readable storage media include, but are not limited to, a read only memory (ROM), a random access memory (RAM), a register, cache memory, semiconductor memory devices, magnetic media such as internal hard disks and removable disks, magneto-optical media, and optical media such as CD-ROM disks, and digital versatile disks (DVDs). A processor in association with software may be used to implement a radio frequency transceiver for use in a WTRU, WTRU, terminal, base station, RNC, or any host computer.

CLAIMS

What Is Claimed:

1. A wireless transmit/receive unit (WTRU) for using a short message service (SMS), the WTRU comprising:
 - a processor, and;
 - a memory, the memory comprising instructions that when executed by the processor cause the processor to:
 - send, to a mobility management entity (MME), an indication that the WTRU is operating in an optimized transmission mode for SMS, wherein the WTRU communicates with the MME using fewer messages in the optimized transmission mode for SMS than in a normal mode for SMS;
 - send a data service request to the MME, wherein the data service request comprises control protocol (CP)-DATA and relay protocol (RP)-DATA;
 - receive a service accept message from the MME; and
 - based on receiving the service accept message from the MME, implicitly determine that the CP-DATA has been successfully acknowledged.
2. The WTRU of claim 1, wherein an Evolved Packet System (EPS) Mobility Management (EMM) layer of the WTRU indicates to an SMS layer of the WTRU that successful acknowledgement of the CP-DATA has been implicitly determined.
3. The WTRU of claim 1, wherein the processor receives the service accept message from the MME when the WTRU is transitioning from an idle mode to a connected mode.
4. The WTRU of claim 1, wherein the data service request comprises the indication that the WTRU is performing in the optimized transmission mode.
5. The WTRU of claim 1, wherein the data service request indicates to the MME to refrain from sending a CP-ACK.
6. The WTRU of claim 1, wherein the service accept message comprises a CP-ACK.

7. The WTRU of claim 1, wherein the processor implicitly determines that the CP-DATA has been successfully acknowledged, absent the WTRU receiving a CP-ACK.
8. The WTRU of claim 1, wherein the WTRU uses the SMS in a Cellular Internet of Things (CIoT).
9. A wireless transmit/receive unit (WTRU) for using a short message service (SMS), the WTRU comprising:
 - a processor, and;
 - a memory, the memory comprising instructions that when executed by the processor cause the processor to:
 - send, to a mobility management entity (MME), an indication that the WTRU is operating in an optimized transmission mode for SMS, wherein the WTRU communicates with the MME using fewer messages in the optimized transmission mode than in a normal mode for SMS;
 - send a data service request to the MME, wherein the data service request comprises control protocol (CP)-DATA and relay protocol (RP)-DATA; and
 - receive a service accept message from the MME, wherein the service accept message comprises a CP-ACK.
10. The WTRU of claim 9, wherein an Evolved Packet System (EPS) Mobility Management (EMM) layer of the WTRU forwards the CP-ACK from the service accept message to an SMS layer of the WTRU.
11. The WTRU of claim 9 wherein an Evolved Packet System (EPS) Mobility Management (EMM) layer of the WTRU indicates to an SMS layer of the WTRU that successful acknowledgement of the CP-DATA has been implicitly determined.
12. The WTRU of claim 9, wherein a Radio Link Control (RLC) layer of the evolved node-B (eNodeB) or a Packet Data Convergence Protocol (PDCP) layer of the eNodeB indicates to the WTRU that the CP-DATA has been received at the MME.
13. The WTRU of claim 12, wherein the RLC layer of the eNodeB or the PDCP layer of the eNodeB indicates to the WTRU that the CP-DATA has been received at the MME, prior to the WTRU receiving the service accept message from the MME.

14. A mobility management entity (MME) for using a short message service (SMS), the MME comprising:
 - a processor, and;
 - a memory, the memory comprising instructions that when executed by the processor cause the processor to:
 - receive, from a wireless transmit/receive unit (WTRU), an indication that the WTRU is operating in an optimized transmission mode for SMS, wherein the WTRU communicates with the MME using fewer messages in the optimized transmission mode than in a normal mode for SMS;
 - receive a data service request from the WTRU, wherein the data service request comprises control protocol (CP)-DATA and relay protocol (RP)-DATA;
 - and
 - send a service accept message to the WTRU, wherein the service accept message implicitly indicates to the WTRU that the CP-DATA has been successfully acknowledged.
15. The MME of claim 14, wherein the processor refrains from sending a CP-ACK to the WTRU.
16. The MME of claim 14, wherein the service accept message is an implicit CP-ACK.
17. A method for using a short message service (SMS), the method comprising:
 - sending, from a wireless transmit/receive unit (WTRU) to a mobility management entity (MME), an indication that the WTRU is operating in an optimized transmission mode for SMS, wherein the WTRU communicates with the MME using fewer messages in the optimized transmission mode for SMS than in a normal mode for SMS;
 - sending, via a control protocol (CP), a data service request to the MME, wherein the data service request comprises CP-DATA and relay protocol (RP)-DATA;
 - receiving, via the CP, a service accept message from the MME; and
 - based on receiving the service accept message from the MME, implicitly determining that the CP-DATA has been successfully acknowledged.

18. The method of claim 17, wherein an Evolved Packet System (EPS) Mobility Management (EMM) layer of the WTRU indicates to an SMS layer of the WTRU that successful acknowledgement of the CP-DATA has been implicitly determined.
19. The method of claim 17, wherein the processor receives the service accept message from the MME when the WTRU is transitioning from an idle mode to a connected mode.
20. The method of claim 17, wherein the data service request comprises the indication that the WTRU is performing in the optimized transmission mode.
21. The method of claim 17, wherein the data service request indicates to the MME to refrain from sending the CP-ACK.
22. The method of claim 17, wherein the service accept message comprises a relay protocol (RP)-ACK.
23. The method of claim 17, wherein it is determined that the CP-DATA has been successfully acknowledged, absent the WTRU receiving a CP-ACK.
24. The method of claim 17, wherein the WTRU uses the SMS in a Cellular Internet of Things (CIoT).

100

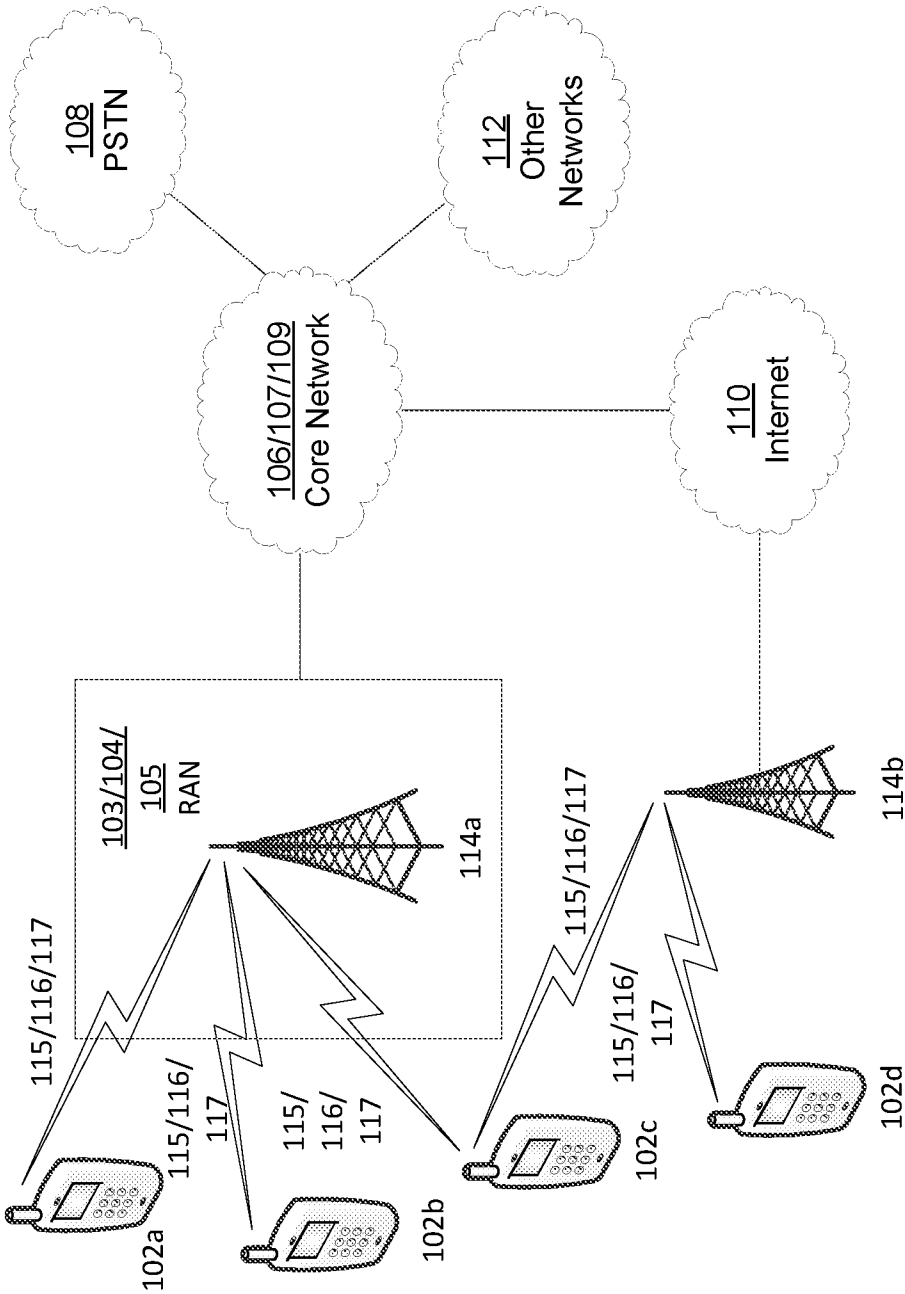


FIG. 1A

2/11

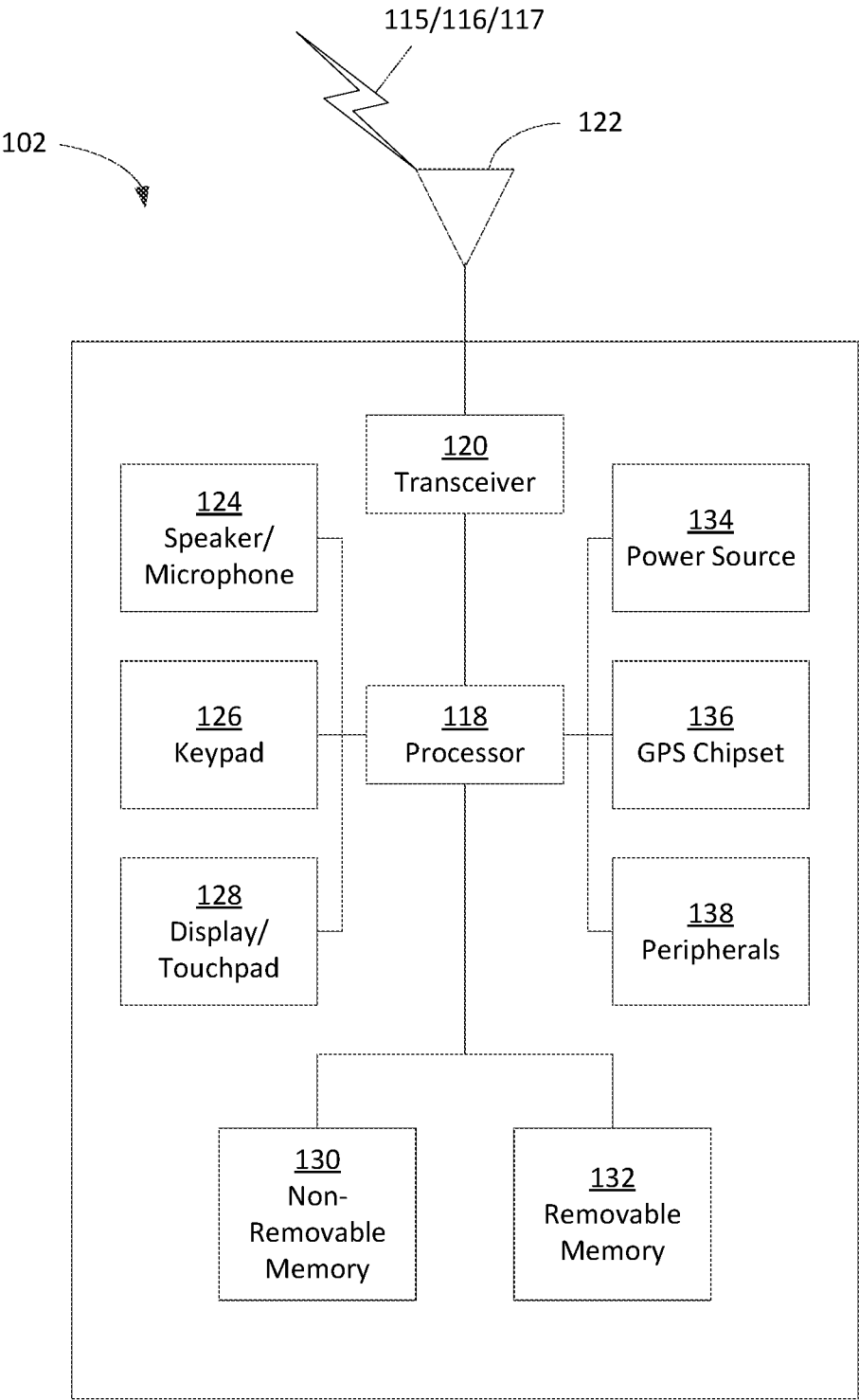


FIG. 1B

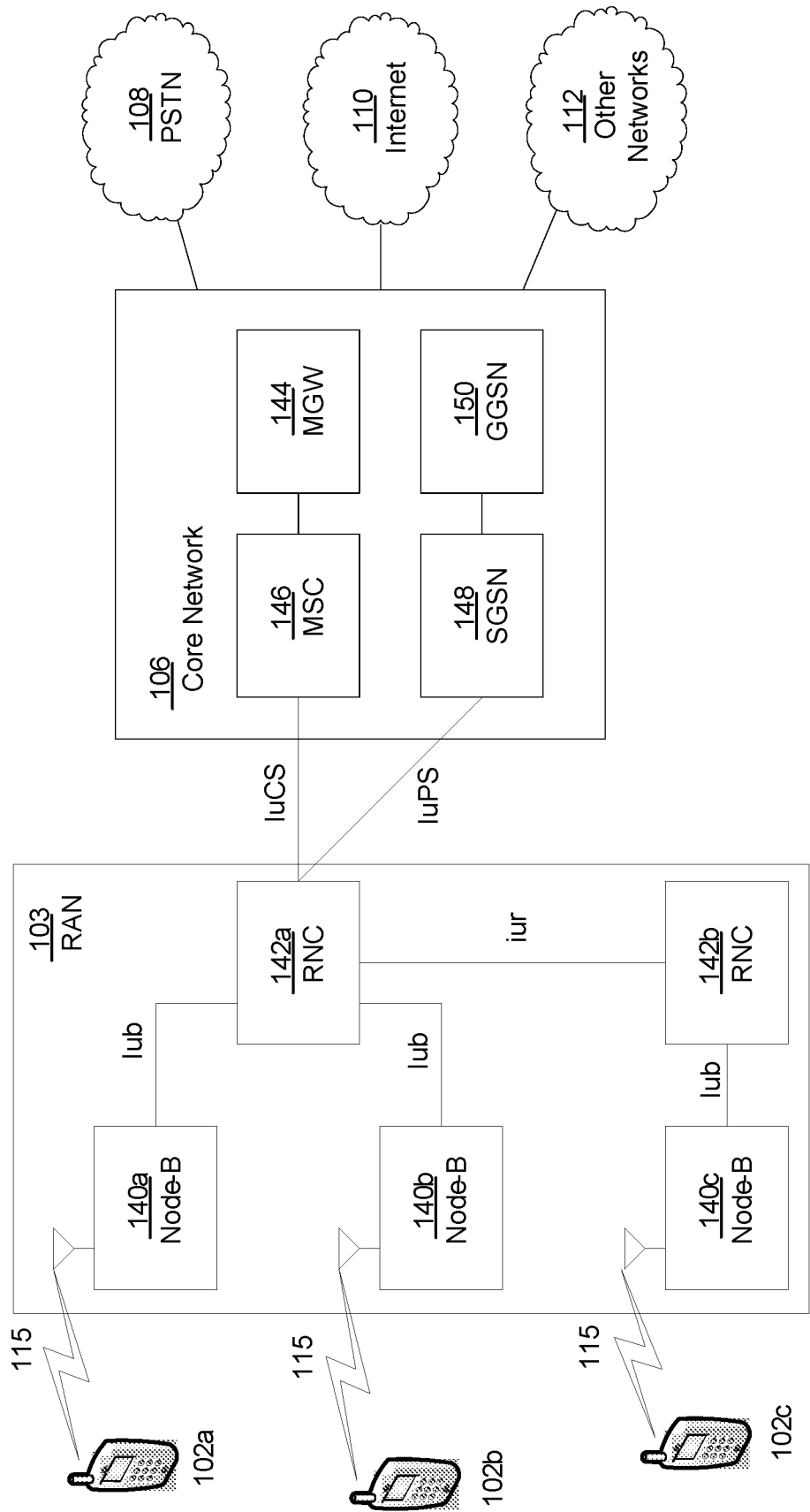


FIG. 1C

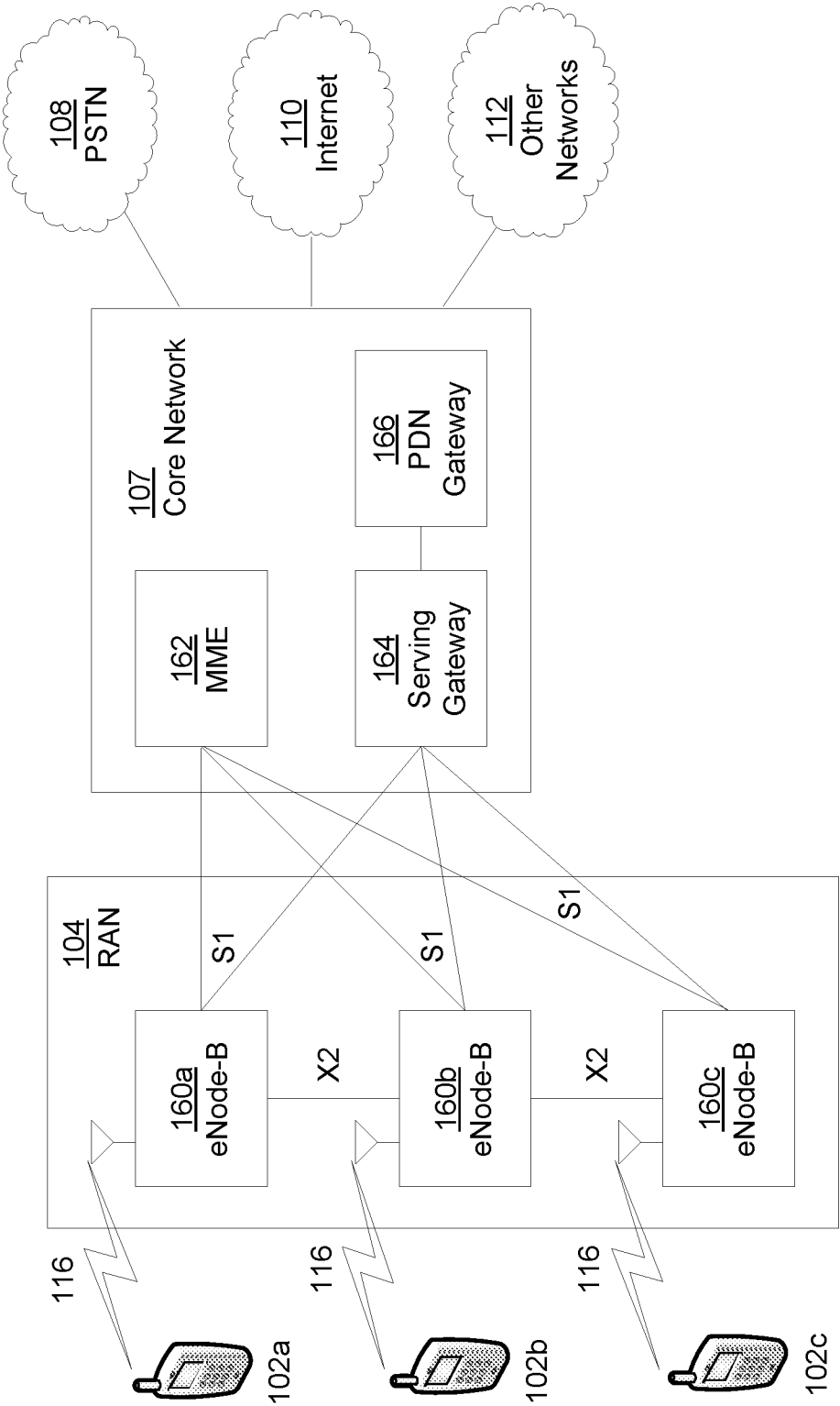


FIG. 1D

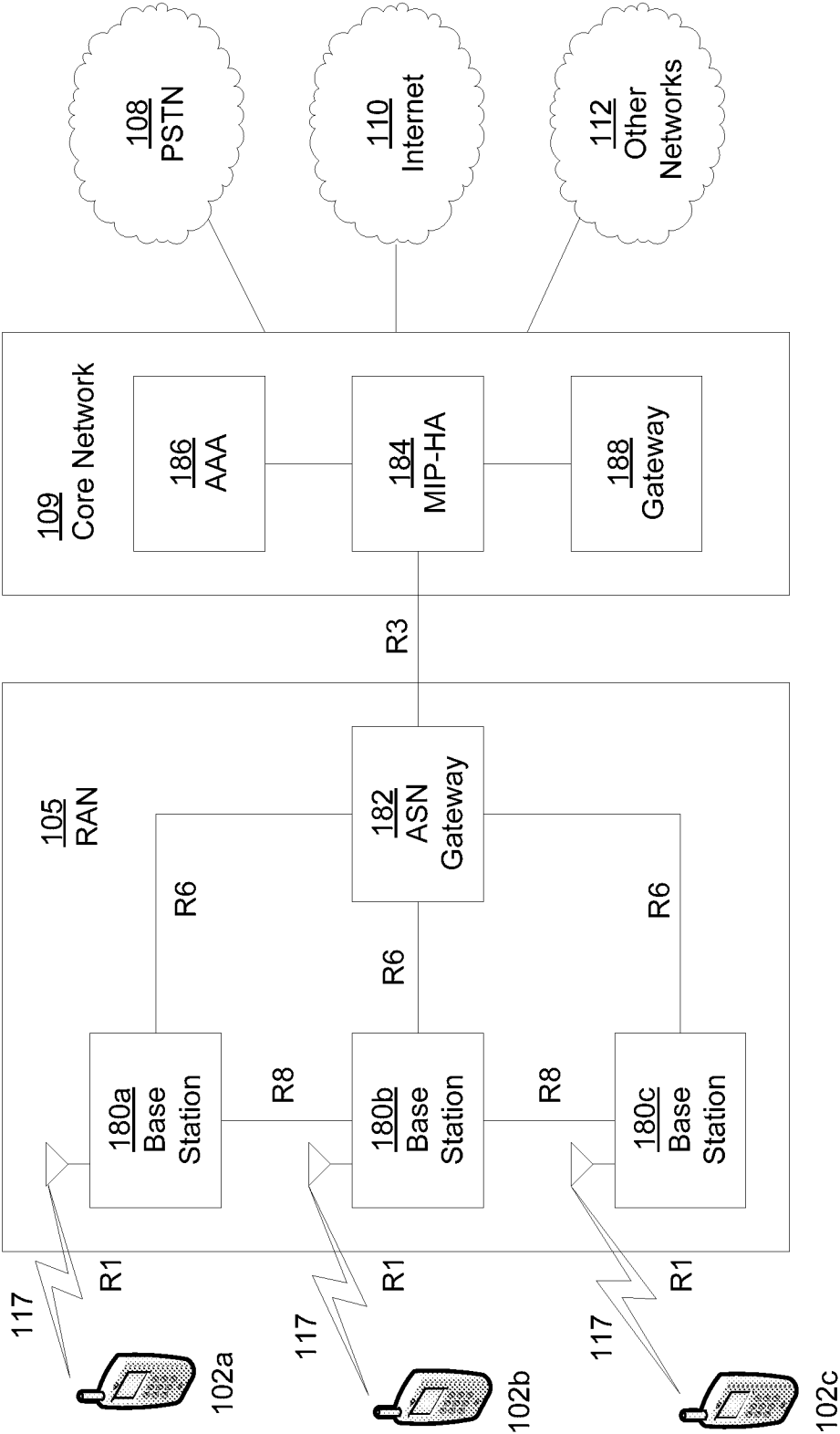


FIG. 1E

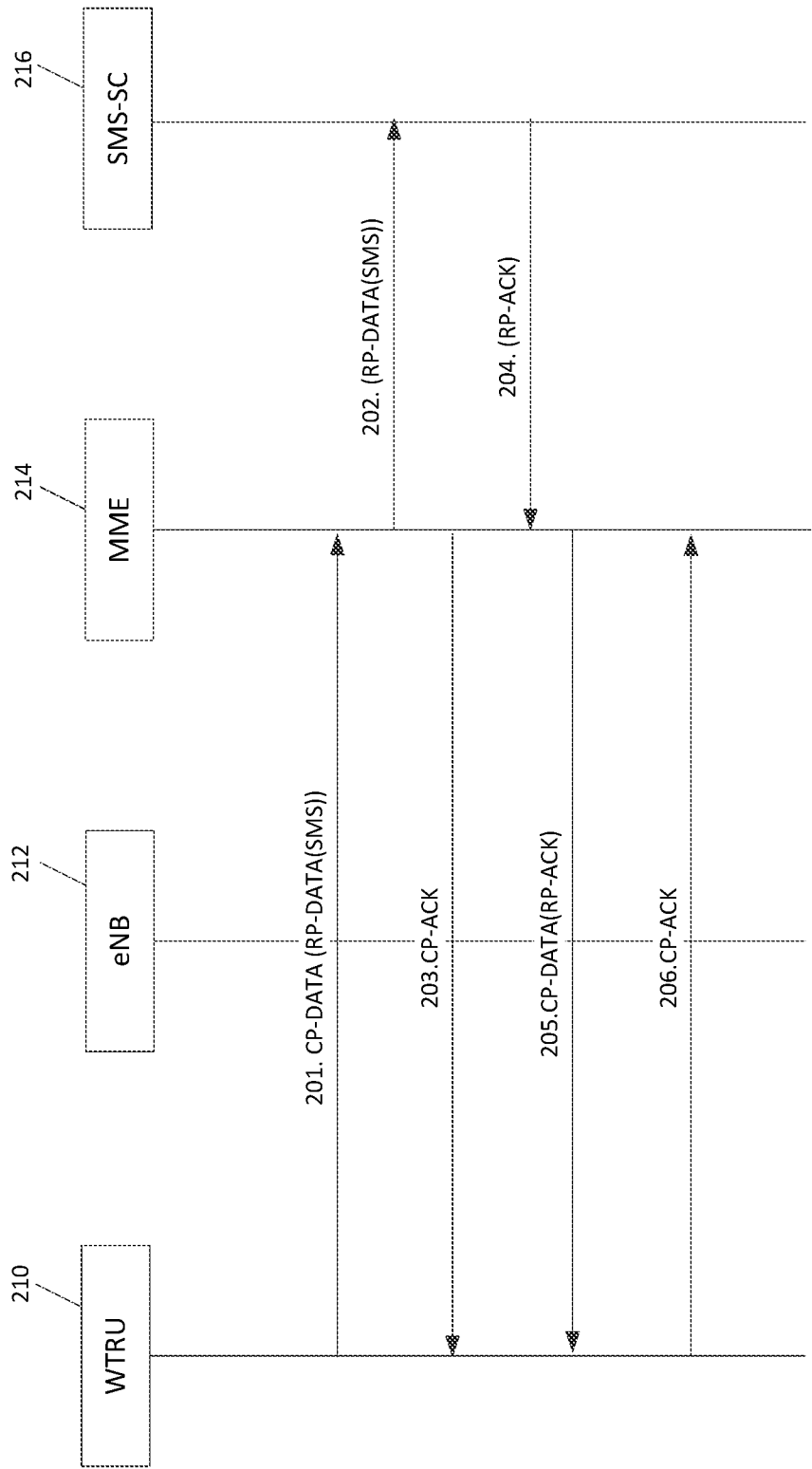


FIG. 2

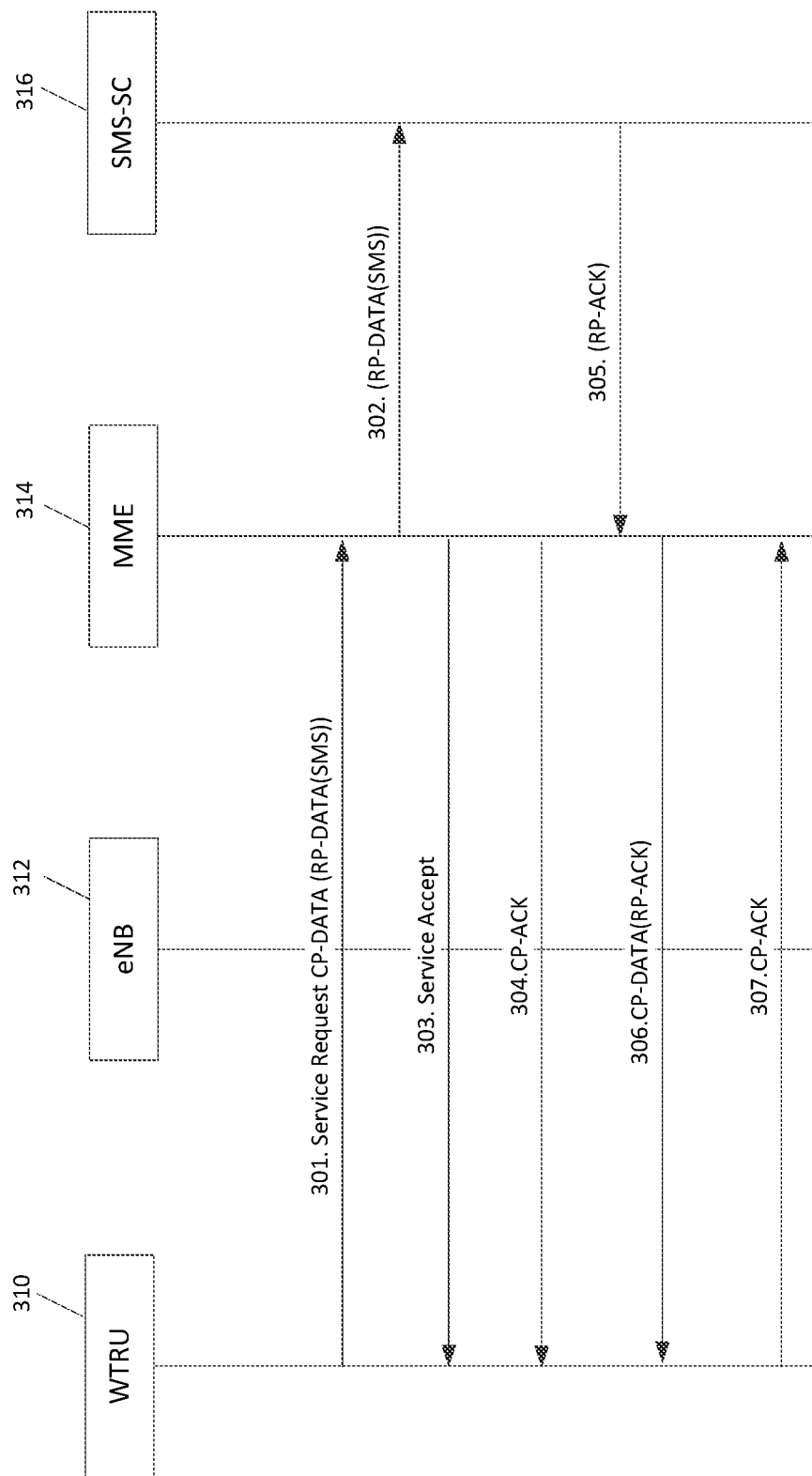


FIG. 3

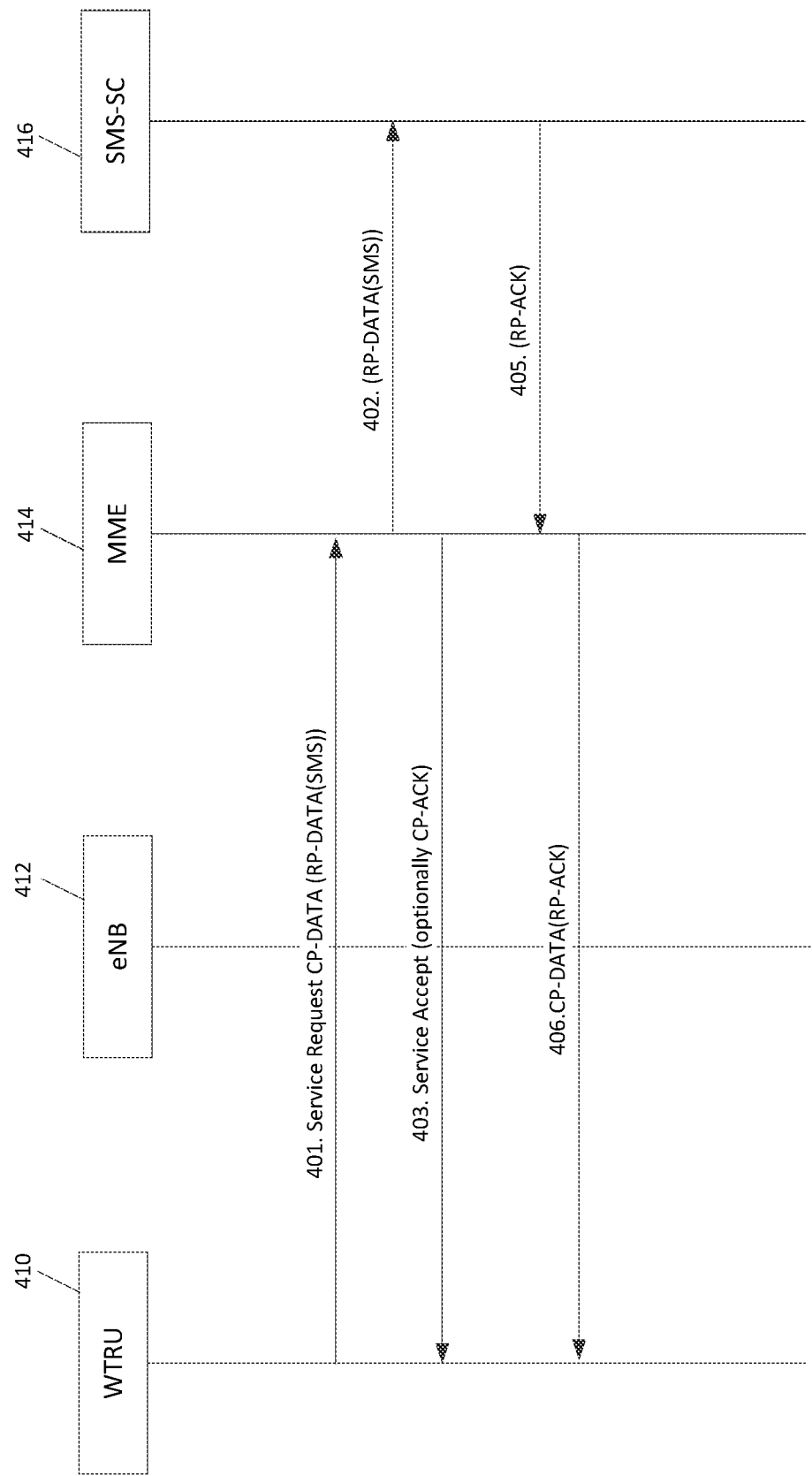


FIG. 4

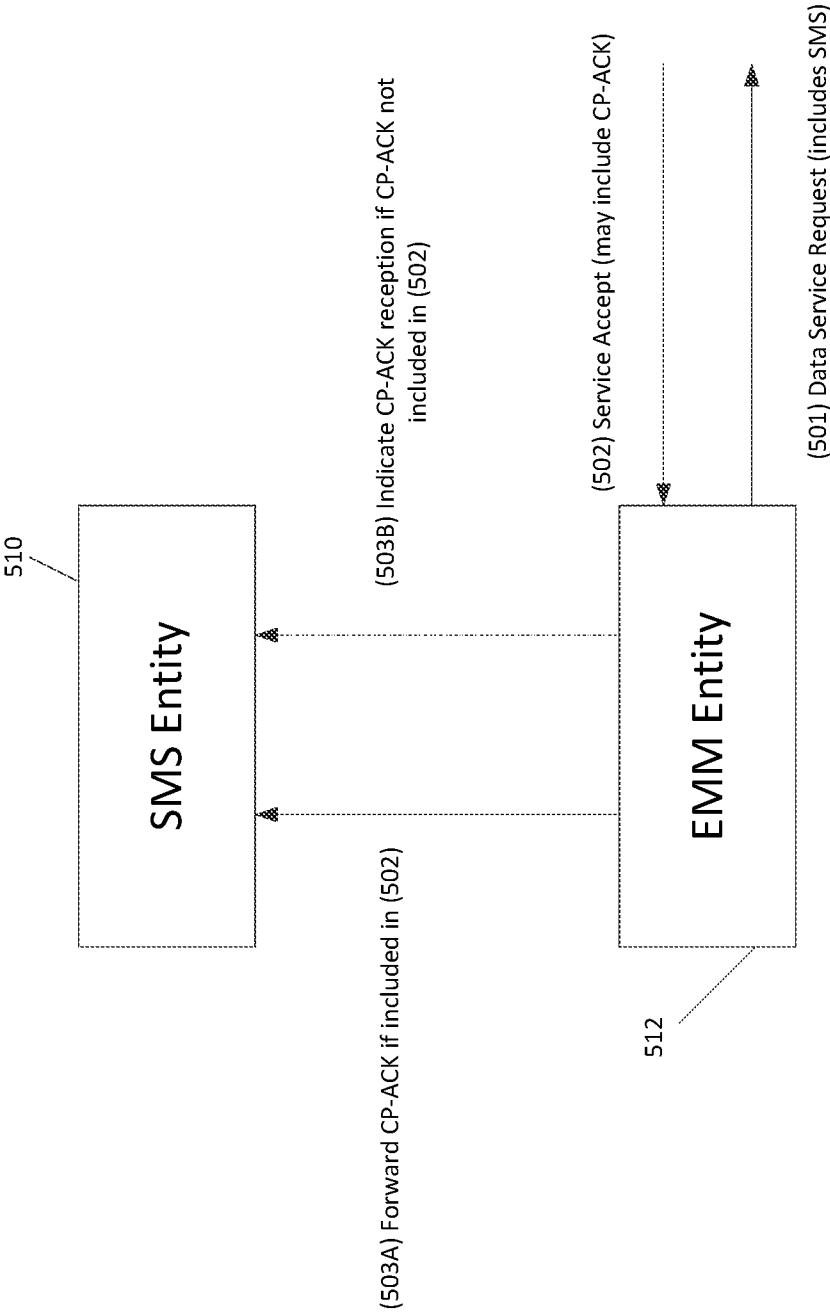


FIG. 5

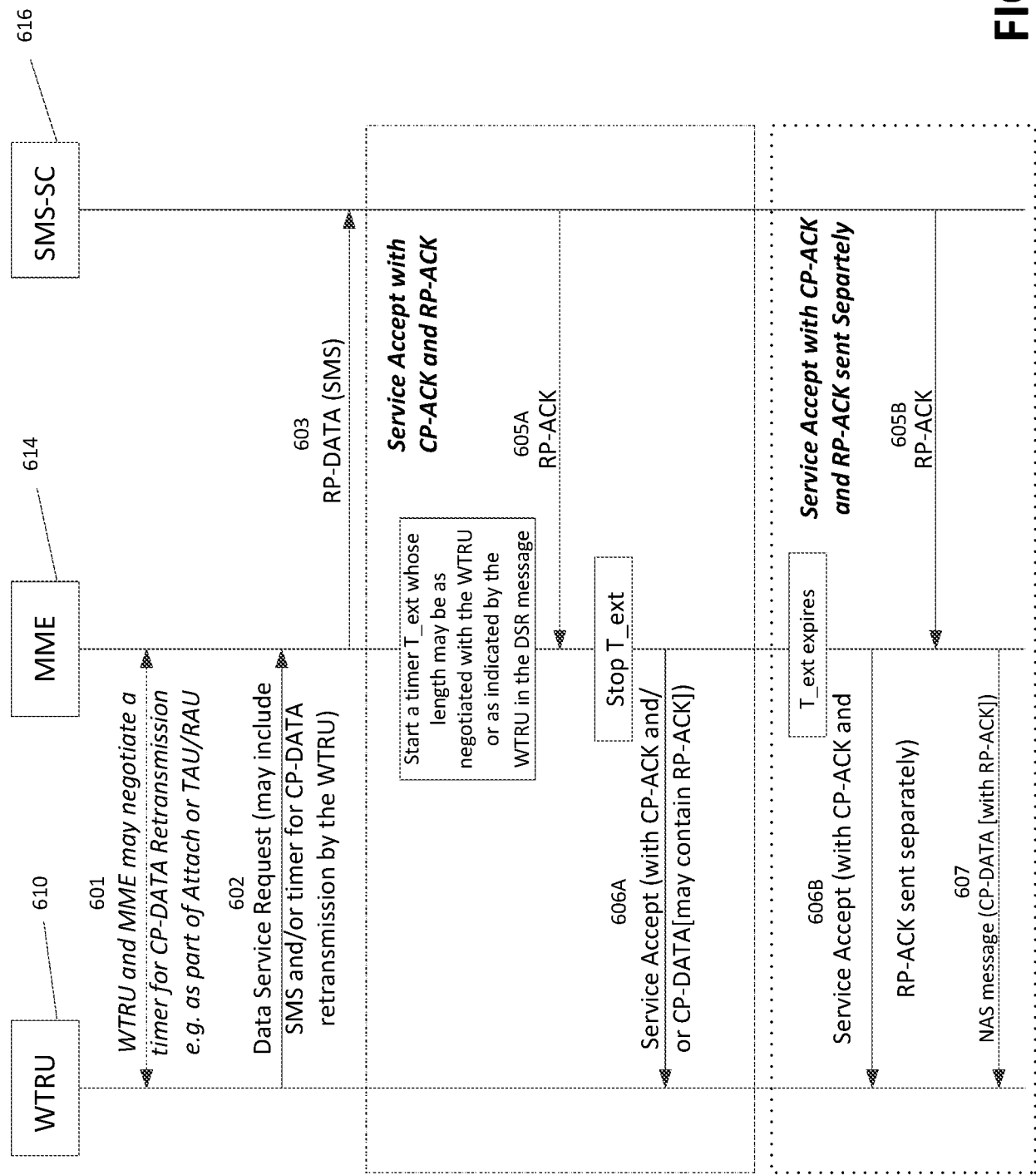


FIG. 6

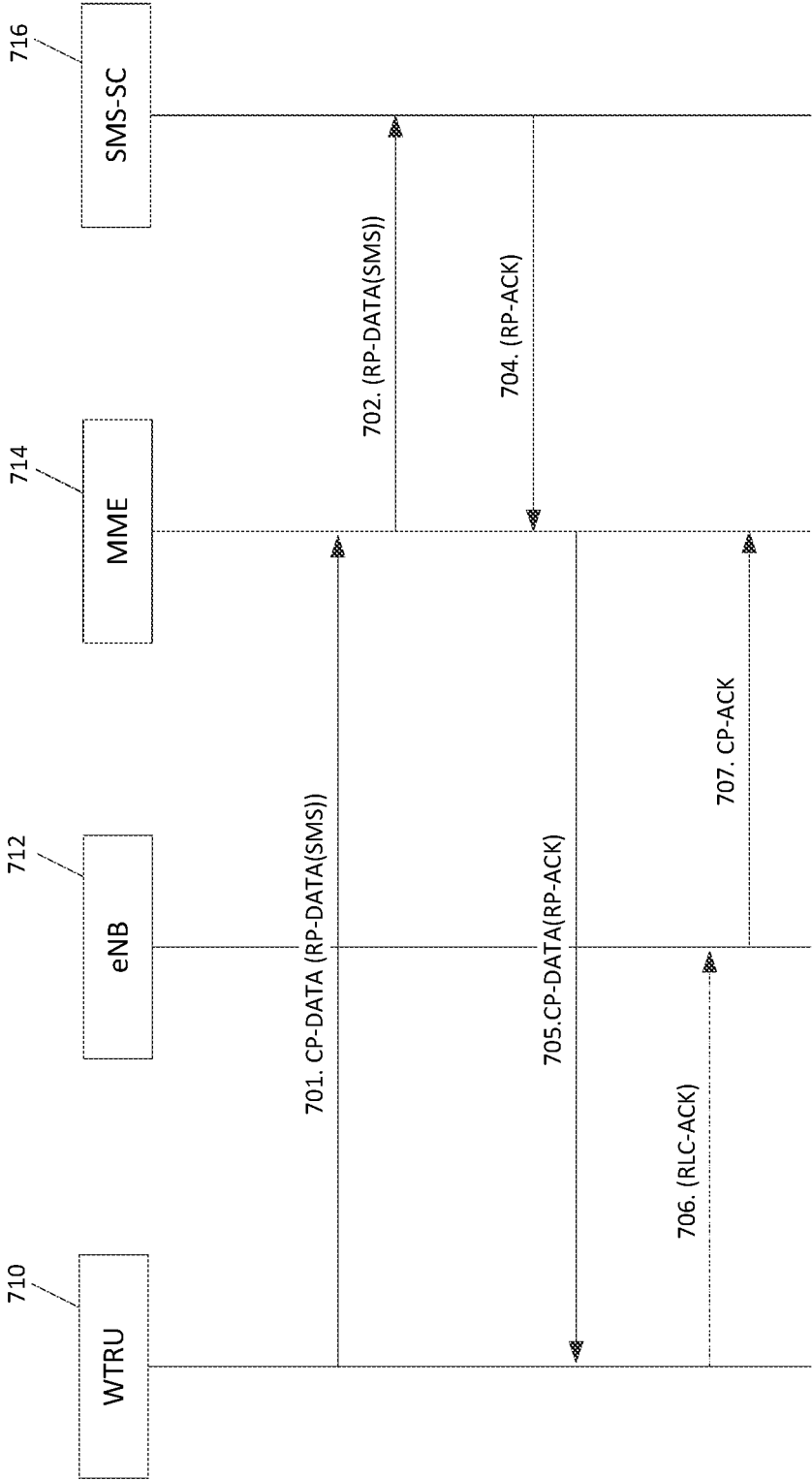


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/029870

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W4/14
ADD.

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 H04L

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study on architecture enhancements for Cellular Internet of Things (Release 13)", 3GPP STANDARD; 3GPP TR 23.720, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. SA WG2, no. V13.0.0, 15 March 2016 (2016-03-15), pages 1-94, XP051087943, [retrieved on 2016-03-15] abstract Section "6.16 Solution 16: Optimised SMS over PS without combined attach and default PDN connection" on page 71-76 -/-	1-24



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"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

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"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

24 July 2017

Date of mailing of the international search report

08/08/2017

Name and mailing address of the ISA/

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Authorized officer

Bub, Armin

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2017/029870

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Section "6.17 Solution 17: Optimized SMS relay for CIoT" on page 76-79 ----- US 2014/287752 A1 (STOJANOVSKI SASO [FR]) 25 September 2014 (2014-09-25) abstract claims 1,8,9 figures 2,3 paragraph [0021] - paragraph [0052] -----	1-24

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2017/029870

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