



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

(21) International Application Number:
PCT/US2024/044612

(22) International Filing Date:
30 August 2024 (30.08.2024)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/536,148 01 September 2023 (01.09.2023) US

(71) Applicant: **INTERDIGITAL PATENT HOLDINGS, INC.** [US/US]; 200 Bellevue Parkway, Suite 300, Wilmington, Delaware 19809 (US).

(72) Inventors: **OGNENOSKI, Ognen**; 64 Great Eastern Street, Flat 5, London Greater London EC2A 3QR (GB). **MESTRAH, Yasser**; 80 Leadenhall St. 4th Floor, London Greater London EC3A 3DH (GB). **MOURAD, Alain**; 80 Leadenhall St. 4th Floor, London Greater London EC3A 3DH (GB). **PELLETIER, Benoit**; 1000 Sherbrooke St., Montreal, Québec H3A 3G4 (CA). **HASEGAWA, Fumihiro**; 1000 Sherbrooke St., Montreal, Québec H3A 3G4

(CA). **TOOHER, Patrick**; 1000 Sherbrooke St., Montreal, Québec H3A 3G4 (CA).

(74) Agent: **ALBASSAM, Majid**; 200 Bellevue Parkway, Suite 300, Wilmington, Delaware 19809 (US).

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

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE,

(54) Title: METHODS, ARCHITECTURES, APPARATUSES AND SYSTEMS FOR SENSING INFORMATION FROM 3GPP AND/OR NON-3GPP SOURCES AND TRANSMITTING SENSING STATUS REPORT

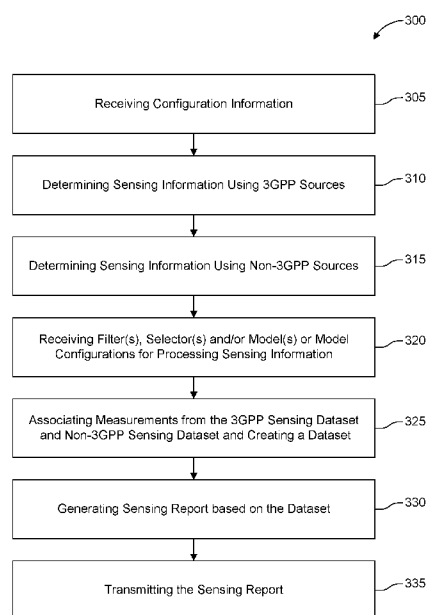


FIG. 3

(57) Abstract: Procedures, methods, architectures, apparatuses, systems, devices, and computer program products for the sensing of information from 3GPP and/or non-3GPP sources, and transmitting of sensing status report(s), are described. One method may include receiving configuration information that indicates 3GPP measurement configurations, localization measurement configurations, and/or sensing-related measurement information. The method may include determining, in accordance with the received configuration information, 3GPP sensing information based on 3GPP sources and non-3GPP sensing information based on non-3GPP sources. The method may include receiving at least one filter, determining a sensing dataset based on an association between the 3GPP sensing information and the non-3GPP sensing information, and transmitting a sensing report or a portion of the sensing report, which indicates information based on a result of processing the sensing dataset with the at least one filter.

SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,
GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

METHODS, ARCHITECTURES, APPARATUSES AND SYSTEMS FOR SENSING INFORMATION FROM 3GPP AND/OR NON-3GPP SOURCES AND TRANSMITTING SENSING STATUS REPORT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 63/536,148 filed September 1, 2023, which is incorporated herein by reference in its entirety.

FIELD

[0002] Some example embodiments described in the present disclosure are generally directed to the fields of communications, software and encoding, including, for example, to methods, architectures, apparatuses, systems related to sensing information from 3GPP and/or non-3GPP sources, and transmitting of sensing status report(s).

BACKGROUND

[0003] Integrated sensing and communications, like artificial intelligence (AI), has become a prominent technology for 6G wireless technology. In the current 3GPP system, there is no support for sensing capabilities; however, it may be anticipated that emerging trends related to sensing and communications will be adopted in 3GPP.

SUMMARY

[0004] Some embodiments may include a method, which may be implemented by a wireless transmit/receive unit (WTRU) or other device or node. The method may include receiving, e.g., from a network element or other device, configuration information indicating any of: 3GPP measurement configurations, localization measurement configurations, and/or sensing-related measurement information. The method may include determining, in accordance with any of the 3GPP measurement configurations, the localization measurement configurations and/or the sensing-related measurement information, 3GPP sensing information based on 3GPP sources and non-3GPP sensing information based on non-3GPP sources. The method may include receiving at least one filter, and determining a sensing dataset based on an association between the 3GPP sensing information and the non-3GPP sensing information. The method may include transmitting a sensing report or a portion of the sensing report to the network element, wherein the sensing report or the portion of the sensing report indicates information based on a result of processing the sensing dataset with the at least one filter.

[0005] Some embodiments may include a wireless transmit/receive unit (WTRU) that comprises any of a processor, a receiver, a transmitter, and/or memory. The circuitry may be configured to receive, e.g., from a network element or other device, configuration information indicating any of: 3GPP measurement configurations, localization measurement configurations, and/or sensing-related measurement information. The circuitry may be configured to determine, in accordance with any of the 3GPP measurement configurations, the localization measurement configurations and/or the sensing-related measurement information, 3GPP sensing information based on 3GPP sources and non-3GPP sensing information based on non-3GPP sources. The circuitry may be configured to receive at least one filter, and to determine a sensing dataset based on an association between the 3GPP sensing information and the non-3GPP sensing information. The circuitry may be configured to transmit a sensing report or portion of the sensing report to the network element, wherein the sensing report or the portion of the sensing report indicates information based on a result of processing the sensing dataset with the at least one filter.

[0006] In some embodiments, the sensing dataset is determined according to a predefined criteria that may include or indicate any of raw sensing data and/or processed sensing data, such as, but not limited to, one or more timestamps, number of obstacles, and/or one or more density coefficients, etc.

[0007] In some embodiments, the configuration information further indicates rules for integrity or validation criteria, and the sensing report may be generated according to these rules for integrity or validation criteria.

[0008] In some embodiments, the 3GPP measurement configurations may include any of: measurement configurations and/or resources, reporting configurations, and/or assistance information.

[0009] In some embodiments, the localization measurement configuration may be used to determine localization information associated with the WTRU including any of positions and/or coordinates associated with the WTRU.

[0010] In some embodiments, the sensing-related measurement information may include an indication of any of measurement methods and/or associated metrics.

[0011] In some embodiments, the 3GPP sources may include any of positioning measurements, methods or signals and/or sensing measurements, methods or signals.

[0012] In some embodiments, the non-3GPP sources may include any of a wireless local area network (WLAN), Bluetooth, mounted or embedded cameras, and/or lidar measurements.

[0013] In some embodiments, the WTRU may be configured to receive and/or determine whether one or more trigger conditions are satisfied and, based on the trigger condition being satisfied, the WTRU may determine the sensing dataset and transmit the sensing report.

[0014] In some embodiments, the WTRU may be configured to receive and/or determine whether one or more triggering conditions are satisfied and, based on the trigger condition being satisfied, the WTRU may determine which actions to perform and/or which information to apply, for example, when determining the sensing data and/or transmitting the sensing report or portion of it, and/or when determining any of the other information or actions discussed herein.

[0015] In some embodiments, the transmitting of the sensing report or portion thereof may include transmitting an indication of one or more elements from the sensing dataset.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] A more detailed understanding may be had from the detailed description below, given by way of example in conjunction with drawings appended hereto. Figures in such drawings, like the detailed description, are examples. As such, the Figures (FIGs.) and the detailed description are not to be considered limiting, and other equally effective examples are possible and likely. Furthermore, like reference numerals ("ref.") in the FIGs. indicate like elements, and wherein:

[0017] FIG. 1A is a system diagram illustrating an example communications system;

[0018] FIG. 1B is a system diagram illustrating an example wireless transmit/receive unit (WTRU) that may be used within the communications system illustrated in FIG. 1A;

[0019] FIG. 1C is a system diagram illustrating an example radio access network (RAN) and an example core network (CN) that may be used within the communications system illustrated in FIG. 1A;

[0020] FIG. 1D is a system diagram illustrating a further example RAN and a further example CN that may be used within the communications system illustrated in FIG. 1A;

[0021] FIG. 2A illustrates an example of downlink (DL) localization of a WTRU;

[0022] FIG. 2B illustrates an example of monostatic sensing in which transmission and reception are collocated on the same devices;

[0023] FIG. 2C illustrates an example of bistatic sensing in which transmission and reception are not collocated;

[0024] FIG. 3 is an example flow diagram of a method, according to an embodiment; and

[0025] FIG. 4 is an example diagram of a process, according to an embodiment.

DETAILED DESCRIPTION

[0026] In the following detailed description, numerous specific details are set forth to provide a thorough understanding of embodiments and/or examples disclosed herein. However, it will be understood that such embodiments and examples may be practiced without some or all of the specific details set forth herein. In other instances, well-known methods, procedures, components and circuits have not been described in detail, so as not to obscure the following description. Further, embodiments and examples not specifically described herein may be practiced in lieu of, or in combination with, the embodiments and other examples described, disclosed or otherwise provided explicitly, implicitly and/or inherently (collectively "provided") herein. Although various embodiments are described and/or claimed herein in which an apparatus, system, device, etc. and/or any element thereof carries out an operation, process, algorithm, function, etc. and/or any portion thereof, it is to be understood that any embodiments described and/or claimed herein assume that any apparatus, system, device, etc. and/or any element thereof is configured to carry out any operation, process, algorithm, function, etc. and/or any portion thereof.

[0027] The methods, apparatuses and systems provided herein are well-suited for communications involving both wired and wireless networks. An overview of various types of wireless devices and infrastructure is provided with respect to FIGs. 1A-1D, where various elements of the network may utilize, perform, be arranged in accordance with and/or be adapted and/or configured for the methods, apparatuses and systems provided herein.

[0028] FIG. 1A is a system diagram illustrating 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), zero-tail (ZT) unique-word (UW) discrete Fourier transform (DFT) spread OFDM (ZT UW DTS-s OFDM), unique word OFDM (UW-OFDM), resource block-filtered OFDM, filter bank multicarrier (FBMC), and the like.

[0029] As shown in FIG. 1A, the communications system 100 may include wireless transmit/receive units (WTRUs) 102a, 102b, 102c, 102d, a radio access network (RAN) 104/113, a core network (CN) 106/115, 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, any of which may be referred to as a "station" and/or a "STA", may be configured to transmit and/or receive wireless signals and may include (or be) a user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a subscription-based unit, a pager, a cellular telephone, a personal digital assistant (PDA), a smartphone, a laptop, a netbook, a personal computer, a wireless sensor, a hotspot or Mi-Fi device, an Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device and applications (e.g., remote surgery), an industrial device and applications (e.g., a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless networks, and the like. Any of the WTRUs 102a, 102b, 102c and 102d, or any other WTRU mentioned or described herein, may be interchangeably referred to as a UE.

[0030] The communications systems 100 may also include a base station 114a and/or 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, e.g., to facilitate access to one or more communication networks, such as the CN 106/115, the Internet 110, and/or the networks 112. By way of example, the base stations 114a, 114b may be any of a base transceiver station (BTS), a Node-B (NB), an eNode-B (eNB), a Home Node-B (HNB), a Home eNode-B (HeNB), a gNode-B (gNB), a NR Node-B (NR NB), a site controller, an access point (AP), a wireless router, and 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.

[0031] The base station 114a may be part of the RAN 104/113, 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 on one or more carrier frequencies, which may be referred to as a cell (not shown). These frequencies may be in licensed spectrum, unlicensed spectrum, or a combination of licensed and unlicensed spectrum. A cell may provide coverage for a wireless service to a specific geographical area that may be relatively fixed or that may change over time. 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 an embodiment,

the base station 114a may include three transceivers, i.e., one for each sector of the cell. In an embodiment, the base station 114a may employ multiple-input multiple output (MIMO) technology and may utilize multiple transceivers for each or any sector of the cell. For example, beamforming may be used to transmit and/or receive signals in desired spatial directions.

[0032] The base stations 114a, 114b may communicate with one or more of the WTRUs 102a, 102b, 102c, 102d over an air interface 116, which may be any suitable wireless communication link (e.g., radio frequency (RF), microwave, centimeter wave, micrometer wave, infrared (IR), ultraviolet (UV), visible light, etc.). The air interface 116 may be established using any suitable radio access technology (RAT).

[0033] 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 the like. For example, the base station 114a in the RAN 104/113 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 116 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).

[0034] In an 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 116 using Long Term Evolution (LTE) and/or LTE-Advanced (LTE-A) and/or LTE-Advanced Pro (LTE-A Pro).

[0035] In an embodiment, the base station 114a and the WTRUs 102a, 102b, 102c may implement a radio technology such as NR Radio Access, which may establish the air interface 116 using New Radio (NR).

[0036] In an embodiment, the base station 114a and the WTRUs 102a, 102b, 102c may implement multiple radio access technologies. For example, the base station 114a and the WTRUs 102a, 102b, 102c may implement LTE radio access and NR radio access together, for instance using dual connectivity (DC) principles. Thus, the air interface utilized by WTRUs 102a, 102b, 102c may be characterized by multiple types of radio access technologies and/or transmissions sent to/from multiple types of base stations (e.g., an eNB and a gNB).

[0037] In an embodiment, the base station 114a and the WTRUs 102a, 102b, 102c may implement radio technologies such as IEEE 802.11 (i.e., Wireless Fidelity (Wi-Fi)), IEEE 802.16 (i.e., 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 the like.

[0038] 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, an industrial facility, an air corridor (e.g., for use by drones), a roadway, and the like. In an 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 an 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 an embodiment, the base station 114b and the WTRUs 102c, 102d may utilize a cellular-based RAT (e.g., WCDMA, CDMA2000, GSM, LTE, LTE-A, LTE-A Pro, NR, etc.) to establish any of a small cell, 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 required to access the Internet 110 via the CN 106/115.

[0039] The RAN 104/113 may be in communication with the CN 106/115, 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. The data may have varying quality of service (QoS) requirements, such as differing throughput requirements, latency requirements, error tolerance requirements, reliability requirements, data throughput requirements, mobility requirements, and the like. The CN 106/115 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 104/113 and/or the CN 106/115 may be in direct or indirect communication with other RANs that employ the same RAT as the RAN 104/113 or a different RAT. For example, in addition to being connected to the RAN 104/113, which may be utilizing an NR radio technology, the CN 106/115 may also be in communication with another RAN (not shown) employing any of a GSM, UMTS, CDMA 2000, WiMAX, E-UTRA, or Wi-Fi radio technology.

[0040] The CN 106/115 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/or the internet protocol (IP) in the TCP/IP internet protocol suite. The networks 112 may include wired and/or wireless communications networks owned and/or operated by other service providers. For example, the networks 112 may include another CN connected to one or more RANs, which may employ the same RAT as the RAN 104/114 or a different RAT.

[0041] Some or all 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.

[0042] FIG. 1B is a system diagram illustrating 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/or other elements/peripherals 138, among others. It will be appreciated that the WTRU 102 may include any sub-combination of the foregoing elements while remaining consistent with an embodiment.

[0043] 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 Arrays (FPGAs) circuits, any other type of integrated circuit (IC), a state machine, and 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, e.g., in an electronic package or chip.

[0044] 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 116. For example, in an embodiment, the transmit/receive element 122 may be an antenna configured to transmit and/or receive RF signals. In an 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 an

embodiment, the transmit/receive element 122 may be configured to transmit and/or 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.

[0045] 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. For example, the WTRU 102 may employ MIMO technology. Thus, in an 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 116.

[0046] 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 NR and IEEE 802.11, for example.

[0047] 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 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).

[0048] 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 the like.

[0049] 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 116 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.

[0050] The processor 118 may further be coupled to other elements/peripherals 138, which may include one or more software and/or hardware modules/units that provide additional features, functionality and/or wired or wireless connectivity. For example, the elements/peripherals 138 may include an accelerometer, an e-compass, a satellite transceiver, a digital camera (e.g., for photographs and/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, a virtual reality and/or augmented reality (VR/AR) device, an activity tracker, and the like. The elements/peripherals 138 may include one or more sensors, the sensors may be one or more of a gyroscope, an accelerometer, a hall effect sensor, a magnetometer, an orientation sensor, a proximity sensor, a temperature sensor, a time sensor; a geolocation sensor; an altimeter, a light sensor, a touch sensor, a magnetometer, a barometer, a gesture sensor, a biometric sensor, and/or a humidity sensor.

[0051] The WTRU 102 may include a full duplex radio for which transmission and reception of some or all of the signals (e.g., associated with particular subframes for both the uplink (e.g., for transmission) and downlink (e.g., for reception) may be concurrent and/or simultaneous. The full duplex radio may include an interference management unit to reduce and or substantially eliminate self-interference via either hardware (e.g., a choke) or signal processing via a processor (e.g., a separate processor (not shown) or via processor 118). In an embodiment, the WTRU 102 may include a half-duplex radio for which transmission and reception of some or all of the signals (e.g., associated with particular subframes for either the uplink (e.g., for transmission) or the downlink (e.g., for reception)).

[0052] FIG. 1C is a system diagram illustrating the RAN 104 and the CN 106 according to an embodiment. As noted above, the RAN 104 may employ an E-UTRA radio technology to communicate with the WTRUs 102a, 102b, and 102c over the air interface 116. The RAN 104 may also be in communication with the CN 106.

[0053] 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 an 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.

[0054] Each of the eNode-Bs 160a, 160b, and 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 (UL) and/or downlink (DL), and the like. As shown in FIG. 1C, the eNode-Bs 160a, 160b, 160c may communicate with one another over an X2 interface.

[0055] The CN 106 shown in FIG. 1C may include a mobility management entity (MME) 162, a serving gateway (SGW) 164, and a packet data network (PDN) gateway (PGW) 166. While each of the foregoing elements are depicted as part of the CN 106, it will be appreciated that any one of these elements may be owned and/or operated by an entity other than the CN operator.

[0056] The MME 162 may be connected to each of the eNode-Bs 160a, 160b, and 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 the like. The MME 162 may provide a control plane function for switching between the RAN 104 and other RANs (not shown) that employ other radio technologies, such as GSM and/or WCDMA.

[0057] The SGW 164 may be connected to each of the eNode-Bs 160a, 160b, 160c in the RAN 104 via the S1 interface. The SGW 164 may generally route and forward user data packets to/from the WTRUs 102a, 102b, 102c. The SGW 164 may perform other functions, such as anchoring user planes during inter-eNode-B handovers, triggering paging when DL data is available for the WTRUs 102a, 102b, 102c, managing and storing contexts of the WTRUs 102a, 102b, 102c, and the like.

[0058] The SGW 164 may be connected to the PGW 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.

[0059] The CN 106 may facilitate communications with other networks. For example, the CN 106 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 traditional land-line communications devices. For example, the CN 106 may include, or may communicate with, an IP gateway (e.g., an IP multimedia subsystem (IMS) server) that serves as an interface between the CN 106 and the PSTN 108. In addition, the CN 106 may provide the WTRUs 102a,

102b, 102c with access to the other networks 112, which may include other wired and/or wireless networks that are owned and/or operated by other service providers.

[0060] Although the WTRU is described in FIGs. 1A-1D as a wireless terminal, it is contemplated that in certain representative embodiments that such a terminal may use (e.g., temporarily or permanently) wired communication interfaces with the communication network.

[0061] In representative embodiments, the other network 112 may be a WLAN.

[0062] A WLAN in infrastructure basic service set (BSS) mode may have an access point (AP) for the BSS and one or more stations (STAs) associated with the AP. The AP may have an access or an interface to a distribution system (DS) or another type of wired/wireless network that carries traffic into and/or out of the BSS. Traffic to STAs that originates from outside the BSS may arrive through the AP and may be delivered to the STAs. Traffic originating from STAs to destinations outside the BSS may be sent to the AP to be delivered to respective destinations. Traffic between STAs within the BSS may be sent through the AP, for example, where the source STA may send traffic to the AP and the AP may deliver the traffic to the destination STA. The traffic between STAs within a BSS may be considered and/or referred to as peer-to-peer traffic. The peer-to-peer traffic may be sent between (e.g., directly between) the source and destination STAs with a direct link setup (DLS). In certain representative embodiments, the DLS may use an 802.11e DLS or an 802.11z tunneled DLS (TDLS). A WLAN using an Independent BSS (IBSS) mode may not have an AP, and the STAs (e.g., all of the STAs) within or using the IBSS may communicate directly with each other. The IBSS mode of communication may sometimes be referred to herein as an "ad-hoc" mode of communication.

[0063] When using the 802.11ac infrastructure mode of operation or a similar mode of operations, the AP may transmit a beacon on a fixed channel, such as a primary channel. The primary channel may be a fixed width (e.g., 20 MHz wide bandwidth) or a dynamically set width via signaling. The primary channel may be the operating channel of the BSS and may be used by the STAs to establish a connection with the AP. In certain representative embodiments, Carrier sense multiple access with collision avoidance (CSMA/CA) may be implemented, for example in 802.11 systems. For CSMA/CA, the STAs (e.g., every STA), including the AP, may sense the primary channel. If the primary channel is sensed/detected and/or determined to be busy by a particular STA, the particular STA may back off. One STA (e.g., only one station) may transmit at any given time in a given BSS.

[0064] High throughput (HT) STAs may use a 40 MHz wide channel for communication, for example, via a combination of the primary 20 MHz channel with an adjacent or nonadjacent 20 MHz channel to form a 40 MHz wide channel.

[0065] Very high throughput (VHT) STAs may support 20 MHz, 40 MHz, 80 MHz, and/or 160 MHz wide channels. The 40 MHz, and/or 80 MHz, channels may be formed by combining contiguous 20 MHz channels. A 160 MHz channel may be formed by combining 8 contiguous 20 MHz channels, or by combining two non-contiguous 80 MHz channels, which may be referred to as an 80+80 configuration. For the 80+80 configuration, the data, after channel encoding, may be passed through a segment parser that may divide the data into two streams. Inverse fast fourier transform (IFFT) processing, and time domain processing, may be done on each stream separately. The streams may be mapped on to the two 80 MHz channels, and the data may be transmitted by a transmitting STA. At the receiver of the receiving STA, the above-described operation for the 80+80 configuration may be reversed, and the combined data may be sent to a medium access control (MAC) layer, entity, etc.

[0066] Sub 1 GHz modes of operation are supported by 802.11af and 802.11ah. The channel operating bandwidths, and carriers, are reduced in 802.11af and 802.11ah relative to those used in 802.11n, and 802.11ac. 802.11af supports 5 MHz, 10 MHz and 20 MHz bandwidths in the TV white space (TVWS) spectrum, and 802.11ah supports 1 MHz, 2 MHz, 4 MHz, 8 MHz, and 16 MHz bandwidths using non-TVWS spectrum. According to a representative embodiment, 802.11ah may support meter type control/machine-type communications (MTC), such as MTC devices in a macro coverage area. MTC devices may have certain capabilities, for example, limited capabilities including support for (e.g., only support for) certain and/or limited bandwidths. The MTC devices may include a battery with a battery life above a threshold (e.g., to maintain a very long battery life).

[0067] WLAN systems, which may support multiple channels, and channel bandwidths, such as 802.11n, 802.11ac, 802.11af, and 802.11ah, include a channel which may be designated as the primary channel. The primary channel may have a bandwidth equal to the largest common operating bandwidth supported by all STAs in the BSS. The bandwidth of the primary channel may be set and/or limited by a STA, from among all STAs in operating in a BSS, which supports the smallest bandwidth operating mode. In the example of 802.11ah, the primary channel may be 1 MHz wide for STAs (e.g., MTC type devices) that support (e.g., only support) a 1 MHz mode, even if the AP, and other STAs in the BSS support 2 MHz, 4 MHz, 8 MHz, 16 MHz, and/or other channel bandwidth operating modes. Carrier sensing and/or network allocation vector (NAV) settings may depend on the status of the primary channel. If the primary channel is busy, for example, due to a STA (which supports only a 1 MHz operating mode), transmitting to the AP, the entire available frequency bands may be considered busy even though a majority of the frequency bands remains idle and may be available.

[0068] In the United States, the available frequency bands, which may be used by 802.11ah, are from 902 MHz to 928 MHz. In Korea, the available frequency bands are from 917.5 MHz to 923.5 MHz. In Japan, the available frequency bands are from 916.5 MHz to 927.5 MHz. The total bandwidth available for 802.11ah is 6 MHz to 26 MHz depending on the country code.

[0069] FIG. 1D is a system diagram illustrating the RAN 113 and the CN 115 according to an embodiment. As noted above, the RAN 113 may employ an NR radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 116. The RAN 113 may also be in communication with the CN 115.

[0070] The RAN 113 may include gNBs 180a, 180b, 180c, though it will be appreciated that the RAN 113 may include any number of gNBs while remaining consistent with an embodiment. The gNBs 180a, 180b, 180c may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 116. In an embodiment, the gNBs 180a, 180b, 180c may implement MIMO technology. For example, gNBs 180a, 180b may utilize beamforming to transmit signals to and/or receive signals from the WTRUs 102a, 102b, 102c. Thus, the gNB 180a, for example, may use multiple antennas to transmit wireless signals to, and/or receive wireless signals from, the WTRU 102a. In an embodiment, the gNBs 180a, 180b, 180c may implement carrier aggregation technology. For example, the gNB 180a may transmit multiple component carriers to the WTRU 102a (not shown). A subset of these component carriers may be on unlicensed spectrum while the remaining component carriers may be on licensed spectrum. In an embodiment, the gNBs 180a, 180b, 180c may implement Coordinated Multi-Point (CoMP) technology. For example, WTRU 102a may receive coordinated transmissions from gNB 180a and gNB 180b (and/or gNB 180c).

[0071] The WTRUs 102a, 102b, 102c may communicate with gNBs 180a, 180b, 180c using transmissions associated with a scalable numerology. For example, OFDM symbol spacing and/or OFDM subcarrier spacing may vary for different transmissions, different cells, and/or different portions of the wireless transmission spectrum. The WTRUs 102a, 102b, 102c may communicate with gNBs 180a, 180b, 180c using subframe or transmission time intervals (TTIs) of various or scalable lengths (e.g., including a varying number of OFDM symbols and/or lasting varying lengths of absolute time).

[0072] The gNBs 180a, 180b, 180c may be configured to communicate with the WTRUs 102a, 102b, 102c in a standalone configuration and/or a non-standalone configuration. In the standalone configuration, WTRUs 102a, 102b, 102c may communicate with gNBs 180a, 180b, 180c without also accessing other RANs (e.g., such as eNode-Bs 160a, 160b, 160c). In the standalone configuration, WTRUs 102a, 102b, 102c may utilize one or more of gNBs 180a, 180b, 180c as a

mobility anchor point. In the standalone configuration, WTRUs 102a, 102b, 102c may communicate with gNBs 180a, 180b, 180c using signals in an unlicensed band. In a non-standalone configuration WTRUs 102a, 102b, 102c may communicate with/connect to gNBs 180a, 180b, 180c while also communicating with/connecting to another RAN such as eNode-Bs 160a, 160b, 160c. For example, WTRUs 102a, 102b, 102c may implement DC principles to communicate with one or more gNBs 180a, 180b, 180c and one or more eNode-Bs 160a, 160b, 160c substantially simultaneously. In the non-standalone configuration, eNode-Bs 160a, 160b, 160c may serve as a mobility anchor for WTRUs 102a, 102b, 102c and gNBs 180a, 180b, 180c may provide additional coverage and/or throughput for servicing WTRUs 102a, 102b, 102c.

[0073] Each of the gNBs 180a, 180b, 180c 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 UL and/or DL, support of network slicing, dual connectivity, interworking between NR and E-UTRA, routing of user plane data towards user plane functions (UPFs) 184a, 184b, routing of control plane information towards access and mobility management functions (AMFs) 182a, 182b, and the like. As shown in FIG. 1D, the gNBs 180a, 180b, 180c may communicate with one another over an Xn interface.

[0074] The CN 115 shown in FIG. 1D may include at least one AMF 182a, 182b, at least one UPF 184a, 184b, at least one session management function (SMF) 183a, 183b, and at least one Data Network (DN) 185a, 185b. While each of the foregoing elements are depicted as part of the CN 115, it will be appreciated that any of these elements may be owned and/or operated by an entity other than the CN operator.

[0075] The AMF 182a, 182b may be connected to one or more of the gNBs 180a, 180b, 180c in the RAN 113 via an N2 interface and may serve as a control node. For example, the AMF 182a, 182b may be responsible for authenticating users of the WTRUs 102a, 102b, 102c, support for network slicing (e.g., handling of different protocol data unit (PDU) sessions with different requirements), selecting a particular SMF 183a, 183b, management of the registration area, termination of NAS signaling, mobility management, and the like. Network slicing may be used by the AMF 182a, 182b, e.g., to customize CN support for WTRUs 102a, 102b, 102c based on the types of services being utilized WTRUs 102a, 102b, 102c. For example, different network slices may be established for different use cases such as services relying on ultra-reliable low latency (URLLC) access, services relying on enhanced massive mobile broadband (eMBB) access, services for MTC access, and/or the like. The AMF 162 may provide a control plane function for switching between the RAN 113 and other RANs (not shown) that employ other radio

technologies, such as LTE, LTE-A, LTE-A Pro, and/or non-3GPP access technologies such as Wi-Fi.

[0076] The SMF 183a, 183b may be connected to an AMF 182a, 182b in the CN 115 via an N11 interface. The SMF 183a, 183b may also be connected to a UPF 184a, 184b in the CN 115 via an N4 interface. The SMF 183a, 183b may select and control the UPF 184a, 184b and configure the routing of traffic through the UPF 184a, 184b. The SMF 183a, 183b may perform other functions, such as managing and allocating UE IP address, managing PDU sessions, controlling policy enforcement and QoS, providing downlink data notifications, and the like. A PDU session type may be IP-based, non-IP based, Ethernet-based, and the like.

[0077] The UPF 184a, 184b may be connected to one or more of the gNBs 180a, 180b, 180c in the RAN 113 via an N3 interface, which may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, e.g., to facilitate communications between the WTRUs 102a, 102b, 102c and IP-enabled devices. The UPF 184a, 184b may perform other functions, such as routing and forwarding packets, enforcing user plane policies, supporting multi-homed PDU sessions, handling user plane QoS, buffering downlink packets, providing mobility anchoring, and the like.

[0078] The CN 115 may facilitate communications with other networks. For example, the CN 115 may include, or may communicate with, an IP gateway (e.g., an IP multimedia subsystem (IMS) server) that serves as an interface between the CN 115 and the PSTN 108. In addition, the CN 115 may provide the WTRUs 102a, 102b, 102c with access to the other networks 112, which may include other wired and/or wireless networks that are owned and/or operated by other service providers. In an embodiment, the WTRUs 102a, 102b, 102c may be connected to a local Data Network (DN) 185a, 185b through the UPF 184a, 184b via the N3 interface to the UPF 184a, 184b and an N6 interface between the UPF 184a, 184b and the DN 185a, 185b.

[0079] In view of FIGs. 1A-1D, and the corresponding description of FIGs. 1A-1D, one or more, or all, of the functions described herein with regard to any of: WTRUs 102a-d, base stations 114a-b, eNode-Bs 160a-c, MME 162, SGW 164, PGW 166, gNBs 180a-c, AMFs 182a-b, UPFs 184a-b, SMFs 183a-b, DNs 185a-b, and/or any other element(s)/device(s) described herein, may be performed by one or more emulation elements/devices (not shown). The emulation devices may be one or more devices configured to emulate one or more, or all, of the functions described herein. For example, the emulation devices may be used to test other devices and/or to simulate network and/or WTRU functions.

[0080] The emulation devices may be designed to implement one or more tests of other devices in a lab environment and/or in an operator network environment. For example, the one or more

emulation devices may perform the one or more, or all, functions while being fully or partially implemented and/or deployed as part of a wired and/or wireless communication network in order to test other devices within the communication network. The one or more emulation devices may perform the one or more, or all, functions while being temporarily implemented/deployed as part of a wired and/or wireless communication network. The emulation device may be directly coupled to another device for purposes of testing and/or may performing testing using over-the-air wireless communications.

[0081] The one or more emulation devices may perform the one or more, including all, functions while not being implemented/deployed as part of a wired and/or wireless communication network. For example, the emulation devices may be utilized in a testing scenario in a testing laboratory and/or a non-deployed (e.g., testing) wired and/or wireless communication network in order to implement testing of one or more components. The one or more emulation devices may be test equipment. Direct RF coupling and/or wireless communications via RF circuitry (e.g., which may include one or more antennas) may be used by the emulation devices to transmit and/or receive data.

[0082] Embodiments disclosed herein are representative and do not limit the applicability of the apparatus, procedures, functions and/or methods to any particular wireless technology, any particular communication technology and/or other technologies. The term network in this disclosure may generally refer to one or more base stations or gNBs or other network entity which in turn may be associated with one or more Transmission/Reception Points (TRPs), or to any other node in the radio access network.

[0083] It is noted that, throughout example embodiments described herein, the terms “serving base station”, “base station”, “gNB”, collectively “gNB” may be used interchangeably to designate any network element such as, e.g., a network element acting as a serving base station. Embodiments described herein are not limited to gNBs and are applicable to any other type of base stations.

[0084] Integrated sensing and communications, like artificial intelligence (AI), has become a prominent promising technology for 6G. In the current 3GPP system, there is no support for sensing capabilities; however, it may be anticipated that emerging trends related to sensing and communications are adopted in 3GPP.

[0085] A reasonable assumption is that the current 3GPP framework related to localization and positioning would represent a starting point from where sensing features and capabilities will emerge. However, there is a clear distinction between localisation and positioning, and sensing. Sensing is a broader concept, and it is distinct from localisation and positioning in at least the

following ways: sensing is a detection and estimation problem, in contrast to localization and positioning being an estimation problem; sensing assumes that the number of objects is not a priori known, whereas in localization and positioning the number of objects is known; and sensing refers to detection and estimation of non-connected devices, objects and/or obstacles, whereas in localization and positioning the estimation is done for connected devices.

[0086] FIG. 2 depicts examples of the topology for localization and positioning, and the topologies for monostatic sensing and bistatic sensing. More specifically, FIG. 2A illustrates an example of downlink (DL) localization of WTRU, FIG. 2B illustrates an example of monostatic sensing in which transmission and reception are collocated on the same devices (e.g., WTRU radar sensor with collocated Tx/Rx), and FIG. 2C illustrates an example of bistatic sensing in which transmission and reception are not collocated but are on different devices (e.g., base station with Tx and WTRU with Rx).

[0087] The adoption of higher frequency bands (e.g., mmWave, THz) may be advantageous for sensing purposes since higher frequencies enable at least the following: (i) obtaining geometric information from the communication channel, i.e., the paths are closely related to the environment geometry (each path in the channel corresponds to a physical object); (ii) utilization of larger bandwidth and better delay resolution; and (iii) usage of larger number of antenna elements fitting at the WTRU/gNB, meaning fine beamforming, and enhanced angular resolution.

[0088] Key performance metrics for sensing may include latency, availability, scalability, accuracy, and resolution (e.g., delay, doppler and angular resolution). A main prerequisite for high accuracy sensing is high resolution.

[0089] Sensing signals are signals that carry information about the physical environment and describe non-connected objects, devices and/or obstacles (e.g., sensing objects). The information embedded in a sensing signal may alternately be referred to using at least any of the following terms: sensing information, situational awareness information, and/or context awareness information. An example of sensing information may include number of obstacles or terrain information. Sensing information may enable the 3GPP system to become cognizant of the environment which can lead to improvement of several operational system capabilities.

[0090] In the current 3GPP system, there is no support for situational-awareness or context-awareness information, and there is no reporting based on such information. Although existing 3GPP signals (such as PRS, CSI-RS, SRS, DM-PRS) may provide rudimentary sensing capabilities, these signals are currently not used for sensing. The same is true for non-3GPP capabilities that interface with the 3GPP system such as WLAN, Bluetooth, sensors, etc. In addition, there may be some external sensing peripherals which can provide situational awareness

information but have no interfaces with the 3GPP system. In this disclosure, sensing sources may be grouped into 3GPP sources (e.g., where sensing is done by the 3GPP system using 3GPP signals exchanged within the system) and non-3GPP sources (e.g., WLAN, Bluetooth, sensors, lidars, cameras, etc.).

[0091] In view of the above, example embodiments can provide at least a solution for how to associate sensing information from 3GPP sources or measurements and/or non-3GPP sources or measurements, and to perform sensing reporting based on the associated sensing information towards the 3GPP network (NW). For example, some example embodiments may include an objective of providing relevant input for improvement of operational procedures of the 3GPP network (e.g., scheduling, beam management, etc.).

[0092] An embodiment may be directed to a method that may be implemented by a WTRU or UE, for example. The method may include receiving configuration information indicating any one or more of: (i) 3GPP measurement configurations, (ii) 3GPP and non-3GPP localization measurement configurations, (iii) sensing-related measurement information, and (iv) models and/or conditions and/or rules for integrity or validation criteria. The method may include determining any one or more of (i) a 3GPP sensing dataset using 3GPP sources, and/or (ii) a non-3GPP sensing dataset using non-3GPP sources. The method may include receiving at least one filter or model configuration, associating measurements from any of the 3GPP datasets and non-3GPP datasets, and creating a WTRU sensing dataset according to predefined criteria or metrics. The method may include generating a sensing report based on a result of processing the WTRU sensing dataset with the at least one filter or model configuration and the models and/or conditions and/or rules for integrity or validation criteria, and transmitting the sensing report.

[0093] An embodiment may be directed to an apparatus, such as a WTRU or UE, which may include any one or more of a processor, memory, transmitter and/or receiver. The apparatus may be configured to receive configuration information indicating any one or more of: (i) 3GPP measurement configurations, (ii) 3GPP and/or non-3GPP localization measurement configurations, (iii) sensing-related measurement information, and/or (iv) models and/or conditions and/or rules for integrity or validation criteria. The apparatus may be configured to determine any one or more of (i) a 3GPP sensing dataset using 3GPP sources, and/or (ii) a non-3GPP sensing dataset using non-3GPP sources. The apparatus may be configured to receive at least one filter or model configuration, associating measurements from any of the 3GPP datasets and non-3GPP datasets, and to create a WTRU sensing dataset according to predefined criteria or metrics. The apparatus may be configured to generate a sensing report based on a result of processing the WTRU sensing dataset with the at least one filter or model configuration and the

models and/or conditions and/or rules for integrity or validation criteria, and to transmit the sensing report or portion thereof.

[0094] In one example, the 3GPP measurement configurations may comprise any of: measurement configurations or resources, reporting configurations, and assistance information (e.g., information associated with objects and/or associated identities).

[0095] In one example, the 3GPP sources may comprise any of positioning measurements, methods or signals and/or sensing measurements, methods or signals.

[0096] In one example, the non-3GPP sources may comprise any of WLAN and/or Bluetooth and/or mounted or embedded cameras or lidar measurements.

[0097] In one example, the method may include, or the apparatus may be configured for, determining whether a trigger condition is satisfied (e.g., a trigger condition received from the network or other entity) and, on condition that the trigger condition is satisfied, performing the associating, generating and/or transmitting procedures discussed above.

[0098] In some embodiments, the method may include, or the apparatus may be configured for, determining whether one or more trigger conditions are satisfied (e.g., a trigger condition received from the network or other entity) and, based on the trigger condition(s) being satisfied, the WTRU may determine which actions to take and/or which information to apply (e.g., sensing data set type, filter condition used for data processing, reporting mode, etc.).

[0099] In one example, the predefined criteria or metrics may include (e.g. indicate) or relate to raw sensing data (e.g., number of obstacles or timestamps) and/or processed sensing data (e.g., sensing measurements or density coefficients).

[0100] In one example, the transmitting of the sensing report may comprise transmitting an indication of one or more elements from the WTRU sensing dataset.

[0101] In example embodiments described herein, the network (NW) may include or refer to any of a base station (e.g., gNB, TRP, RAN node, access node), core network node or function (e.g., AMF, SMF, PCF, NEF) and/or application function (e.g. edge server function, remote server function), for example.

[0102] In example embodiments described herein, sensing information (or situational awareness information, or context awareness information) may refer to any information that describes perceptual phenomena about the physical environment (e.g., terrain information, obstacles or object that impact the wireless propagation characteristics, scenes, maps) and/or characteristics about the physical environment (materials, composition, etc.), for example.

[0103] In example embodiments described herein, sensing dataset may refer to any dataset that is logically organized data structure containing sensing information obtained either via processing and/or via performing measurements related to acquisition of sensing information.

[0104] In example embodiments described herein, sensor may refer to any device, module, machine, or subsystem that detects events or changes in the physical environment (e.g., cameras, lidars, etc.)

[0105] In example embodiments described herein, sensing object may refer to any physical object that is not connected to the 3GPP system such as material objects (e.g., walls, buildings, structures, vehicles, etc.).

[0106] In example embodiments described herein, sensing may refer to an operation of a sensor, as defined above. The operation may include detection and/or estimation in the case when the knowledge regarding the physical environment is not a priori known, and may refer to detecting and/or estimating a sensing object, as defined above.

[0107] Some embodiments may include procedures for associating sensing information from 3GPP sources or measurements and/or non-3GPP sources or measurements, and for reporting to the network based on the associated information.

[0108] In one embodiment, a procedure may be provided for associating sensing information from 3GPP sources or measurements and/or non-3GPP sources or measurements, and for performing reporting (e.g., to the network) based on the associated information. According to an embodiment, a WTRU may be configured to receive, from the NW, configuration information that may include one or more of the following: (i) 3GPP measurements configurations such as, but not limited to, measurement configurations and/or resources, reporting configurations, and/or assistance information; (ii) 3GPP and non-3GPP localization measurement configurations; (iii) sensing-related measurements information, such as measurements methods and/or associated metrics; and/or (iv) models and/or conditions (e.g., *Model_Conditions_Config*) and/or rules for integrity and/or validation criteria (e.g., *Data_Integrity_Config_Checks*).

[0109] In an embodiment, the WTRU may be configured to determine sensing information (e.g., *3GPP sensing dataset*) using 3GPP sources such as, but not limited to, positioning and/or sensing measurements, methods and/or signals. According to an embodiment, the WTRU may be configured to determine sensing information (e.g., *non-3GPP sensing dataset*) using non-3GPP sources such as, but not limited to, WLAN and/or Bluetooth and/or mounted or embedded cameras and/or lidars measurements. In an embodiment, the WTRU may be configured to receive, from the NW, one or more (e.g., multiple) filters, selectors and/or models or model configurations for processing and/or filtering (e.g., *Filter_Conditions*).

[0110] In one embodiment, the WTRU may optionally be configured to determine whether a trigger condition (e.g., a received or pre-configured trigger condition) is satisfied. For example, the trigger condition may determine one or more of the following steps of associating measurements, processing the WTRU-sensing dataset, and transmitting a sensing report as discussed below. For example, in some embodiments, the WTRU may be configured to determine whether one or more trigger conditions are satisfied and, based on the trigger condition(s) being satisfied, the WTRU may determine which actions (e.g., associating measurements, processing the WTRU-sensing dataset, and/or transmitting a sensing report) to take and/or which information to apply (e.g., sensing data set type, filter condition used for data processing, reporting mode, etc.).

[0111] According to an embodiment, the WTRU may be configured to associate measurements from the 3GPP and non-3GPP datasets, and to create a single dataset (e.g., a *WTRU-sensing dataset*) according to a predefined criteria and/or metrics. These criteria and/or metrics may include or relate to, for example, raw sensing data (e.g., number of obstacles or timestamps) and/or processed sensing data (e.g., sensing measurements or density coefficients).

[0112] In an embodiment, the WTRU may be configured to process the WTRU-sensing dataset with the received *Filter_Conditions* and/or *Data_Integrity_Config_Checks*, and to generate a sensing report based on the results of the filtering and/or data integrity checks. According to certain embodiments, the WTRU may be configured to transmit the sensing-report to the NW. For example, the transmitting of the sensing-report may optionally include transmitting one or several elements from the WTRU-sensing dataset.

[0113] As introduced above, certain example embodiments may provide a process(es) or method(s) for associating sensing information from 3GPP and non-3GPP sources/measurements. Further, some embodiments may include process(es) or method(s) for generating and/or transmitting sensing report(s) based on the associated sensing information. FIG. 3 illustrates an example method 300 that may be implemented by a UE or WTRU, according to some embodiments. The example method 300 of FIG. 3 and accompanying disclosures herein may include, may be based on, or may be a synthesization of various embodiments or elements discussed in detail above. For convenience and simplicity of exposition, the example of FIG. 3 may be described with reference to the architecture or system described above with respect to FIGs. 1A-1D, for instance. However, the example method 300 depicted in FIG. 3 may be carried out using different architectures as well. According to some embodiments, the method 300 of FIG. 3 may be implemented by a UE or WTRU, such as the WTRU 102 described in the foregoing.

[0114] It is noted that the method 300 of FIG. 3 may include further steps, procedures or details as discussed in detail elsewhere in this disclosure. As such, the method 300 of FIG. 3 may be

modified to include any of the steps, procedures, elements and/or details illustrated and/or discussed in the foregoing. Moreover, it is noted that the method and/or blocks of FIG. 3 may be modified to include, or to be replaced by, any one or more of the procedures, elements or blocks discussed elsewhere herein. As such, one of ordinary skill in the art would understand that FIG. 3 is provided as one example and modifications thereto are possible while remaining within the scope of certain example embodiments.

[0115] In one embodiment, the method 300 may include, at 305, receiving configuration information from the network (NW). For example, according to an embodiment, the configuration information may include 3GPP measurement configurations, such as measurement resources, objects, reporting configurations and/or associated identities, e.g., as defined in [1] TS 38.331 v17.5.0.

[0116] In some embodiments, the measurement resources may be specifically dedicated resources by the NW to perform measurements. In some embodiments, the measurement objects, reporting configurations and/or identities associating the objects and the reporting configurations may be configured by the NW in multiple combinations such as any of: one identity that links one object with multiple reporting configurations, and/or multiple objects with one reporting configuration, or multiple identities linking multiple objects and multiple configurations.

[0117] According to an embodiment, the configuration information may additionally or alternatively include 3GPP and non-3GPP localization measurement configurations (e.g., as defined in [2] TS 37.355 v17.5.0). These localization measurement configurations enable localization information such as WTRU positions, coordinates, etc.

[0118] According to an embodiment, the configuration information may additionally or alternatively include sensing related measurement information, such as measurements methods and/or associated metrics. These may include information obtained from non-3GPP applications, cameras, lidars, sensing with 3GPP signals (e.g., bi-static and/or monostatic with reference signals such as PRS, DM-RS, CSI-RS, SSR, etc.) where the information may refer to any one or more of the following metrics: resolution, range, accuracy, environmental information, mobility/velocity of objects, etc.

[0119] According to an embodiment, the configuration information may additionally or alternatively include models and/or conditions and/or rules for integrity and/or validation criteria (e.g., *Data_integrity_Config_Checks*). These may be received from the NW, to be used for processing sensing datasets and may contain at least one of the following: models, conditions, and/or rules for integrity or validation criteria. The models may include predictive models such as AI-based, empirical, or probabilistic models that may be used to generate predictions based on the

measurements, or models to discern patterns in the measurements that may indicate to, or be used for, creating sensing information. The conditions may refer to reporting (e.g., report only when all the conditions in the condition list, for example: *List = [Cond_1, Cond_2, ..., Cond_N]* are met), and/or to conditional formatting of the sensing data (e.g., monitor events between timestamps *Timestamp_1* and *Timestamp_2*). Example of conditions in the condition list, for example may include: (i) *Cond_1*: X amount of sensing information in bytes is obtained; (ii) *Cond_2*: Sensing information has not changed in X ms.

[0120] According to an embodiment, the configuration information may additionally or alternatively include rules for integrity/validation criteria. These rules may be applied to check whether the obtained data in the sensing datasets is invalid or unexpected data. These rules may include checks for invalid, special characters, but also for expected values, for example if the dataset contains location of sensing object expressed with coordinates X1 and Y1, one of the rules may be to check if the coordinates X1 and Y1 fall within the expected range of coordinates covered by the network for example *[Xmin, Xmax]* and *[Ymin, Ymax]*. For instance, in the case of X1 and/or Y1 being outside the *[Xmin, Xmax]* and *[Ymin, Ymax]* intervals, then the integrity check may fail.

[0121] In one embodiment, the method 300 may include, at 310, determining sensing information (e.g., first sensing information) using 3GPP sources such as, but not limited to, positioning and/or sensing methods and/or signals. The sensing information from 3GPP sources may be labelled as first sensing data set (e.g., 3GPP sensing dataset). This dataset may include, for example, raw sensing data or information and/or processed sensing data or information such as, but not limited to, information indicating any one or more of a time or time period (e.g., timestamp), information related to one or more associated detected obstacle(s), terrain information, terrain density metrics, certainty levels, and/or the like (e.g., the dataset may include one or multiple data entries, each with at least a timestamps and one or more associated detected obstacles, terrain density metrics, and/or certainty levels, etc.). Example entries of a first sensing data set (e.g., 3GPP sensing dataset) (e.g., as determined in block 310) are given in Table 1 below.

[0122] In one embodiment, the method 300 may include, at 315, determining sensing information (e.g., second sensing information) using non-3GPP sources such as, but not limited to, WLAN measurements, Bluetooth measurements, and/or mounted or embedded cameras and/or lidars.

[0123] In some embodiments, the sensing information from non-3GPP sources may be labelled as a second sensing dataset (e.g., non-3GPP sensing dataset). In an example, a second sensing dataset (e.g., non-3GPP sensing dataset) may include, for example, raw sensing data or information and/or processed sensing data or information such as, but not limited to, information indicating

any one or more of a time or time period (e.g., timestamp), information related to one or more associated detected obstacle(s), and/or additional entries indicating information related to the physical environment, such as visual information, terrain density information, e.g., terrain density coefficient, terrain characteristic(s), and/or the like (e.g., a non-3GPP sensing dataset may include one or more data entries, which may include time or timing information (e.g., a timestamp) and/or one or more associated detected obstacle(s), and/or additional entries containing information about the physical environment, for example, visual information (e.g., terrain density coefficient, terrain characteristic, etc). Example entries of a second sensing dataset (e.g., non-3GPP sensing dataset) are given in Table 2 below.

Table 1: 3GPP sensing dataset example

Entry number	Timestamp	Number of obstacles	Certainty level	Localization of obstacles [in coordinates]	Terrain density coefficient
1	aa::bb:cc	2	50%	X1, Y1, and X2, Y2	low
2	aa::bb:cc+1	3	70%	X1, Y1, and X2, Y2, and X3, Y3	medium

Table 2: non-3GPP sensing dataset example

Entry number	Timestamp	Number of obstacles	Levels of certainty	Localization of obstacles	Terrain density coefficient	Additional entry
1	aa::bb:cc	4	85%	X1+1, Y1+1, and X2+2, Y2+2, X3+1, Y3+1, and X4+2, Y4+2,	medium	BitstreamA
2	aa::bb:cc+1	6	90%	X1+1, Y1+1, and X2+2, Y2+2, X3+1, Y3+1, and X4+2, Y4+2, X1+1, Y1+1, and X2+2, Y2+2,	high	BitstreamB

[0124] It is noted that, in some embodiments, the additional entry shown in Table 2 may be a non-encoded bitstream carrying visual information, i.e., perceptual information about the environment, acquired by a non-3GPP source.

[0125] In one embodiment, the method 300 may include, at 320, receiving (e.g., from the NW) one or more (e.g., multiple) filters, selectors and/or models and/or model configurations for processing sensing information. In some embodiments, the method may include receiving NW-defined criteria, or the WTRU can be preconfigured with the NW-defined criteria. These NW received filters, selectors and/or models or model configurations and/or NW-defined criteria may be used, for instance, for associating measurements from the first sensing dataset (e.g., 3GPP datasets) and the second sensing dataset (e.g., non-3GPP datasets) and/or for processing.

[0126] According to one example embodiment, the method 300 may optionally include (not illustrated) determining a triggering condition, where the triggering condition may impact the execution of the following steps that are referred to in the following paragraphs such as: associating the measurements from the 3GPP sensing dataset and non-3GPP sensing dataset, and/or determining an association criteria/metric, and/or processing the WTRU-sensing dataset, and/or determining a filter/selector/model, and/or transmitting the sensing report whenever one or more triggering condition(s) are satisfied. The trigger condition(s) may refer to or may be measurement-based, request-based, and/or validation or filtering-based conditions. For example, in some embodiments, the method may include determining whether one or more trigger conditions are satisfied (e.g., a trigger condition received from the network or other entity) and, based on the trigger condition(s) being satisfied, the WTRU may determine which actions to take and/or which information to apply (e.g., sensing data set type, filter condition used for data processing, reporting mode, etc.).

[0127] For example, in the case of a measurement-based trigger condition, the WTRU may be configured with a particular threshold(s) or set of thresholds. The WTRU may conduct measurements related to the sensing datasets and/or associated data. The WTRU may determine whether the conducted measurements related to the sensing datasets and/or associated data to the sensing datasets are above or below preconfigured threshold(s) in which case it may execute at least one of the following steps, such as associating the measurements from the 3GPP sensing dataset and non-3GPP sensing dataset, and/or determining an association criteria/metric, and/or processing the WTRU-sensing dataset, and/or determining a filter/selector/model, and/or transmitting the sensing report.

[0128] For example, in the case of a request-based trigger condition, the WTRU may receive a particular request from the NW such that it needs to perform a step based on the request. For example, the WTRU may receive explicit request for associating the measurements from the 3GPP sensing dataset and non-3GPP sensing dataset, and/or determining an association criteria/metric, and/or processing the WTRU-sensing dataset, and/or determining a filter/selector/model, and/or transmitting the sensing report.

[0129] For example, in the case of a validation/filtering-based trigger condition, the WTRU may perform a step such as associating the measurements from the 3GPP sensing dataset and non-3GPP sensing dataset, and/or determining an association criteria/metric, and/or processing the WTRU-sensing dataset, and/or determining a filter/selector/model, and/or transmitting the sensing report, based on the outcome of validation and/or the filtering.

[0130] In one embodiment, the method 300 may include, at 325, associating measurements from the first sensing dataset or information (e.g., 3GPP sensing dataset) and second sensing dataset or information (e.g., non-3GPP sensing dataset) to produce a third dataset or information (e.g., a single dataset), e.g., which may be labelled as a third sensing dataset or information (e.g., WTRU-sensing-dataset). In some embodiments, the measurements from the first sensing dataset may be associated with the second sensing dataset according to predefined criteria or metrics, which may include or relate to raw sensing data and/or processed sensing data such as, but not limited to, any of timestamps, number of obstacles, terrain density coefficient, or multiple combinations of these. In some embodiments, the association may be performed by NW-defined preconfigured criteria. Examples for an association of measurements from the first and second sensing datasets may include any one or more of the following:

- Association based on timestamps: The WTRU may match an entry from the first sensing dataset (e.g., 3GPP sensing dataset) having timestamp X to an entry from the second sensing dataset (e.g., non-3GPP sensing dataset) having a timestamp with a value closest to X;
- Association based on levels of certainty: The WTRU may match entries from the first sensing dataset (e.g., 3GPP sensing dataset) to entries from the second sensing dataset (e.g., non-3GPP sensing dataset) having certainty above a preconfigured threshold and/or discard remaining entries;
- Association based on terrain density coefficient: The WTRU may match entries from the first sensing dataset (e.g., 3GPP sensing dataset) to entries from the second sensing dataset (e.g., non-3GPP sensing dataset) that are characterized with a certain or similar level of terrain density coefficient, such as 'Low', 'Medium', and 'High'.

[0131] It should be noted that, in certain embodiments as will be discussed in more detail below, the WTRU may be configured to operate with (e.g., only with) 3GPP sources and/or measurements or with (e.g., only with) non-3GPP sources and/or measurements. In such embodiments, steps 310 or 315 of the method 300 may be omitted and the associating step 325 may be done for (e.g., only for) the 3GPP sources/measurements or for (e.g., only for) the non-3GPP sources and/or measurements.

[0132] According to one embodiment, the method 300 may include, at 330, generating a sensing report based on the third sensing dataset. For example, the generating at 330 may include processing the third sensing dataset (e.g., the WTRU-sensing dataset) with or using one or more of (e.g., each of) the configured filters, selectors and/or models or model configurations and generating the sensing report based on the result of the processing.

[0133] Further, in certain embodiments, the method 300 may optionally include using the rules for integrity and/or validation criteria and performing integrity checks, and as a result, entries that have not passed integrity checks may be, for example, discarded and/or not used for the sensing report, and/or the reporting in this case may contain what integrity checks have failed and the reason for the failure of the checks. In some embodiments, the entries that have passed the integrity checks may be used as the content of the sensing report. For example, the sensing report may contain at least one or more of the following: cause/description (e.g., a description/cause regarding an event in the physical environment relevant for the system operation such as: expecting a set of 3 obstacles in the next 10s to block the line-of-sight to the NW); associated metric (e.g., level of certainty for the cause/description, expressed in percentage, confidence interval, accuracy coefficient, etc.); associated filter (e.g., filter, selector and/or model or model configuration, e.g., configured by the NW, used by the WTRU to generate the entry, i.e., the content of the sensing report).

[0134] An example of the content of the sensing report is depicted in the example of Table 3 below.

Table 3: Content of the sensing report example

Indication index	Cause/Description	associated metric	associated filter
1	Expecting a set of obstacles in the next 10 s	95%	Filter A

2	Expecting clear LOS for the next 1min	60%	Filter B
---	---	-----	----------

[0135] Several options for the content of the sensing report are discussed in the following. As an example, the indication indexes in the sensing report may be useful for reducing the information volume exchanged over the air. For example, all set of entries with their associated indexes may be initially exchanged with the NW, and for following updates, the WTRU may transmit the indication index and changes that occurred because of the updates (for example the associated metric value has changed for the indexed entry).

[0136] In one example, the cause/description may be derived based on running predictive models such as AI-based, probabilistic, or empirical models with the data in the WTRU-sensing-dataset. Based on these predictions, descriptions about the surrounding environment and about the situation/scene can be derived, for example: in the next X [ms], there will not be a clear LOS; or in X [ms] from now, there will be a tunnel on the moving trajectory that will degrade the wireless link; or approaching a dense terrain (with many WTRUs) in X [ms].

[0137] As an example, the associated metric may be a certainty level, threshold, error margin, prediction accuracy, and/or confidence interval, or the like, which may be expressed in percentage or dimensionless unit.

[0138] In one example, the associated filter may be to indicate what kind of filter, selector and/or model or model configuration was used to generate the cause/description and associated metric. The available filters may be predetermined and/or preconfigured by the NW, for example.

[0139] In one embodiment, the method 300 may include, at 335, transmitting the sensing report to the NW, and/or transmitting one or several elements or entries from the content of the sensing report. In one example, the sensing report may be configured by the RRC and generated by a MAC procedure using MAC CE. In another example, the sensing report may be configured and transmitted using RRC messages. In another example, the WTRU may receive a request (from the gNB or NW) to transmit the sensing report, for example, based on periodic reporting configuration where the WTRU may be configured with periodic resources to transmit the sensing report, or based on aperiodic reporting configuration where the WTRU may receive an aperiodic/one-shot request to transmit the sensing report. For example, the WTRU may receive the periodic reporting configuration and/or the aperiodic reporting configuration in a DCI, MAC CE, or RRC. According to an embodiment, the WTRU may apply prioritization of the sensing report that may be controlled by a RRC-based approach (e.g., mapped to SRB, DRB, depending on the management done at the

LCP), or a MAC-level approach (e.g., MAC CE/MAC-level padding, and prioritization depending on the data for example the BSR).

[0140] In some embodiments, the WTRU may optionally be configured with triggers for triggering the transmission of the sensing report. For example, the WTRU may receive information indicating triggers associated with the transmitting of the sensing report. As introduced above, the transmission of the sensing report may be periodic, aperiodic, or event-driven. Some examples of triggering and reporting of the sensing report may include trigger(s) based on measurements, explicit trigger(s), trigger(s) based on sensing data becoming available above a threshold, trigger(s) based on UL resources being allocated, and/or trigger(s) for retransmission based on timer expiration.

[0141] For the case of triggers based on measurements, the WTRU may perform relevant measurements and transmit the sensing report when certain (e.g., one or more) measurement conditions are met. For example, any one or more of the following conditions:

- Condition_A: Based on filtering values in the content of the sensing report, for example the WTRU transmits the sensing report when (e.g., as soon as) an entry with associated metric greater than *Threshold_A* appears in the content of the sensing report.
- Condition_B: Based on successful integrity checks. The WTRU transmits the sensing report when (e.g., as soon as) all entries have passed the integrity checks. In another case, the WTRU may transmit the sensing report when (e.g., as soon as) a particular integrity check has failed and may indicate in the sensing report content the reason for failure of the integrity check.
- Condition_C: Combination of at least one example from *Condition_A* and at least one example from *Condition_B*.

[0142] For the case of an explicit trigger, the WTRU may be configured by a RRC message to perform, for example, network-periodically configured reporting, or dynamic reporting based on certain thresholds, conditions, and/or priority levels. Thresholds, conditions, and priority levels may be NW defined, and the priority levels may include priorities with respect to the other reporting procedures/reports such as BSR, PHR, etc.

[0143] For the case where the trigger is based on sensing data becoming available above a threshold, the WTRU may be configured to transmit the sensing report when (e.g., as soon as) sensing data in the WTRU-sensing-dataset becomes available above a threshold.

[0144] For the case where the trigger is based on UL resources being allocated, the WTRU may transmit the sensing report based on received allocation for UL resources. This may be with the goal of aiding future UL resource allocations, based on the information reported in the sensing

report. In addition, if the received UL resource allocation is sufficient for transmitting the data for the running services, the WTRU may use remaining resources for transmission of the sensing report.

[0145] For the case where the trigger is for retransmission based on timer expiration, the WTRU may retransmit the sensing report as soon as a configured timer expires.

[0146] Additionally, in some embodiments as introduced above, the WTRU may utilize and/or receive one or more trigger condition(s) to determine the actions to perform and/or the information or parameters to apply. For example, the WTRU may determine whether one or more trigger conditions are satisfied (e.g., a trigger condition received from the network or other entity) and, based on the trigger condition(s) being satisfied, the WTRU may determine which actions to take and/or which information to apply such as, but not limited to, the sensing data set type to use, the filter condition used for data processing, the reporting mode (e.g. associated with transmitting a sensing report), or the like.

[0147] It should be noted that FIG. 3 is provided as one example method, according to some embodiments. However, the method depicted in FIG. 3 may be modified according to certain embodiments, including by omitting, combining or adding certain steps as may be discussed elsewhere herein.

[0148] Some embodiments may include representative procedure(s) for associating sensing information from 3GPP sources and/or measurements, and/or for reporting to the network based on the associated information.

[0149] In one embodiment, the WTRU may be configured to operate with (e.g., only with) 3GPP sources and/or measurements. In this case, the method may be similar to that of FIG. 3, however the association step may be modified. For instance, in this embodiment, the association may be done for (e.g., only for) 3GPP sources and/or measurements. In this case, the first sensing dataset or information (e.g., 3GPP-sensing dataset) may be composed of sub-datasets, e.g., indexed with $i=1,2,3,\dots,N$, where each sub-dataset may be derived by using a different sensing method and/or physical signal and/or physical layer measurements related to localization and/or sensing metrics. The association in this case may be done across sub-datasets, and the results of this association may include the generation of the third sensing dataset or information (e.g., WTRU-sensing dataset).

[0150] Some embodiments may include representative procedure(s) for associating sensing information from non-3GPP sources and/or measurements, and/or for reporting to the network based on the associated information.

[0151] In one embodiment, the WTRU may be configured to operate with (e.g., only with) non-3GPP sources and/or measurements. In this case, the method may be similar to that of FIG. 3, however the association step may be modified. For instance, in this embodiment, the association may be done for (e.g., only for) non-3GPP sources and/or measurements. In this case, the second sensing dataset in FIG. 3 (e.g., the non-3GPP-sensing dataset) may be composed of sub-datasets, e.g., indexed with $i=1,2,3,\dots,N$, where each sub-dataset may be derived by using a different entities (e.g., devices, cameras, lidars, sensors and/or the like) and obtaining sensing information from these entities. The association in this case may be done across sub-datasets, and the results of this association may include the generation of the third sensing dataset (e.g., WTRU-sensing dataset).

[0152] Some embodiments may include representative procedure(s) for using different reporting methods to transmit sensing report(s) or associated sensing information to the NW.

[0153] In one embodiment, instead of (or in addition to) using the sensing reporting procedure as described above, the WTRU may transmit the sensing report or elements and/or entries from the sensing report using existing reporting procedures, for example, as additional information appended to the MAC CE for the BSR.

[0154] FIG. 4 illustrates an input-process-output diagram 400 depicting an example, according to an embodiment. As illustrated in the example of FIG. 4, the input block 410 shows examples of the relevant information and/or configurations that may be received from the NW, whereas the output block 420 shows examples of the relevant information that may be generated and/or provided to the NW according to certain embodiments. The process block 415 shows the procedures that may be performed at the WTRU according to certain embodiments. In the given example of FIG. 4, the WTRU may receive any one or more of the relevant configurations and/or models at 410, and the WTRU may associate 3GPP and non-3GPP sensing datasets into a unified WTRU-sensing dataset, e.g., based on a criterion at 418. After processing the WTRU-sensing dataset with a configured filter, the WTRU may generate a sensing report based on the result of the filter and may transmit the sensing report, for example, based on a predefined trigger condition. The sensing report may be generated towards the NW, and may contain information related to the perceptual information about the surrounding environment, as information generated by the WTRU, and not available at the NW. The sensing information can allow design and optimization of multiple operational procedures at the NW, such as beamforming, scheduling, etc.

[0155] Although features and elements are provided 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. The present disclosure is not to be limited in terms of the particular embodiments described in this application, which are intended as

illustrations of various aspects. Many modifications and variations may be made without departing from its spirit and scope, as will be apparent to those skilled in the art. No element, act, or instruction used in the description of the present application should be construed as critical or essential to the invention unless explicitly provided as such. Functionally equivalent methods and apparatuses within the scope of the disclosure, in addition to those enumerated herein, will be apparent to those skilled in the art from the foregoing descriptions. Such modifications and variations are intended to fall within the scope of the appended claims. The present disclosure is to be limited only by the terms of the appended claims, along with the full scope of equivalents to which such claims are entitled. It is to be understood that this disclosure is not limited to particular methods or systems.

[0156] In some example embodiments described herein, (e.g., configuration) information may be described as received by a WTRU from the network, for example, through system information or via any kind of protocol message. Although not explicitly mentioned throughout embodiments described herein, the same (e.g., configuration) information may be pre-configured in the WTRU (e.g., via any kind of pre-configuration methods such as e.g., via factory settings), such that this (e.g., configuration) information may be used by the WTRU without being received from the network.

[0157] Any characteristic, variant or embodiment described for a method is compatible with an apparatus device comprising means for processing the disclosed method, such as with a device comprising a processor configured to process the disclosed method, a computer program product comprising program code instructions and a non-transitory computer-readable storage medium storing program instructions.

[0158] The foregoing embodiments are discussed, for simplicity, with regard to the terminology and structure of infrared capable devices, i.e., infrared emitters and receivers. However, the embodiments discussed are not limited to these systems but may be applied to other systems that use other forms of electromagnetic waves or non-electromagnetic waves such as acoustic waves.

[0159] It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting. As used herein, the term "video" or the term "imagery" may mean any of a snapshot, single image and/or multiple images displayed over a time basis. As another example, when referred to herein, the terms "user equipment" and its abbreviation "UE", the term "remote" and/or the terms "head mounted display" or its abbreviation "HMD" may mean or include (i) a wireless transmit and/or receive unit (WTRU); (ii) any of a number of embodiments of a WTRU; (iii) a wireless-capable and/or wired-capable (e.g., tetherable) device configured with, inter alia, some or all structures and functionality of a WTRU;

(iii) a wireless-capable and/or wired-capable device configured with less than all structures and functionality of a WTRU; or (iv) the like. Details of an example WTRU, which may be representative of any WTRU recited herein, are provided herein with respect to FIGs. 1A-1D. As another example, various disclosed embodiments herein *supra* and *infra* are described as utilizing a head mounted display. Those skilled in the art will recognize that a device other than the head mounted display may be utilized and some or all of the disclosure and various disclosed embodiments can be modified accordingly without undue experimentation. Examples of such other device may include a drone or other device configured to stream information for providing the adapted reality experience.

[0160] In addition, the methods provided 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 electronic signals (transmitted over wired or wireless connections) and 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, UE, terminal, base station, RNC, or any host computer.

[0161] Variations of the method, apparatus and system provided above are possible without departing from the scope of the invention. In view of the wide variety of embodiments that can be applied, it should be understood that the illustrated embodiments are examples only, and should not be taken as limiting the scope of the following claims. For instance, the embodiments provided herein include handheld devices, which may include or be utilized with any appropriate voltage source, such as a battery and the like, providing any appropriate voltage.

[0162] Moreover, in the embodiments provided above, processing platforms, computing systems, controllers, and other devices that include processors are noted. These devices may include at least one Central Processing Unit ("CPU") and memory. In accordance with the practices of persons skilled in the art of computer programming, reference to acts and symbolic representations of operations or instructions may be performed by the various CPUs and memories. Such acts and operations or instructions may be referred to as being "executed," "computer executed" or "CPU executed."

[0163] One of ordinary skill in the art will appreciate that the acts and symbolically represented operations or instructions include the manipulation of electrical signals by the CPU. An electrical

system represents data bits that can cause a resulting transformation or reduction of the electrical signals and the maintenance of data bits at memory locations in a memory system to thereby reconfigure or otherwise alter the CPU's operation, as well as other processing of signals. The memory locations where data bits are maintained are physical locations that have particular electrical, magnetic, optical, or organic properties corresponding to or representative of the data bits. It should be understood that the embodiments are not limited to the above-mentioned platforms or CPUs and that other platforms and CPUs may support the provided methods.

[0164] The data bits may also be maintained on a computer readable medium including magnetic disks, optical disks, and any other volatile (e.g., Random Access Memory (RAM)) or non-volatile (e.g., Read-Only Memory (ROM)) mass storage system readable by the CPU. The computer readable medium may include cooperating or interconnected computer readable medium, which exist exclusively on the processing system or are distributed among multiple interconnected processing systems that may be local or remote to the processing system. It should be understood that the embodiments are not limited to the above-mentioned memories and that other platforms and memories may support the provided methods.

[0165] In an illustrative embodiment, any of the operations, processes, etc. described herein may be implemented as computer-readable instructions stored on a computer-readable medium. The computer-readable instructions may be executed by a processor of a mobile unit, a network element, and/or any other computing device.

[0166] There is little distinction left between hardware and software implementations of aspects of systems. The use of hardware or software is generally (but not always, in that in certain contexts the choice between hardware and software may become significant) a design choice representing cost versus efficiency tradeoffs. There may be various vehicles by which processes and/or systems and/or other technologies described herein may be effected (e.g., hardware, software, and/or firmware), and the preferred vehicle may vary with the context in which the processes and/or systems and/or other technologies are deployed. For example, if an implementer determines that speed and accuracy are paramount, the implementer may opt for a mainly hardware and/or firmware vehicle. If flexibility is paramount, the implementer may opt for a mainly software implementation. Alternatively, the implementer may opt for some combination of hardware, software, and/or firmware.

[0167] The foregoing detailed description has set forth various embodiments of the devices and/or processes via the use of block diagrams, flowcharts, and/or examples. Insofar as such block diagrams, flowcharts, and/or examples include one or more functions and/or operations, it will be understood by those within the art that each function and/or operation within such block diagrams,

flowcharts, or examples may be implemented, individually and/or collectively, by a wide range of hardware, software, firmware, or virtually any combination thereof. In an embodiment, several portions of the subject matter described herein may be implemented via Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs), digital signal processors (DSPs), and/or other integrated formats. However, those skilled in the art will recognize that some aspects of the embodiments disclosed herein, in whole or in part, may be equivalently implemented in integrated circuits, as one or more computer programs running on one or more computers (e.g., as one or more programs running on one or more computer systems), as one or more programs running on one or more processors (e.g., as one or more programs running on one or more microprocessors), as firmware, or as virtually any combination thereof, and that designing the circuitry and/or writing the code for the software and or firmware would be well within the skill of one of skill in the art in light of this disclosure. In addition, those skilled in the art will appreciate that the mechanisms of the subject matter described herein may be distributed as a program product in a variety of forms, and that an illustrative embodiment of the subject matter described herein applies regardless of the particular type of signal bearing medium used to actually carry out the distribution. Examples of a signal bearing medium include, but are not limited to, the following: a recordable type medium such as a floppy disk, a hard disk drive, a CD, a DVD, a digital tape, a computer memory, etc., and a transmission type medium such as a digital and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communications link, a wireless communication link, etc.).

[0168] Those skilled in the art will recognize that it is common within the art to describe devices and/or processes in the fashion set forth herein, and thereafter use engineering practices to integrate such described devices and/or processes into data processing systems. That is, at least a portion of the devices and/or processes described herein may be integrated into a data processing system via a reasonable amount of experimentation. Those having skill in the art will recognize that a typical data processing system may generally include one or more of a system unit housing, a video display device, a memory such as volatile and non-volatile memory, processors such as microprocessors and digital signal processors, computational entities such as operating systems, drivers, graphical user interfaces, and applications programs, one or more interaction devices, such as a touch pad or screen, and/or control systems including feedback loops and control motors (e.g., feedback for sensing position and/or velocity, control motors for moving and/or adjusting components and/or quantities). A typical data processing system may be implemented utilizing any suitable commercially available components, such as those typically found in data computing/communication and/or network computing/communication systems.

[0169] The herein described subject matter sometimes illustrates different components included within, or connected with, different other components. It is to be understood that such depicted architectures are merely examples, and that in fact many other architectures may be implemented which achieve the same functionality. In a conceptual sense, any arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality may be achieved. Hence, any two components herein combined to achieve a particular functionality may be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermedial components. Likewise, any two components so associated may also be viewed as being "operably connected", or "operably coupled", to each other to achieve the desired functionality, and any two components capable of being so associated may also be viewed as being "operably couplable" to each other to achieve the desired functionality. Specific examples of operably couplable include but are not limited to physically mateable and/or physically interacting components and/or wirelessly interactable and/or wirelessly interacting components and/or logically interacting and/or logically interactable components.

[0170] With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

[0171] It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, where only one item is intended, the term "single" or similar language may be used. As an aid to understanding, the following appended claims and/or the descriptions herein may include usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim including such introduced claim recitation to embodiments including only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should be interpreted to mean "at least one" or "one or more"). The same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a

specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should be interpreted to mean at least the recited number (e.g., the bare recitation of "two recitations," without other modifiers, means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B." Further, the terms "any of" followed by a listing of a plurality of items and/or a plurality of categories of items, as used herein, are intended to include "any of," "any combination of," "any multiple of," and/or "any combination of multiples of" the items and/or the categories of items, individually or in conjunction with other items and/or other categories of items. Moreover, as used herein, the term "set" is intended to include any number of items, including zero. Additionally, as used herein, the term "number" is intended to include any number, including zero. And the term "multiple", as used herein, is intended to be synonymous with "a plurality".

[0172] In addition, where features or aspects of the disclosure are described in terms of Markush groups, those skilled in the art will recognize that the disclosure is also thereby described in terms of any individual member or subgroup of members of the Markush group.

[0173] As will be understood by one skilled in the art, for any and all purposes, such as in terms of providing a written description, all ranges disclosed herein also encompass any and all possible subranges and combinations of subranges thereof. Any listed range can be easily recognized as sufficiently describing and enabling the same range being broken down into at least equal halves, thirds, quarters, fifths, tenths, etc. As a non-limiting example, each range discussed herein may be readily broken down into a lower third, middle third and upper third, etc. As will also be understood by one skilled in the art all language such as "up to," "at least," "greater than," "less than," and the

like includes the number recited and refers to ranges which can be subsequently broken down into subranges as discussed above. Finally, as will be understood by one skilled in the art, a range includes each individual member. Thus, for example, a group having 1-3 cells refers to groups having 1, 2, or 3 cells. Similarly, a group having 1-5 cells refers to groups having 1, 2, 3, 4, or 5 cells, and so forth.

[0174] Moreover, the claims should not be read as limited to the provided order or elements unless stated to that effect. In addition, use of the terms "means for" in any claim is intended to invoke 35 U.S.C. §112, ¶ 6 or means-plus-function claim format, and any claim without the terms "means for" is not so intended.

[0175] Although various embodiments have been described in terms of communication systems, it is contemplated that the systems may be implemented in software on microprocessors/general purpose computers (not shown). In certain embodiments, one or more of the functions of the various components may be implemented in software that controls a general-purpose computer.

[0176] In addition, although some example embodiments are illustrated and described herein, the invention is not intended to just be limited to the details shown. Rather, various modifications and variations may be made in the details within the scope and range of equivalents of the claims and without departing from the spirit or scope invention.

REFERENCES

[0177] The following references may have been referred to hereinabove, each of which is incorporated herein by reference in its entirety:

[0178] [1] TS 38.331 v17.5.0, June 2023;

[0179] [2] TS 37.355 v17.5.0, June 2023.

ABBREVIATIONS AND ACRONYMS

AMF	Access and Mobility Management Function
CSI-RS	Channel State Information Reference Signal
DCI	Downlink Control Information
DL	Downlink
DM-PRS	Demodulation Reference Signal
DRB	Data Radio Bearer
LCP	Logical Channel Prioritization
MAC	Medium Access Control
MAC CE	MAC Control Element
NEF	Network Exposure Function

NW	Network
PCF	Policy Control Function
PRS	Positioning Reference Signal
RRC	Radio Resource Control
SMF	Session Management Function
SRB	Signalling Radio Bearer
SRS	Sounding Reference Signal
TRP	Transmission Reception Point
WLAN	Wireless Local Area Network

CLAIMS

What is claimed is:

1. A method implemented by a wireless transmit/receive unit (WTRU), the method comprising:
 - receiving, from a network element, configuration information indicating any of: (i) 3GPP measurement configurations, (ii) localization measurement configurations, and (iii) sensing-related measurement information;
 - determining, in accordance with any of the 3GPP measurement configurations, the localization measurement configurations and the sensing-related measurement information, 3GPP sensing information based on 3GPP sources and non-3GPP sensing information based on non-3GPP sources;
 - receiving at least one filter;
 - determining a sensing dataset based on an association between the 3GPP sensing information and the non-3GPP sensing information;
 - transmitting a sensing report or a portion of the sensing report to the network element, wherein the sensing report or the portion of the sensing report indicates information based on a result of processing the sensing dataset with the at least one filter.
2. The method of claim 1, wherein the determining comprises determining the sensing dataset according to a predefined criteria comprising any of: raw sensing data and processed sensing data.
3. The method of any of claims 1-2, wherein the configuration information further indicates rules for integrity or validation criteria, and wherein the sensing report is generated according to the rules for integrity or validation criteria.
4. The method of any of claims 1-3, wherein the 3GPP measurement configurations comprise any of: measurement configurations, reporting configurations, and assistance information.
5. The method of any of claims 1-4, wherein the localization measurement configuration is used to determine localization information associated with the WTRU including any of positions and coordinates associated with the WTRU.

6. The method of any of claims 1-5, wherein the sensing-related measurement information comprises an indication of any of measurement methods and/or associated metrics.
7. The method of any of claims 1-6, wherein the 3GPP sources comprise any of positioning measurements, methods or signals and/or sensing measurements, methods or signals.
8. The method of any of claims 1-7, wherein the non-3GPP sources comprise any of wireless local area network (WLAN), Bluetooth, mounted or embedded cameras or lidar measurements.
9. The method of any of claims 1-8, comprising:
 - determining whether a trigger condition is satisfied; and
 - on condition that the trigger condition is satisfied, performing the determining of the sensing dataset and the transmitting of the sensing report.
10. The method of any of claims 1-8, comprising:
 - determining whether a trigger condition is satisfied; and
 - based on the trigger condition being satisfied, determining which actions to perform and/or which information to apply when determining the sensing dataset and/or transmitting the sensing report or portion thereof.
11. The method of any of claims 1-10, wherein the transmitting comprises transmitting an indication of one or more elements from the sensing dataset.
12. A wireless transmit/receive unit (WTRU) comprising any of a processor, a receiver, a transmitter, and memory, the circuitry configured to:
 - receive, from a network element, configuration information indicating any of: (i) 3GPP measurement configurations, (ii) localization measurement configurations, and (iii) sensing-related measurement information;
 - determine, in accordance with any of the 3GPP measurement configurations, the localization measurement configurations and the sensing-related measurement information, 3GPP sensing information based on 3GPP sources and non-3GPP sensing information based on non-3GPP sources;
 - receive at least one filter;

determine a sensing dataset based on an association between the 3GPP sensing information and the non-3GPP sensing information;

transmit a sensing report or portion of the sensing report to the network element, wherein the sensing report or the portion of the sensing report indicates information based on a result of processing the sensing dataset with the at least one filter.

13. The WTRU of claim 12, wherein the sensing dataset is determined according to a predefined criteria comprising any of: raw sensing data and processed sensing data.

14. The WTRU of any of claims 12-13, wherein the configuration information further indicates rules for integrity or validation criteria, and wherein the sensing report is generated according to the rules for integrity or validation criteria.

15. The WTRU of any of claims 12-14, wherein the 3GPP measurement configurations comprise any of: measurement configurations, reporting configurations, and assistance information.

16. The WTRU of any of claims 12-15, wherein the localization measurement configuration is used to determine localization information associated with the WTRU including any of positions and coordinates associated with the WTRU.

17. The WTRU of any of claims 12-16, wherein the sensing-related measurement information comprises an indication of any of measurement methods and/or associated metrics.

18. The WTRU of any of claims 12-17, wherein the 3GPP sources comprise any of positioning measurements, methods or signals and/or sensing measurements, methods or signals.

19. The WTRU of any of claims 12-18, wherein the non-3GPP sources comprise any of wireless local area network (WLAN), Bluetooth, mounted or embedded cameras, or lidar measurements.

20. The WTRU of any of claims 12-19, wherein the circuitry is configured to:

determine whether a trigger condition is satisfied; and

on condition that the trigger condition is satisfied, determine the sensing dataset and transmit the sensing report.

21. The WTRU of any of claims 12-19, wherein the circuitry is configured to:
- determine whether a trigger condition is satisfied; and
 - based on the trigger condition being satisfied, determine which actions to perform and/or which information to apply when determining the sensing dataset and/or transmitting the sensing report or portion thereof.
22. The WTRU of any of claims 12-21, wherein the transmitting comprises transmitting an indication of one or more elements from the sensing dataset.

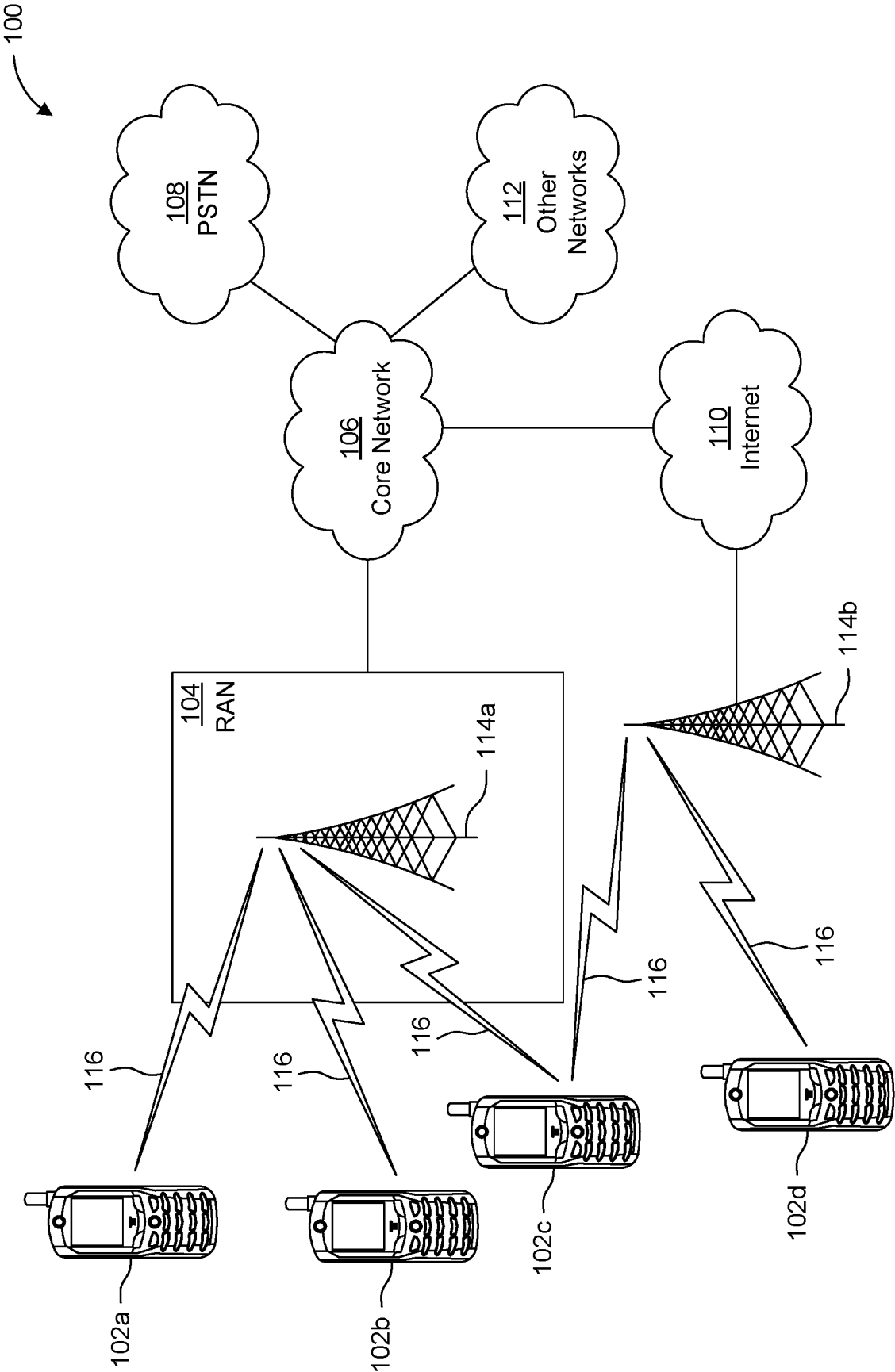


FIG. 1A

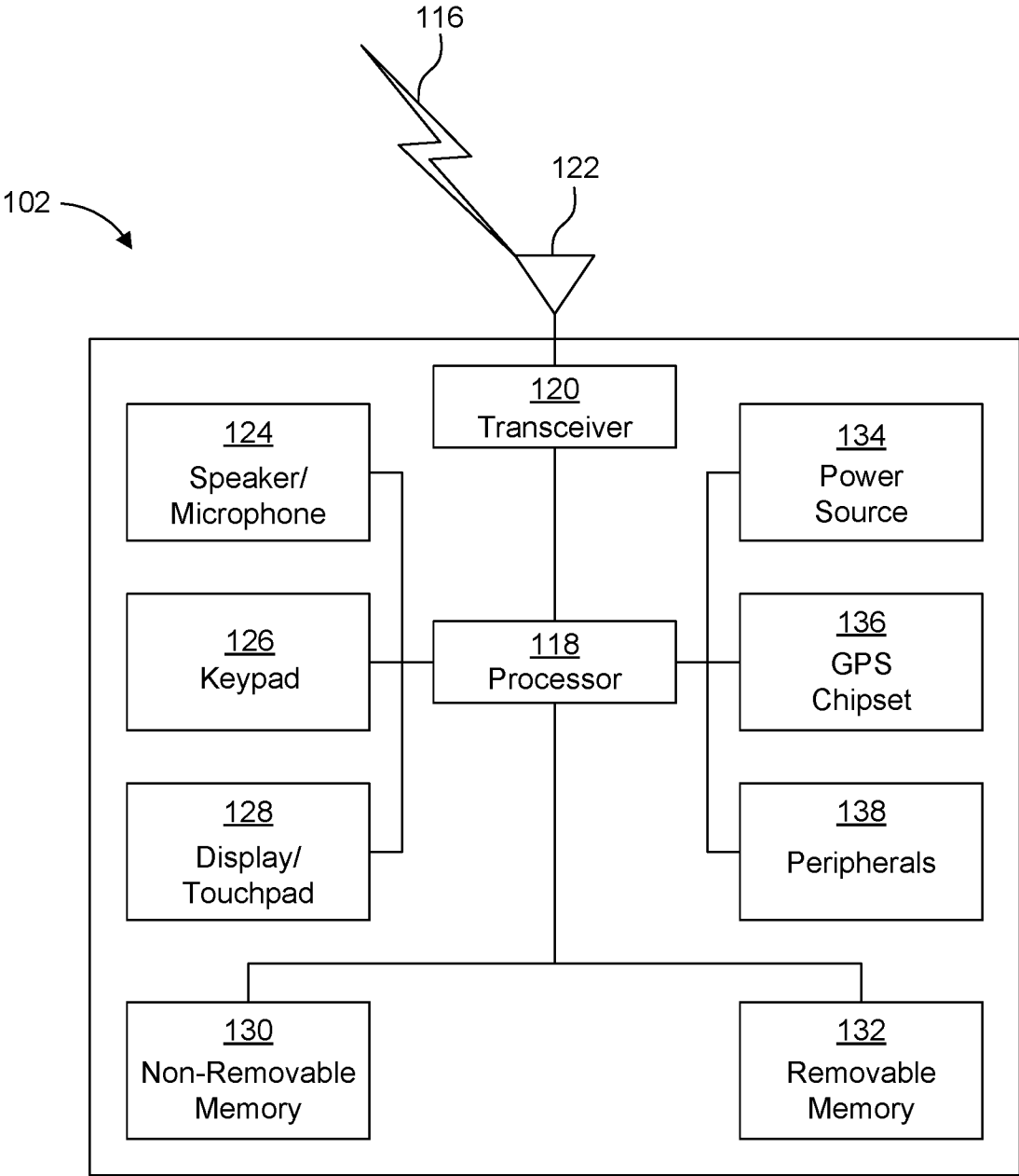


FIG. 1B

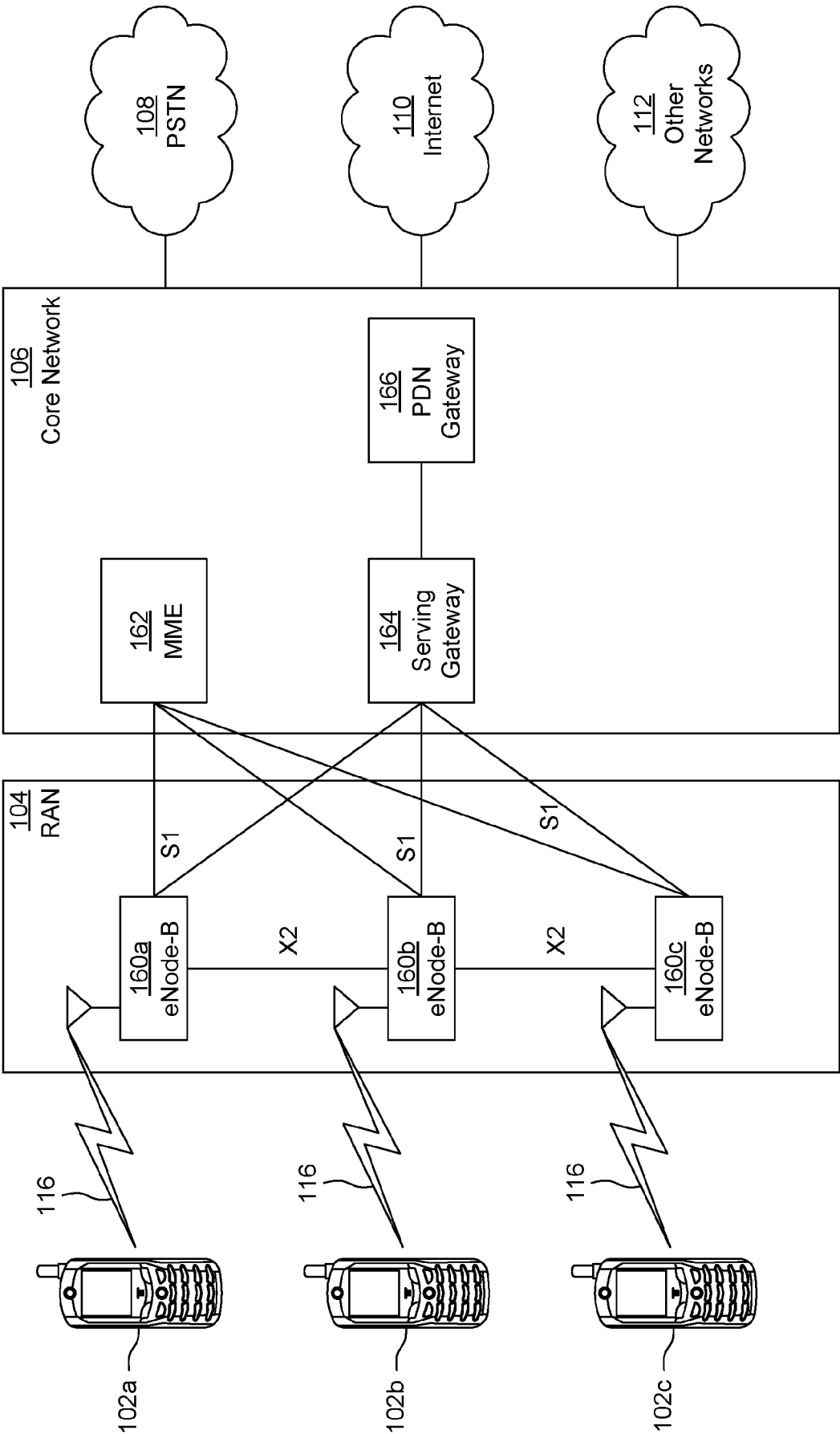


FIG. 1C

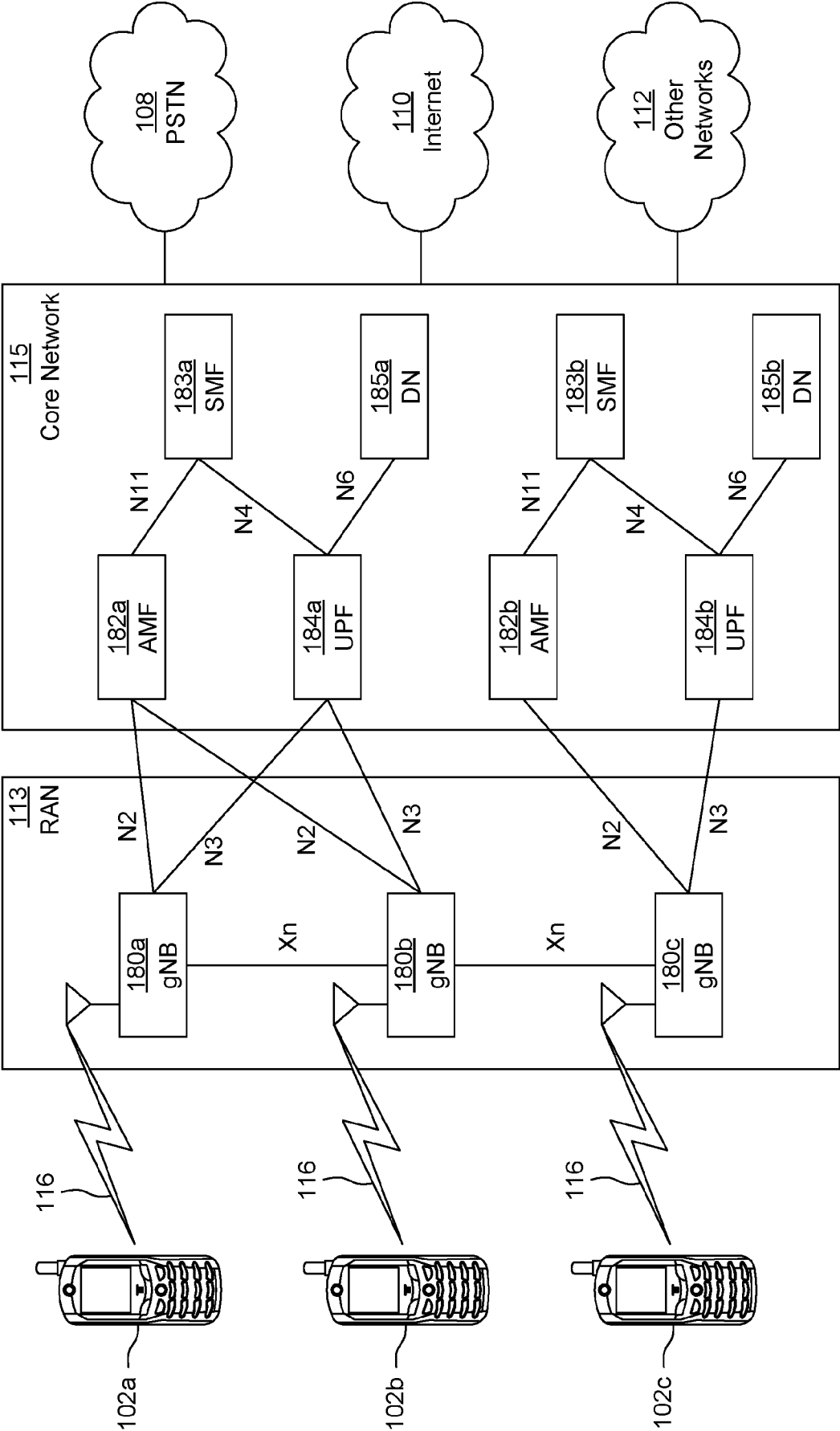


FIG. 1D

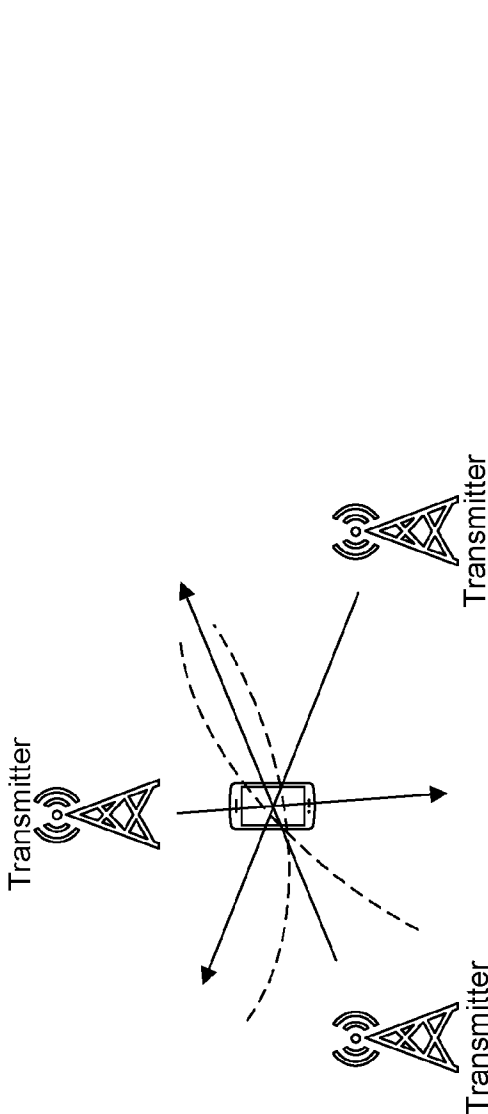


FIG. 2A

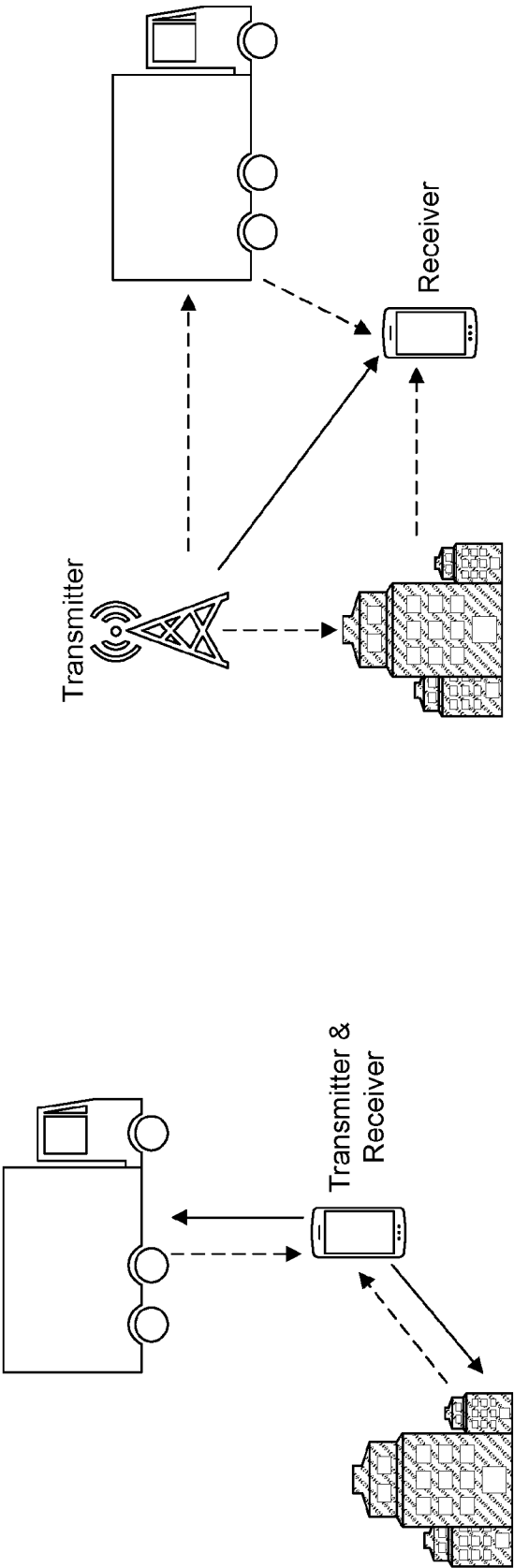


FIG. 2C

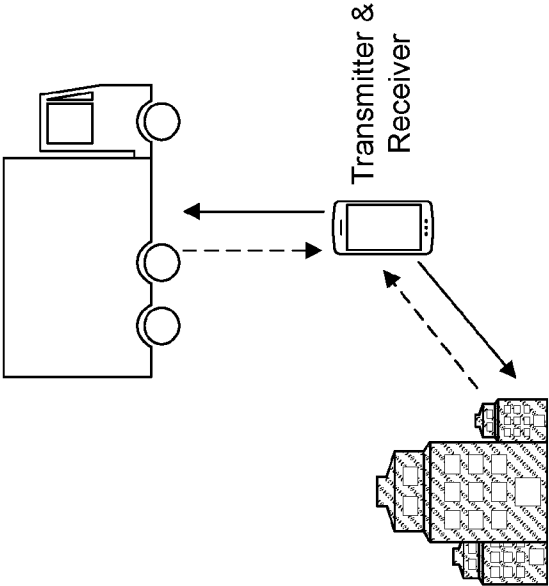


FIG. 2B

6/7

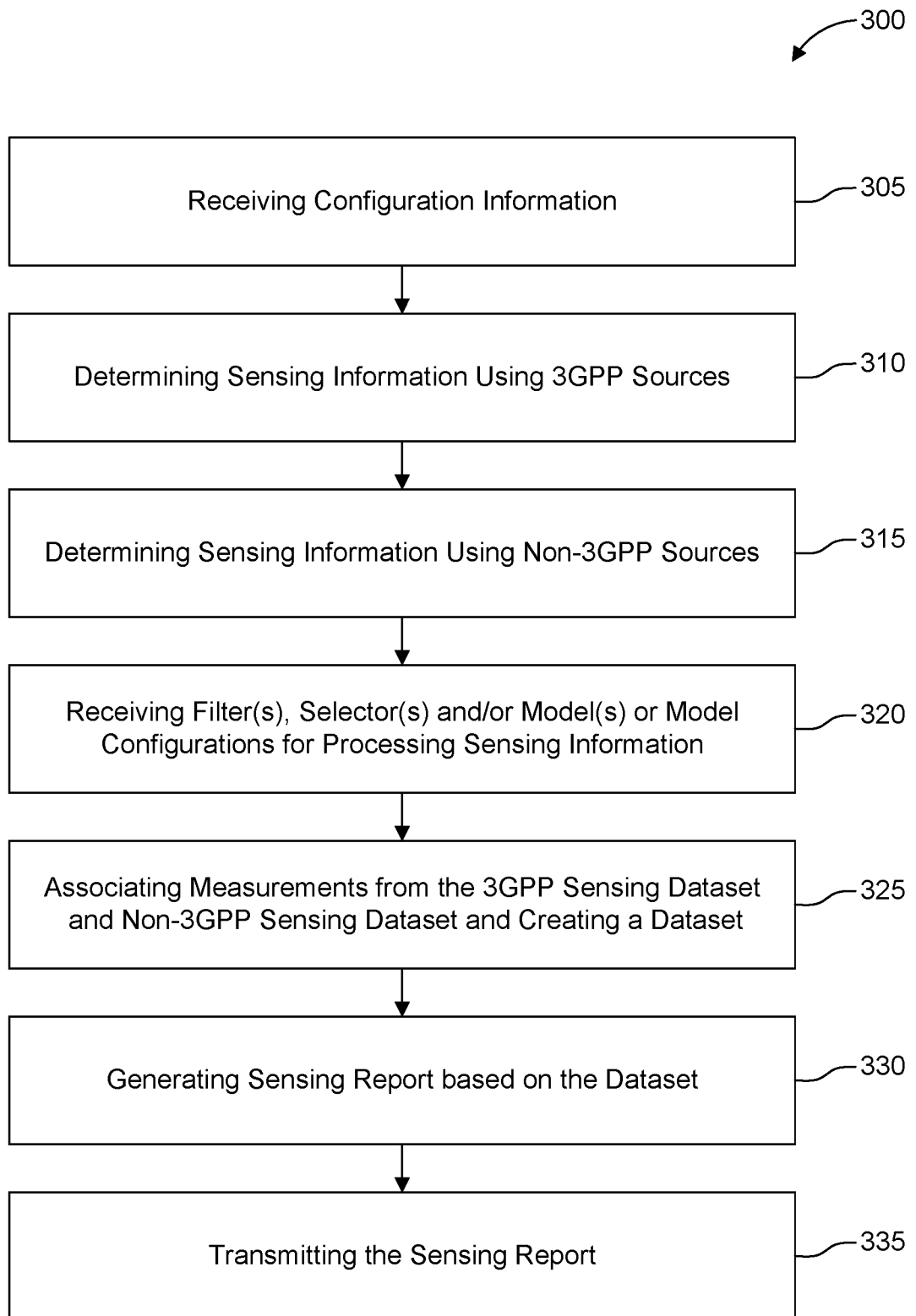


FIG. 3

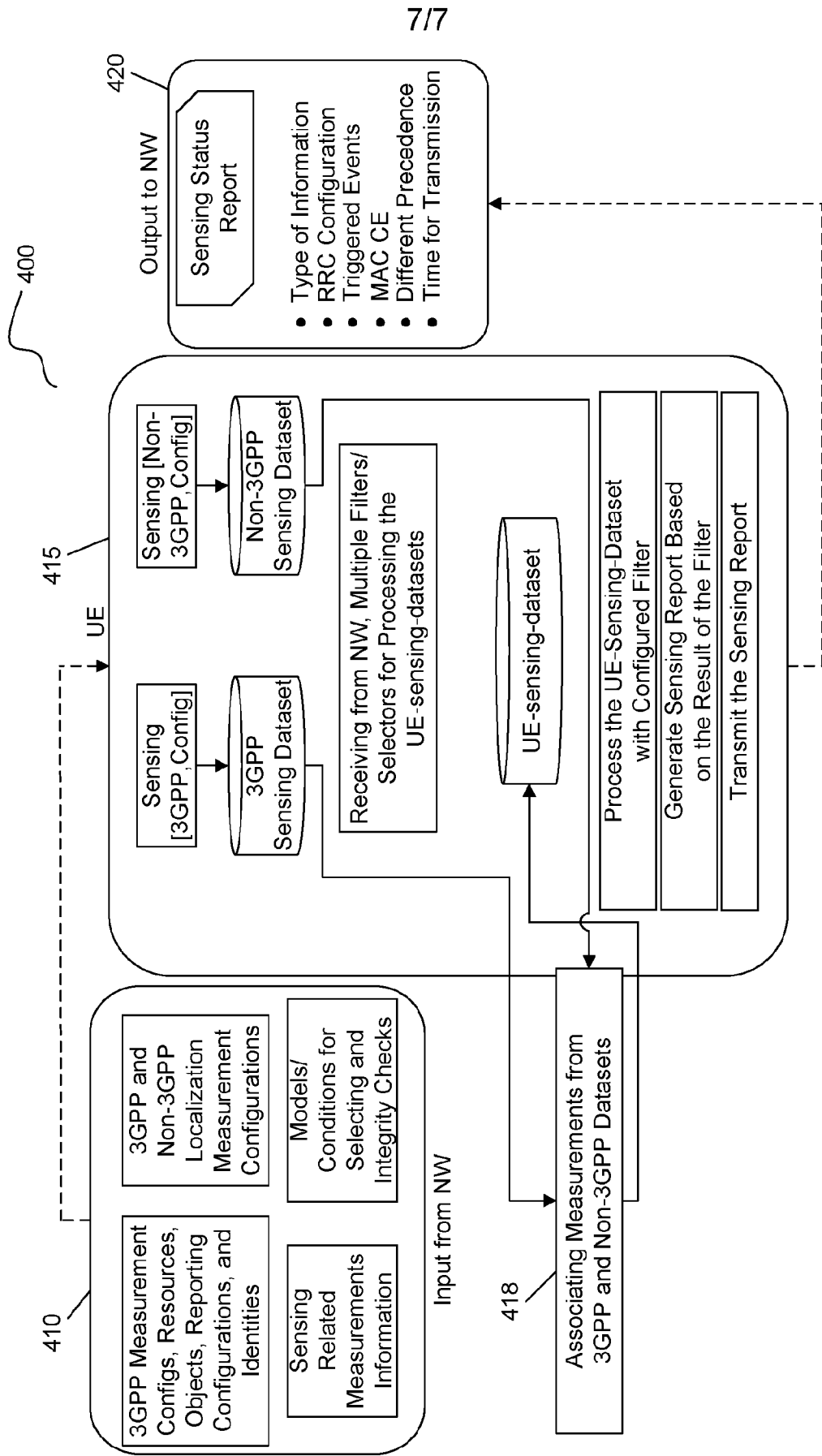


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2024/044612

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W24/10

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ATLE MONRAD ET AL: "Update of use case on sensing in smart cities", 3GPP DRAFT; S1-230060; TYPE PCR; FS_SENSING, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. SA WG1, no. Athens, GR; 20230220 - 20230224 10 February 2023 (2023-02-10), XP052236782, Retrieved from the Internet: URL:https://www.3gpp.org/ftp/tsg_sa/WG1_Ser- v/TSGS1_101_Athens/Docs/S1-230060.zip S1-230060_Sensing_UC_on_smart-cities_v2.docx [retrieved on 2023-02-10]	1,2,4,7, 8,11-13, 15,18, 19,22
Y	figures 5.5.3-1 - / - -	3,5,6,9,

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

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

22 November 2024

Date of mailing of the international search report

03/12/2024

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Atanasovski, Igor

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2024/044612

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	sections 5.5.2 - 5.5.3; page 2 - page 3 -----	10,14, 16,17, 20,21
Y	WO 2022/155244 A2 (IDAC HOLDINGS INC [US]) 21 July 2022 (2022-07-21)	3,14
A	page 50, paragraph 00192 - page 51 -----	1,2, 4-13, 15-22
Y	US 2022/046385 A1 (SUNDARARAJAN JAY KUMAR [US] ET AL) 10 February 2022 (2022-02-10)	5,6,16, 17
A	figure 9 page 18, paragraph 0201 - page 18, paragraph 0205 -----	1-4, 7-15, 18-22
Y	WO 2023/014795 A1 (INTERDIGITAL PATENT HOLDINGS INC [US]) 9 February 2023 (2023-02-09)	9,10,20, 21
A	page 41, paragraph 0195 - page 43, paragraph 0203 -----	1-8, 11-19,22

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2024/044612

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2022155244 A2	21-07-2022	EP 4278205 A2	22-11-2023
		US 2024295625 A1	05-09-2024
		WO 2022155244 A2	21-07-2022

US 2022046385 A1	10-02-2022	BR 112023001361 A2	14-02-2023
		CN 116057402 A	02-05-2023
		EP 4193165 A1	14-06-2023
		KR 20230044410 A	04-04-2023
		US 2022046385 A1	10-02-2022
		US 2024048945 A1	08-02-2024
		WO 2022031673 A1	10-02-2022

WO 2023014795 A1	09-02-2023	EP 4381310 A1	12-06-2024
		WO 2023014795 A1	09-02-2023
