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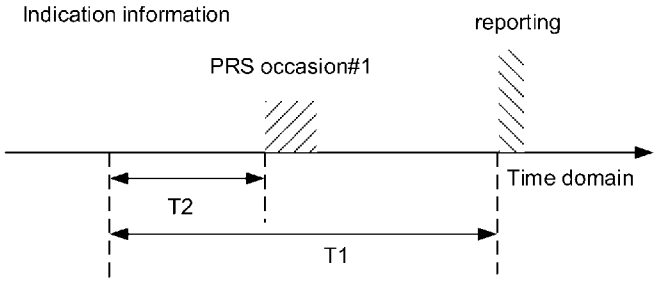


Figure 3

(57) Abstract: Various aspects of the present disclosure relate to a method and apparatus of supporting data collection. An exemplary method performed by a UE includes: receiving PRSs based on configuration information related to PRS reception; reporting channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information includes: timing information, power information, amplitude information, phase information, or any combination thereof; and reporting position related information, wherein, the position related information includes: position information, Doppler information, time difference information based on the at least one PRS, RTT information based on the at least one PRS, RSRP information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof; wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

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METHOD AND APPARATUS OF SUPPORTING DATA COLLECTION

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to technologies of supporting data collection, e.g., for positioning.

BACKGROUND

[0002] A wireless communications system may include one or multiple network communication devices, such as base stations, which may support wireless communications for one or multiple user communication devices, which may be otherwise known as user equipment (UE), or other suitable terminology. The wireless communications system may support wireless communications with one or multiple user communication devices by utilizing resources of the wireless communication system (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers, or the like). Additionally, the wireless communications system may support wireless communications across various radio access technologies including third generation (3G) radio access technology, fourth generation (4G) radio access technology, fifth generation (5G) radio access technology, among other suitable radio access technologies beyond 5G (e.g., sixth generation (6G)).

SUMMARY

[0003] An article "a" before an element is unrestricted and understood to refer to "at least one" of those elements or "one or more" of those elements. The terms "a," "at least one," "one or more," and "at least one of one or more" may be interchangeable. As used herein, including in the claims, "or" as used in a list of items (e.g., a list of items prefaced by a phrase such as "at least one of" or "one or more of" or "one or both of") indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase "based on" shall not be construed as a reference to a closed set of conditions. For example, an example step that is

described as "based on condition A" may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase "based on" shall be construed in the same manner as the phrase "based at least in part on. Further, as used herein, including in the claims, a "set" may include one or more elements.

[0004] Some implementations of the methods and apparatuses described herein may further include a UE for wireless communication, which includes: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the UE to: receive positioning reference signals (PRSs) based on configuration information related to PRS reception; report channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information includes: timing information, power information, amplitude information, phase information, or any combination thereof; and report position related information, wherein, the position related information includes: position information, Doppler information, time difference information based on the at least one PRS, round trip time (RTT) information based on the at least one PRS, reference signal receiving power (RSRP) information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof; wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

[0005] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: report the channel related information aperiodically based on received indication information after a first duration between receiving the indication information and reporting the channel related information, wherein the first duration is configured or predefined.

[0006] In some implementations of the methods and apparatuses described herein, the configuration information related to PRS reception is included in the indication information, and there is a second duration between receiving the indication information and the PRS reception, wherein, the second duration is configured or predefined.

[0007] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: in the case that the first duration is larger than a first threshold and the second duration is larger than a second threshold, determine a time instance of a PRS occasion associated with the PRS reception as the first time instance; otherwise, determine a time instance of a PRS occasion before receiving the indication information as the first time instance.

[0008] In some implementations of the methods and apparatuses described herein, the first time instance is a starting time instance, ending time instance or middle time instance of the PRS occasion.

[0009] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: receive the PRSs based on the configuration information related to PRS reception periodically; and report the channel related information based on at least one PRS received on an associated PRS occasion periodically.

[0010] In some implementations of the methods and apparatuses described herein, in the case that periodicity of the PRSs is smaller than that of reporting the channel related information, the at least one processor is configured to cause the UE to: for each reporting the channel related information, determine one PRS occasion among multiple PRS occasions as the associated PRS occasion to determine the channel related information.

[0011] In some implementations of the methods and apparatuses described herein, the multiple PRS occasions are earlier than the reporting the channel related information and a time domain duration between each PRS occasion of the multiple PRS occasions and the reporting the channel related information is larger than a predefined or configured threshold.

[0012] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: determine a latest one of the multiple PRS occasion as the associated PRS occasion.

[0013] In some implementations of the methods and apparatuses described herein, a starting position of the multiple PRS occasions for each reporting the channel related information is after the associated PRS occasion for nearest previous reporting the channel

related information, and an ending position of the multiple PRS occasions is earlier than reporting the channel related information by more than a predefined or configured threshold.

[0014] In some implementations of the methods and apparatuses described herein, a starting position of the multiple PRS occasions for each reporting the channel related information is after a configured time domain position.

[0015] In some implementations of the methods and apparatuses described herein, the configured time domain position is periodic.

[0016] In some implementations of the methods and apparatuses described herein, the associated PRS occasion is configured or predefined to be first one, middle one, or last one of the multiple PRS occasions.

[0017] In some implementations of the methods and apparatuses described herein, the starting position is in unit of ms, slot, symbol or PRS periodicity.

[0018] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to report timing related information of the associated PRS occasion, and the timing related information is a starting time instance, ending time instance or middle time instance of the PRS occasion.

[0019] In some implementations of the methods and apparatuses described herein, the position related information includes the position information, a time instance associated with the position information, speed information, and a timer associated with validity of the position related information.

[0020] In some implementations of the methods and apparatuses described herein, the position related information includes Doppler information associated with multiple PRS resources or multiple transmit-receive points (TRPs).

[0021] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: receive configured time instances; and report the position related information including the position information corresponding to the configured time instances.

[0022] In some implementations of the methods and apparatuses described herein, the position information is with respect to global coordinate system or with respect to previous position information.

[0023] In some implementations of the methods and apparatuses described herein, each of the configured time instances is a slot index, symbol index, coordinated universal time (UTC) time or PRS occasion index.

[0024] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: report the channel related information and the position related information associated with a same time instance together.

[0025] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to determine a quality indicator associated with the position related information.

[0026] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to determine the quality indicator based on type of a receiver of the UE.

[0027] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to determine the quality indicator based on a confidence level of reporting the position information.

[0028] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to determine the quality indicator based on a reporting metric associated with an adopted position method.

[0029] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to determine the quality indicator based on an adopted position method.

[0030] In some implementations of the methods and apparatuses described herein, the adopted position method is a method based on reference signal time difference (RSTD), RTT, RSRP, reference signal receiving power per path (RSRPP), reference signal carrier phase (RSCP), wireless local area networks (WLAN) , sensing or blue tooth.

[0031] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to determine the quality indicator based on signal to interference plus noise ratio (SINR), RSRP, reference signal receiving quality (RSRQ) or channel state information (CSI) or any combination thereof measured based on the at least one PRS.

[0032] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to determine the quality indicator based on a number of PRS ports, time domain density of PRS or frequency domain density of PRS.

[0033] In some implementations of the methods and apparatuses described herein, the quality indicator is associated with a timer, and the quality indicator is valid during the timer.

[0034] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to report the first time instance and the second time instance.

[0035] Some implementations of the methods and apparatuses described herein may further include a processor for wireless communication, which includes: at least one controller coupled with at least one memory and configured to cause the at least one processor to: receive PRSs based on configuration information related to PRS reception; report channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information includes: timing information, power information, amplitude information, phase information, or any combination thereof; and report position related information, wherein, the position related information includes: position information, Doppler information, time difference information based on the at least one PRS, RTT information based on the at least one PRS, RSRP information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof; wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

[0036] Some implementations of the methods and apparatuses described herein may further include a network equipment (NE) for wireless communication, which includes: at

least one memory; and at least one processor coupled with the at least one memory and configured to cause the NE to: transmit PRSs based on configuration information related to PRS reception; receiving reporting of channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information includes: timing information, power information, amplitude information, phase information, or any combination thereof; and receiving reporting of position related information, wherein, the position related information includes: position information, Doppler information, time difference information based on the at least one PRS, RTT information based on the at least one PRS, RSRP information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof; wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

[0037] Some implementations of the methods and apparatuses described herein may further include a method performed by a UE, which includes: receiving PRSs based on configuration information related to PRS reception; reporting channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information includes: timing information, power information, amplitude information, phase information, or any combination thereof; and reporting position related information, wherein, the position related information includes: position information, Doppler information, time difference information based on the at least one PRS, RTT information based on the at least one PRS, RSRP information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof; wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] Figure 1 illustrates an example of a wireless communications system in accordance with aspects of the present disclosure.

[0039] Figure 2 illustrates an example of Case 2b in accordance with aspects of the present disclosure.

[0040] Figure 3 illustrate an exemplary scenario of aperiodic reporting of channel related information in accordance with aspects of the present disclosure.

[0041] Figure 4 illustrate another exemplary scenario of aperiodic reporting of channel related information in accordance with aspects of the present disclosure.

[0042] Figure 5 illustrates an example of determining the associated PRS occasion from multiple PRS occasions in accordance with aspects of the present disclosure.

[0043] Figure 6 illustrates an example of a UE in accordance with aspects of the present disclosure.

[0044] Figure 7 illustrates an example of a processor in accordance with aspects of the present disclosure.

[0045] Figure 8 illustrates an example of a NE in accordance with aspects of the present disclosure.

[0046] Figure 9 illustrates a flowchart of method performed by a UE in accordance with aspects of the present disclosure.

[0047] Figure 10 illustrates a flowchart of method performed by a NE in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0048] Regarding to data collection for artificial intelligence (AI) (or AI/machine learning (ML)) based positioning, at least the following information of data with potential specification impact are identified: 1) ground truth label; 2) measurement (corresponding to model input); 3) quality indicator for and/or associated with ground truth label and/or measurement; 4) reference signal (RS) configuration(s) at least for deriving measurement; and 5) time stamp at least for and/or associated with collected data. Thus, legacy positioning technologies shall be improved to adapt to AI/ML based positioning, wherein, issues related to time stamp and quality indicator associated with ground truth label and measurement, e.g.,

how to associate the ground truth label and measurement to the same time stamp and how to determine and report the quality indicator etc. should be solved.

[0049] At least considering the aforementioned technical problems, aspects of the present disclosure provide technical solutions of supporting data collection, e.g., a method and apparatus of supporting data collection, e.g., for positioning.

[0050] For example, in accordance with aspects of the present disclosure, an entity, e.g., LMF will transmit configuration information related to PRS reception (or PRS configuration information or the like) to UE, e.g., directly or via a gNB or the like. For example, the configuration information related to PRS reception may include time/frequency domain resources (e.g., PRS occasions), or RSs (e.g., PRS identities (IDs)) or RS sets (e.g., PRS set IDs) for UE positioning measurement. The time/frequency domain resources (e.g., PRS occasions), or RSs (e.g., PRS IDs) or RS sets are periodic or aperiodic. The configuration information may be used to determine the ground truth label and/or reporting.

[0051] After receiving the configuration information related to PRS reception, UE will receive PRSs based on the configuration information related to PRS reception. UE will collect data, e.g., related to positioning and report the collected data.

[0052] For example, UE will determine and report channel related information based on at least one PRS received on a PRS occasion to the LMF. Exemplary channel related information may be: timing information, power information, amplitude information, phase information, or any combination thereof, e.g., channel impulse response (CIR), power delay profile (PDP), and/or delay profile (DP).

[0053] UE will also determine and report position related information to the LMF. In accordance with aspects of the present disclosure, in a case (referred as Case 2b hereinafter) where the AI/ML model is trained at LMF and assisted by UE, e.g., based on downlink (DL) PRS measurement and/or reporting, the ground truth label (ground truth) may be the UE position, and/or the UE measurement result based on legacy positioning methods, e.g. RSTD, RSRP, RSRPP, RSCP, etc. Thus, exemplary position related information may be: position information, Doppler information, time difference information based on the at least one PRS,

RTT information based on the at least one PRS, RSRP information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof.

[0054] The channel related information and the position related information will be associated based on a first time instance associated with the PRS occasion based on which the channel related information is determined and a second time instance associated with the position related information. The first time instance and second time instance may be a first time stamp and a second time stamp respectively. Accordingly, either the network side (including the core network and the gNB) or UE side will determine (or pair, or associate or link or the like) the channel related information and the position related information associated with the same time instance for data collection.

[0055] In some implementation of the present disclosure, UE will transmit the first time instance to the network side by including the first time instance in the collected data, e.g., in the channel related information or separate from the channel related data, and UE will transmit the second time instance to the network side by including the second time instance in the collected data, e.g., in the position related information or separate from the position related information. For the channel related information and the position related information associated with the same time instance, e.g., the same time stamp, the network side will associate (or map or the like) them based on the first time instance and the second time instance. In some other implementation of the present disclosure, the network side will configure the channel related information and the corresponding position related information to be reported together, so that the channel related information and the corresponding position related information will be associated with the same time instance, e.g., the same time stamp for the same PRS occasion, and UE will transmit the channel related information and the position related information associated with the same time instance, together to the network side.

[0056] In short, technical solutions disclosed in the present disclosure will improve the existing positioning technology, increase the accuracy of AI/ML model for positioning and facilitate the implementation of AI/ML model for positioning. In addition, although the collected data, e.g., the channel related information and position related information are illustrated for positioning herein, they may be used for other purposes in the future.

Accordingly, the protection scope of the present disclosure should not be unduly limited to positioning.

[0057] Aspects of the present disclosure are described in the context of a wireless communications system.

[0058] Figure 1 illustrates an example of a wireless communications system 100 in accordance with aspects of the present disclosure. The wireless communications system 100 may include one or more NE 102, one or more UE 104, and a core network (CN) 106. The wireless communications system 100 may support various radio access technologies. In some implementations, the wireless communications system 100 may be a 4G network, such as an LTE network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communications system 100 may be a NR network, such as a 5G network, a 5G-Advanced (5G-A) network, or a 5G ultrawideband (5G-UWB) network. In other implementations, the wireless communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G, for example, 6G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0059] The one or more NE 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the NE 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a network function, a network entity, a RAN, a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. An NE 102 and a UE 104 may communicate via a communication link, which may be a wireless or wired connection. For example, an NE 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

[0060] An NE 102 may provide a geographic coverage area for which the NE 102 may support services for one or more UEs 104 within the geographic coverage area. For example, an NE 102 and a UE 104 may support wireless communication of signals related to services

(e.g., voice, video, packet data, messaging, broadcast, etc.) according to one or multiple radio access technologies. In some implementations, an NE 102 may be moveable, for example, a satellite associated with a non-terrestrial network (NTN). In some implementations, different geographic coverage areas 112 associated with the same or different radio access technologies may overlap, but the different geographic coverage areas may be associated with different NE 102.

[0061] The one or more UE 104 may be dispersed throughout a geographic region of the wireless communications system 100. A UE 104 may include or may be referred to as a remote unit, a mobile device, a wireless device, a remote device, a subscriber device, a transmitter device, a receiver device, or some other suitable terminology. In some implementations, the UE 104 may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE 104 may be referred to as an Internet-of-Things (IoT) device, an Internet-of-Everything (IoE) device, or machine-type communication (MTC) device, among other examples.

[0062] A UE 104 may be able to support wireless communication directly with other UEs 104 over a communication link. For example, a UE 104 may support wireless communication directly with another UE 104 over a device-to-device (D2D) communication link. In some implementations, such as vehicle-to-vehicle (V2V) deployments, vehicle-to-everything (V2X) deployments, or cellular-V2X deployments, the communication link 114 may be referred to as a sidelink. For example, a UE 104 may support wireless communication directly with another UE 104 over a PC5 interface.

[0063] An NE 102 may support communications with the CN 106, or with another NE 102, or both. For example, an NE 102 may interface with other NE 102 or the CN 106 through one or more backhaul links (e.g., S1, N2, N2, or network interface). In some implementations, the NE 102 may communicate with each other directly. In some other implementations, the NE 102 may communicate with each other or indirectly (e.g., via the CN 106. In some implementations, one or more NE 102 may include subcomponents, such as an access network entity, which may be an example of an access node controller (ANC). An ANC may communicate with the one or more UEs 104 through one or more other access network transmission entities, which may be referred to as a radio heads, smart radio heads, or TRPs.

[0064] The CN 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The CN 106 may be an evolved packet core (EPC), or a 5G core (5GC), which may include a control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management functions (AMF)) and a user plane entity that routes packets or interconnects to external networks (e.g., a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). In some implementations, the control plane entity may manage non-access stratum (NAS) functions, such as mobility, authentication, and bearer management (e.g., data bearers, signal bearers, etc.) for the one or more UEs 104 served by the one or more NE 102 associated with the CN 106.

[0065] The CN 106 may communicate with a packet data network over one or more backhaul links (e.g., via an S1, N2, N2, or another network interface). The packet data network may include an application server. In some implementations, one or more UEs 104 may communicate with the application server. A UE 104 may establish a session (e.g., a protocol data unit (PDU) session, or the like) with the CN 106 via an NE 102. The CN 106 may route traffic (e.g., control information, data, and the like) between the UE 104 and the application server using the established session (e.g., the established PDU session). The PDU session may be an example of a logical connection between the UE 104 and the CN 106 (e.g., one or more network functions of the CN 106).

[0066] In the wireless communications system 100, the NEs 102 and the UEs 104 may use resources of the wireless communications system 100 (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers)) to perform various operations (e.g., wireless communications). In some implementations, the NEs 102 and the UEs 104 may support different resource structures. For example, the NEs 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the NEs 102 and the UEs 104 may support a single frame structure. In some other implementations, such as in 5G and among other suitable radio access technologies, the NEs 102 and the UEs 104 may support various frame structures (i.e., multiple frame structures). The NEs 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0067] One or more numerologies may be supported in the wireless communications system 100, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g., μ=0) may be associated with a first subcarrier spacing (e.g., 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g., μ=0) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., μ=1) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., μ=2) may be associated with a third subcarrier spacing (e.g., 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g., μ=3) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., μ=4) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0068] A time interval of a resource (e.g., a communication resource) may be organized according to frames (also referred to as radio frames). Each frame may have a duration, for example, a 10 millisecond (ms) duration. In some implementations, each frame may include multiple subframes. For example, each frame may include 10 subframes, and each subframe may have a duration, for example, a 1 ms duration. In some implementations, each frame may have the same duration. In some implementations, each subframe of a frame may have the same duration.

[0069] Additionally or alternatively, a time interval of a resource (e.g., a communication resource) may be organized according to slots. For example, a subframe may include a number (e.g., quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communications system 100. For instance, the first, second, third, fourth, and fifth numerologies (i.e., μ=0, μ=1, μ=2, μ=3, μ=4) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g., quantity) of symbols (e.g., OFDM symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols.

The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., μ =0) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0070] In the wireless communications system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communications system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5 (114.25 GHz – 300 GHz). In some implementations, the NEs 102 and the UEs 104 may perform wireless communications over one or more of the operating frequency bands. In some implementations, FR1 may be used by the NEs 102 and the UEs 104, among other equipment or devices for cellular communications traffic (e.g., control information, data). In some implementations, FR2 may be used by the NEs 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

[0071] FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g., μ=0), which includes 15 kHz subcarrier spacing; a second numerology (e.g., μ=1), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., μ=3), which includes 120 kHz subcarrier spacing.

[0072] According to agreements in RAN1#114, for direct AI/ML positioning with LMF-side model, e.g., Cases 2b and 3b, various types of measurement report of positioning related information containing timing, power and/or phase information of the channel response are identified if beneficial and necessary (e.g., tradeoff positioning accuracy requirement and signaling overhead). Regarding Case 2b, it is related to UE-assisted/LMF-based positioning

with LMF-side model, direct AI/ML positioning. Although a legacy LMF is usually regarded as a function entity in CN, herein, LMF may be placed in the CN side or RAN side.

[0073] Figure 2 illustrates an example of Case 2b in accordance with aspects of the present disclosure.

[0074] As shown in Figure 2, it assumed that the AI/ML positioning model is at the LMF side and is assisted by UE, i.e., in Case 2b. In step 201, the LMF will transmit PRS configuration (or configuration information related to PRS transmission or the like) to the RAN side, e.g., to a gNB or a TRP, wherein the PRS configuration will be used by the RAN side for a transmission of PRS to the UE. In step 203, the LMF will transmit the same PRS configuration to UE so that the UE will receive the PRS from the RAN side based on the PRS configuration. Accordingly, the gNB or TRP will transmit PRSs to UE based on the PRS configuration and UE will receive PRSs based on the PRS configuration in step 205. UE will perform measurements based on the PRSs received from the network side to derive measurements results and will collect data for reporting. For example, UE will report the channel related information to the LMF side in step 207 and will report position related information to the LMF side in step 209, so that the LMF side can perform AI/ML model training based on the data collected from the UE side.

[0075] However, due to UE mobility, the channel related information, e.g., CIR, PDP and/or DP etc., may change from time to time, and the position related information (e.g., UE position for Case 2b) may also change from time to time. Thus, the channel related information and the position related information should be associated with the same time instance, e.g., the same time stamp to be paired or combined for data collection.

[0076] More details of the present disclosure are illustrated in the following in view of some exemplary implementations of the present disclosure. Persons skilled in the art should well know that although most exemplary implementations of the present disclosure are illustrated in the perspective view of UE, the corresponding or consistent operations in the network side, e.g., the LMF side or gNB side would also be clearly determined under the teaching and suggestions in UE side.

[0077] First, regarding the channel related information, UE may report it aperiodically or periodically to the network side, e.g., to LMF.

[0078] For example, in accordance with some aspects of the present disclosure, UE will receive indication information (or triggering information, or triggering signaling or the like) indicating (or configuring or triggering or the like) aperiodic reporting of channel related information. The indication information may be transmitted from LMF. In another embodiment, the indication information can also be preconfigured to gNB by the LMF, and the indication information is further transmitted from gNB to UE. Accordingly, UE will report the channel related information based on the indication information. There is a duration between receiving the indication information and reporting the channel related information (hereinafter, referred as the first duration), which is configured or predefined. In the case that the indication information is or include the configuration information related to PRS reception, the indication information may further indicate a PRS reception, e.g., indicating aperiodic PRSs. There is a duration between receiving the indication information and the PRS reception (hereinafter, referred as the second duration). Similarly, the second duration is configured or predefined. When determining the time instance (hereinafter, referred as the first time instance, or first time stamp) associated with the reported channel related information, UE will consider the relationship between the first duration and the corresponding configured or predefined threshold (hereinafter, referred as the first threshold, e.g., 4ms or 5ms) thereof, and that between the second duration and the corresponding configured or predefined threshold (hereinafter, referred as the second threshold, e.g. 1ms or 2ms) thereof. When the PRS occasion of the PRS reception occupies multiple slots or symbols, the starting or ending or middle time instance of the PRS occasion will be determined to be the first time instance.

[0079] For example, in the case that the first duration is larger than the first threshold and the second duration is larger than the second threshold, UE will determine a time instance of a PRS occasion associated with the PRS reception as the first time instance. In this case, the PRS occasion is between the indication information and the reporting. Otherwise, UE will determine a time instance of a PRS occasion before receiving the indication information as the first time instance. An exemplary determined PRS occasion before receiving the

indication information may be a PRS occasion nearest to the indication information and satisfying a timeline requirement. For example, the PRS occasion is earlier than the indication information by at least 4ms or 5ms. The timeline requirement may also be similar to the reference resource requirements. The reference resource requirements may be different from or as the same as that in legacy 3rd generation partnership project (3GPP) release, e.g., that a duration between the determine PRS occasion and the reporting triggered by the indication information should be not smaller than 4ms or 5ms.

[0080] Figure 3 and Figure 4 respectively illustrate an exemplary scenario of aperiodic reporting of channel related information in accordance with aspects of the present disclosure.

[0081] Referring to Figure 3, it is assumed that the first duration, e.g. T1 is larger than the first threshold, and the second duration, e.g., T2 is larger than the second threshold. T1 is larger than T2. The motivation for the first threshold is to provide enough time for UE to prepare the reporting. The motivation for the second threshold is to provide enough time for gNB to prepare the PRS transmission and for UE to receive the PRS. Thus, there is enough time between the aperiodic triggering signaling (indication information) and the corresponding channel related information reporting. There will be a PRS reception between the aperiodic triggering signaling and the corresponding channel related information reporting, e.g., in PRS occasion#1. UE will determine the channel related information based on the PRS(s) received in PRS occasion#1. UE will determine a time instance, e.g., a starting time instance, ending time instance or middle time instance of PRS occasion#1 as the first time instance.

[0082] Referring to Figure 4, it is assumed that the second duration (not shown) is smaller than the second threshold, and the first duration, e.g., T1 is still larger than the first threshold. Although there is enough time for the UE to prepare for the reporting, there is not enough time for gNB to prepare the PRS transmission and the UE to prepare the PRS reception. So there will not be PRS between the indication information and the reporting. UE will determine a time instance of a PRS occasion before receiving the indication information as the first time instance, e.g., PRS occasion#2, which is the nearest PRS occasion to the indication information. If PRS occasion#2 cannot satisfy the timeline requirement, e.g., the

duration between PRS occasion#2 and indication information is less than 4ms, then PRS occasion#1 will be associated with the aperiodic reporting other than PRS occasion#2.

[0083] There may also be a case that T1 is smaller than the first threshold. Actually this case is an error case and it can be avoided by suitable gNB configuration. If it happens, there is not enough time for UE to prepare the reporting, and the reporting will be omitted by UE.

[0084] In accordance with some other aspects of the present disclosure, the PRSs (or PRS reception) are periodic and reporting of channel related information is periodic. The periodicity of PRS reception or the periodicity of PRSs and the periodicity of reporting channels related information may be different or the same. In some implementations of the present disclosure, each reporting of channel related information is associated with a single PRS occasion. That is, UE will periodically receive the PRSs based on the configuration information related to PRS reception, and periodically report the channel related information based on the PRS(s) received on only one associated PRS occasion.

[0085] In the case that the periodicity of PRSs is smaller than that of reporting the channel related information, for each reporting of the channel related information, there will be multiple PRS occasions corresponding one reporting periodicity. In some implementations of the present disclosure, the multiple PRS occasions are earlier than reporting of the channel related information and a time domain duration (hereinafter, referred as the third duration) between each PRS occasion of the multiple PRS occasions and the reporting of channel related information is larger than a predefined or configured threshold (hereinafter, referred as the third threshold), e.g., 4ms or 5ms as legacy reference resource requirement. UE will determine one PRS occasion among the multiple PRS occasions as the associated PRS occasion to determine the channel related information, which may be the first one, a middle one, or the last one of the multiple PRS occasions.

[0086] There are various manners of determining the associated PRS occasion from the multiple occasions. For example, time domain restriction for channel related information reporting will be configured to restrict the reporting to be based on only one PRS occasion.

[0087] In some implementations of the present disclosure, UE will determine the latest one of the multiple PRS occasion as the associated PRS occasion.

[0088] In some other implementations of the present disclosure, the network side will configure the starting position and ending position of the multiple PRS occasions for each reporting of the channel related information. In some cases, the ending position of PRS occasions for a reporting is implicitly indicated by the starting position for a subsequent reporting. In some cases, the starting position of PRS occasions for a reporting is implicitly indicated by the ending position for an immediately previous reporting. The starting position of PRS occasions for a reporting can also be configured. The starting position is in unit of ms, slot, symbol or PRS periodicity. The ending position may be in the same unit. The configured time domain position may be periodic or not. An exemplary ending position of the multiple PRS occasions is earlier than reporting the channel related information by more than a predefined or configured threshold (hereinafter, referred as the fourth threshold), e.g., 4ms or 5ms as legacy reference resource requirement.

[0089] Then, UE may determine the associated PRS occasion from the multiple PRS occasions based on configuration information from the network side or based on predefined rules, or UE may determine the associated PRS occasion from the multiple PRS occasions based on its own initiative. In the case that UE determines the associated PRS occasion based on its own initiative, UE will report timing related information of the associated PRS occasion to the network side, which is the starting time instance, the ending time instance or the middle time instance of the associated PRS occasion. The UE can also report the PRS occasion index to the network side. Based on the reported timing related information, the network side will determine the associated PRS occasion based on which the reporting of channel related information is determined.

[0090] Figure 5 illustrates an example of determining the associated PRS occasion from multiple PRS occasions in accordance with aspects of the present disclosure.

[0091] Referring to Figure 5, it is assumed that there are a plurality of sets of PRS occasions, each set of PRS occasions includes multiple PRS occasions defined by a starting position and an ending position. In some cases, each set of PRS occasions may be deemed as a window.

[0092] In some cases, there a configured or predefined rule for determining the associated PRS occasion, e.g., that: UE shall determine a PRS occasion among multiple PRS occasions

after a previous associated PRS occasion for the nearest previous reporting of channel related information as the associated PRS occasion for a reporting of channel related information. If there is a configured starting position, and all the multiple PRS occasions associated with a reporting is after the starting position, then any of the multiple PRS occasions can be further selected to be associated with the reporting. If only part of the multiple PRS occasions associated with the reporting is after the starting position, and the other PRS occasions are before the starting position, then only the PRS occasions after the starting position can be further selected to be associated with the reporting. As shown in Figure 5, it is also assumed that reporting #1 and reporting #2 are associated with the first set of PRS occasions determined by the first starting position P1 and the first ending position P2 and reporting#3 are associated the second set of PRS occasions determined by the second starting position P2 (the same as the first ending position) and the second ending position P3. Accordingly, based on the aforementioned rule, UE will determine the first PRS occasion, e.g., O#1 among the first set of PRS occasions as the associated PRS occasion to determine reporting#1. The reason is that only O#1 is after P1 and before reporting#1. The UE will determine the second PRS occasion, e.g., O#2 among the first set of PRS occasions as the associated PRS occasion to determine reporting#2. The reason is that both O#2 and O#3 are after P1, and the duration between O#2 and the reporting is larger than a timeline requirement, and the duration between O#3 and reporting is smaller than the timeline requirement. The UE will determine the first PRS occasion, e.g., O#5 among the second set of PRS occasions as the associated PRS occasion to determine reporting#3.

[0093] In some other cases, UE will determine the associated PRS occasion among each set of PRS occasions based on its own initiative. For example, UE will determine the first PRS occasion, e.g., O#1 among the first set of PRS occasions as the associated PRS occasion to determine reporting#1, determine the second PRS occasion, e.g., O#2 among the first set of PRS occasions as the associated PRS occasion to determine reporting#2, and determine the first PRS occasion, e.g., O#5 among the second set of PRS occasions as the associated PRS occasion to determine reporting#3. UE will report timing related information of the associated PRS occasion to the network side, which is the starting time instance, the ending time instance or the middle time instance of the PRS occasion or the associated PRS occasion index. For example, UE will report the first time instance of each of O#1, O#2 and O#5 to

the network side, or UE will report occasion index#1, #2, #5 (not shown) for reporting#1, #2, #3, respectively.

[0094] Regarding the position related information, in accordance with aspects of the present disclosure, there are also various manners to report the position related information to the network side, e.g., to LMF.

[0095] For example, in some implementations of the present disclosure, the position related information may include position information, a time instance (e.g., the starting time instance) associated with the position information, speed information, and a timer associated with validity of the position related information. Based on the aforementioned information, LMF will determine the UE position from the starting time instance and continue such determination until the starting time instance plus the validity timer. If channel related information associated with a PRS occasion is reported, the channel related information corresponding to the PRS time instance (a time instance for a PRS occasion) is available at the LMF side. Position related information at the PRS time instance can also be determined in LMF side based on the reported position related information as any time instance between the starting time instance and until the starting time instance plus the timer is available. As a result, channel related information and position related information at the same time instance can be associated. The paired channel related information and position related information can be used for data collection and model training at LMF side.

[0096] In some other implementations of the present disclosure, the position related information may include Doppler information associated with multiple PRS resources or multiple TRPs. Based on the Doppler information corresponding to each PRS resource or each TRP, UE speed information including both direction and value information will be determined. Thus, in some cases, the speed information in position related information may be replaced with the Doppler information associated with multiple PRS resources or multiple TRPs. With a further step, the Doppler information can change to speed information, and positioned related information, e.g., UE position at any time instance between the starting time instance and the starting time instance plus timer is available at LMF side. If the PRS time instance is between the starting time instance and the starting time instance plus timer, position at a PRS time instance is available. With channel related information at the PRS time

instance, the channel related information and positioned related information, e.g., UE position can be associated. The associated channel related information and positioned related information, e.g., UE position can be used for data collection and model training at LMF side.

[0097] In some yet other implementations of the present disclosure, LMF will configure multiple time instances to UE. UE will receive the configured time instances, and report the position related information, e.g., including the position information and/or measurement results for positioning corresponding to the configured time instances. For example, UE may report its position corresponding to each configured time instance by a position list. An exemplary configured time instance is a slot index, symbol index, UTC time or PRS occasion index. The reported position related information and channel related information at the same time instance can be associated. The associated channel related information and positioned related information, e.g., UE position can be used for data collection and model training at LMF side.

[0098] In the case that the configured time instance is a slot index or a symbol index. UE may report multiple UE positions corresponding to the multiple configured time instances in a differential manner or not. For example, the first UE position in a reported position list may be with respect to a global coordinate system, and each of the following UE positions may be with respect to a previous UE position or the first position.

[0099] In the case that the configured time instance is a PRS occasion index. LMF may configure a starting position and a duration, which are repeated in a periodic way. Each periodicity defined by a starting position and duration may be deemed as a time domain windows (each window corresponding to a starting position) configured to divide time domain resources. LMF will also configure the PRS occasion index within each duration associated with a corresponding starting position (e.g., within a window). UE will report its positions and/or measurement results for positioning corresponding to each configured PRS occasion index. The reported position related information and channel related information at the same time instance can be associated. The associated channel related information and positioned related information, e.g., UE position can be used for data collection and model training at LMF side.

[0100] In some yet other implementations of the present disclosure, UE will report the channel related information and the position related information associated with the same time instance together, e.g., by a channel related information and the position related information pair list corresponding to multiple PRS occasions. Accordingly, LMF will determine each pair of the received channel related information and position related information associated with the same time instance. The reported position related information and channel related information at the same time instance can be associated. The associated channel related information and positioned related information, e.g., UE position can be used for data collection and model training at LMF side.

[0101] Regarding the quality indicator, e.g., the quality indicator associated with the position related information, UE may also determine and report it in various manners in accordance with aspects of the present disclosure. The quality indicator will be applicable for a single reporting or multiple reportings. In some cases, the quality indicator may be associated with a duration or timer, wherein the quality indicator is valid during the duration or the timer.

[0102] For example, in some implementations of the present disclosure, UE will determine and report the quality indicator based on a confidence level of reporting the position related information. For example, UE will determine and report the quality indicator by using legacy time confidence reporting, which is to describe the reported position uncertainty in unit of meters.

[0103] In some other implementations of the present disclosure, UE will determine and explicitly report the quality indicator with a new reporting metric instead of the legacy one. UE will explicitly report the quality indicator by several bits, wherein different bits are associated with different positioning accuracy.

[0104] In some yet implementations of the present disclosure, UE will determine and report the quality indicator based on the type of a receiver of the UE. For example, the receiver of the UE as a PRU and the receiver of a UE not as a PRU will have different quality indicators.

[0105] In some yet other implementations of the present disclosure, UE will determine and report the quality indicator based on a reporting metric associated with an adopted position method. The position method may be determined by UE and reported to LMF, or predefined, or, configured by LMF. Exemplary position method is a method based on RSTD, RTT, RSRP, RSRPP, RSCP, WLAN, sensing (or sensor) or blue tooth. Different position methods may have the same or different quality indicators. For example, UE with WLAN positioning method, UE with sensing positioning method, or UE with blue tooth positioning method may be considered to have the same quality indicator. UE with WLAN, sensing or blue tooth positioning method, UE with a method based on RSTD or RTT (e.g., timing based R16 positioning method), UE with a method based on RSRP, UE with a method based on RSPPP (e.g., RSPPP based R17 positioning method), and UE with a method based on RSCP (e.g., RSCP based R18 positioning method) may be considered to have different quality indicators. For example, UE with a RSCP based R18 positioning method has better quality than UE with a timing based R16 positioning method.

[0106] In some yet other implementations of the present disclosure, UE will determine and report the quality indicator based on SINR, RSRP, RSRQ or CSI or any combination thereof measured based on PRS(s) received on a PRS occasion.

[0107] In some yet other implementations of the present disclosure, UE will determine and report the quality indicator based on a number of PRS ports, time domain density of PRS or frequency domain density of PRS.

[0108] Figure 6 illustrates an example of a UE 600 in accordance with aspects of the present disclosure. The UE 600 may include a processor 602, a memory 604, a controller 606, and a transceiver 608. The processor 602, the memory 604, the controller 606, or the transceiver 608, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0109] The processor 602, the memory 604, the controller 606, or the transceiver 608, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an

application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0110] The processor 602 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 602 may be configured to operate the memory 604. In some other implementations, the memory 604 may be integrated into the processor 602. The processor 602 may be configured to execute computer-readable instructions stored in the memory 604 to cause the UE 600 to perform various functions of the present disclosure.

[0111] The memory 604 may include volatile or non-volatile memory. The memory 604 may store computer-readable, computer-executable code including instructions when executed by the processor 602 cause the UE 600 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such the memory 604 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[0112] In some implementations, the processor 602 and the memory 604 coupled with the processor 602 may be configured to cause the UE 600 to perform one or more of the functions described herein (e.g., executing, by the processor 602, instructions stored in the memory 604). For example, the processor 602 may support wireless communication at the UE 600 in accordance with examples as disclosed herein. The UE 600 may be configured to support a means for receiving PRSs based on configuration information related to PRS reception; a means for reporting channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information includes: timing information, power information, amplitude information, phase information, or any combination thereof; and a means for reporting position related information, wherein, the position related information includes: position information, Doppler information, time difference information based on the at least one PRS, RTT information based on the at least

one PRS, RSRP information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof; wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

[0113] The controller 606 may manage input and output signals for the UE 600. The controller 606 may also manage peripherals not integrated into the UE 600. In some implementations, the controller 606 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 606 may be implemented as part of the processor 602.

[0114] In some implementations, the UE 600 may include at least one transceiver 608. In some other implementations, the UE 600 may have more than one transceiver 608. The transceiver 608 may represent a wireless transceiver. The transceiver 608 may include one or more receiver chains 610, one or more transmitter chains 612, or a combination thereof.

[0115] A receiver chain 610 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 610 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 610 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 610 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 610 may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0116] A transmitter chain 612 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 612 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmitter chain 612 may also include at least one power amplifier configured

to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 612 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0117] Figure 7 illustrates an example of a processor 700 in accordance with aspects of the present disclosure. The processor 700 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 700 may include a controller 702 configured to perform various operations in accordance with examples as described herein. The processor 700 may optionally include at least one memory 704, which may be, for example, an L1/L2/L3 cache. Additionally, or alternatively, the processor 700 may optionally include one or more arithmetic-logic units (ALUs) 706. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[0118] The processor 700 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g., receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 700) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

[0119] The controller 702 may be configured to manage and coordinate various operations (e.g., signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 700 to cause the processor 700 to support various operations in accordance with examples as described herein. For example, the controller 702 may operate as a control unit of the processor 700, generating control signals that manage the operation of various components

of the processor 700. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0120] The controller 702 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 704 and determine subsequent instruction(s) to be executed to cause the processor 700 to support various operations in accordance with examples as described herein. The controller 702 may be configured to track memory address of instructions associated with the memory 704. The controller 702 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 702 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 700 to cause the processor 700 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 702 may be configured to manage flow of data within the processor 700. The controller 702 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 700.

[0121] The memory 704 may include one or more caches (e.g., memory local to or included in the processor 700 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementations, the memory 704 may reside within or on a processor chipset (e.g., local to the processor 700). In some other implementations, the memory 704 may reside external to the processor chipset (e.g., remote to the processor 700).

[0122] The memory 704 may store computer-readable, computer-executable code including instructions that, when executed by the processor 700, cause the processor 700 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 702 and/or the processor 700 may be configured to execute computer-readable instructions stored in the memory 704 to cause the processor 700 to perform various functions. For example, the processor 700 and/or the controller 702 may be coupled with or to the memory 704, the processor 700, the controller 702, and the memory 704 may be configured to perform various functions described herein. In some examples, the processor 700 may include multiple processors and the memory 704 may include multiple memories. One or

more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[0123] The one or more ALUs 706 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 706 may reside within or on a processor chipset (e.g., the processor 700). In some other implementations, the one or more ALUs 706 may reside external to the processor chipset (e.g., the processor 700). One or more ALUs 706 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 706 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 706 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 706 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 706 to handle conditional operations, comparisons, and bitwise operations.

[0124] The processor 700 may support wireless communication in accordance with examples as disclosed herein. The processor 700 may be configured to or operable to support a means for receiving PRSs based on configuration information related to PRS reception; a means for reporting channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information includes: timing information, power information, amplitude information, phase information, or any combination thereof; and a means for reporting position related information, wherein, the position related information includes: position information, Doppler information, time difference information based on the at least one PRS, RTT information based on the at least one PRS, RSRP information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof; wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

[0125] Figure 8 illustrates an example of a NE 800 in accordance with aspects of the present disclosure. The NE 800 may include a processor 802, a memory 804, a controller 806,

and a transceiver 808. The processor 802, the memory 804, the controller 806, or the transceiver 808, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0126] The processor 802, the memory 804, the controller 806, or the transceiver 808, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0127] The processor 802 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 802 may be configured to operate the memory 804. In some other implementations, the memory 804 may be integrated into the processor 802. The processor 802 may be configured to execute computer-readable instructions stored in the memory 804 to cause the NE 800 to perform various functions of the present disclosure.

[0128] The memory 804 may include volatile or non-volatile memory. The memory 804 may store computer-readable, computer-executable code including instructions when executed by the processor 802 cause the NE 800 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such the memory 804 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[0129] In some implementations, the processor 802 and the memory 804 coupled with the processor 802 may be configured to cause the NE 800 to perform one or more of the functions described herein (e.g., executing, by the processor 802, instructions stored in the memory 804). For example, the processor 802 may support wireless communication at the

NE 800 in accordance with examples as disclosed herein. The NE 800 may be configured to support a means for transmitting PRSs based on configuration information related to PRS reception; a means for receiving channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information includes: timing information, power information, amplitude information, phase information, or any combination thereof; and a means for receiving position related information, wherein, the position related information includes: position information, Doppler information, time difference information based on the at least one PRS, RTT information based on the at least one PRS, RSRP information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof; wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

[0130] The controller 806 may manage input and output signals for the NE 800. The controller 806 may also manage peripherals not integrated into the NE 800. In some implementations, the controller 806 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 806 may be implemented as part of the processor 802.

[0131] In some implementations, the NE 800 may include at least one transceiver 808. In some other implementations, the NE 800 may have more than one transceiver 808. The transceiver 808 may represent a wireless transceiver. The transceiver 808 may include one or more receiver chains 810, one or more transmitter chains 812, or a combination thereof.

[0132] A receiver chain 810 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 810 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 810 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 810 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver

chain 810 may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0133] A transmitter chain 812 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 812 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmitter chain 812 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 812 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0134] Figure 9 illustrates a flowchart of a method in accordance with aspects of the present disclosure. The operations of the method may be implemented by a UE as described herein. In some implementations, the UE may execute a set of instructions to control the function elements of the UE to perform the described functions.

[0135] At 901, the method may include receiving PRSs based on configuration information related to PRS reception. The operations of 901 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 901 may be performed by a UE as described with reference to Figure 6.

[0136] At 903, the method may include reporting channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information includes: timing information, power information, amplitude information, phase information, or any combination thereof. The operations of 903 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 903 may be performed by a UE as described with reference to Figure 6.

[0137] At 905, the method may include reporting position related information, wherein, the position related information includes: position information, Doppler information, time difference information based on the at least one PRS, RTT information based on the at least

one PRS, RSRP information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof; wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information. The operations of 905 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 905 may be performed a UE as described with reference to Figure 6.

[0138] It should be noted that the method described herein describes a possible implementation, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible.

[0139] Figure 10 illustrates a flowchart of a method in accordance with aspects of the present disclosure. The operations of the method may be implemented by a NE as described herein. In some implementations, the NE may execute a set of instructions to control the function elements of the NE to perform the described functions.

[0140] At 1001, the method may include transmitting PRSs based on configuration information related to PRS reception. The operations of 1001 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1001 may be performed by a NE as described with reference to Figure 8.

[0141] At 1003, the method may include receiving channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information includes: timing information, power information, amplitude information, phase information, or any combination thereof. The operations of 1003 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1003 may be performed by a NE as described with reference to Figure 8.

[0142] At 1005, the method may include receiving position related information, wherein, the position related information includes: position information, Doppler information, time difference information based on the at least one PRS, RTT information based on the at least one PRS, RSRP information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof; wherein, the channel related information

and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information . The operations of 1005 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1005 may be performed a NE as described with reference to Figure 8.

[0143] It should be noted that the method described herein describes a possible implementation, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible.

[0144] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

What is claimed is:

1. A user equipment (UE) for wireless communication, comprising:

at least one memory; and

at least one processor coupled with the at least one memory and configured to cause the UE to:

receive positioning reference signals (PRSs) based on configuration information related to PRS reception;

report channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information comprises: timing information, power information, amplitude information, phase information, or any combination thereof; and

report position related information, wherein, the position related information comprises: position information, Doppler information, time difference information based on the at least one PRS, round trip time (RTT) information based on the at least one PRS, reference signal receiving power (RSRP) information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof;

wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

2. The UE of claim 1, wherein, the at least one processor is configured to cause the UE to:

report the channel related information aperiodically based on received indication information after a first duration between receiving the indication information and reporting the channel related information, wherein the first duration is configured or predefined.

3. The UE of claim 2, wherein, the configuration information related to PRS reception is included in the indication information, and there is a second duration between receiving the indication information and the PRS reception, wherein, the second duration is configured or predefined.

4. The UE of claim 3, wherein, the at least one processor is configured to cause the UE to:

in the case that the first duration is larger than a first threshold and the second duration is larger than a second threshold, determine a time instance of a PRS occasion associated with the PRS reception as the first time instance;

otherwise, determine a time instance of a PRS occasion before receiving the indication information as the first time instance.

5. The UE of claim 1, wherein, the at least one processor is configured to cause the UE to:

receive the PRSs based on the configuration information related to PRS reception periodically; and

report the channel related information based on at least one PRS received on an associated PRS occasion periodically.

6. The UE of claim 5, wherein, in the case that periodicity of the PRSs is smaller than that of reporting the channel related information, the at least one processor is configured to cause the UE to:

for each reporting the channel related information, determine one PRS occasion among multiple PRS occasions as the associated PRS occasion to determine the channel related information.

7. The UE of claim 6, wherein, the multiple PRS occasions are earlier than the reporting the channel related information and a time domain duration between each PRS occasion of the multiple PRS occasions and the reporting the channel related information is larger than a predefined or configured threshold.

8. The UE of claim 7, wherein, the at least one processor is configured to cause the UE to:

determine a latest one of the multiple PRS occasion as the associated PRS occasion.

9. The UE of claim 6, wherein, a starting position of the multiple PRS occasions for each reporting the channel related information is after the associated PRS occasion for nearest previous reporting the channel related information, and an ending position of the multiple PRS occasions is earlier than reporting the channel related information by more than a predefined or configured threshold.

10. The UE of claim 9, wherein, the associated PRS occasion is configured or predefined to be first one, middle one, or last one of the multiple PRS occasions.

11. The UE of claim 9, wherein, the at least one processor is configured to cause the UE to report timing related information of the associated PRS occasion, and the timing related information is a starting time instance, ending time instance or middle time instance of the PRS occasion.

12. The UE of claim 1, wherein, the position related information comprises the position information, a time instance associated with the position information, speed information, and a timer associated with validity of the position related information.

13. The UE of claim 1, wherein, the at least one processor is configured to cause the UE to:

receive configured time instances; and

report the position related information including the position information corresponding to the configured time instances.

14. The UE of claim 1, wherein, the at least one processor is configured to cause the UE to:

report the channel related information and the position related information associated with a same time instance together.

15. The UE of claim 1, wherein, the at least one processor is configured to cause the UE to determine a quality indicator associated with the position related information.

16. The UE of claim 15, wherein, the at least one processor is configured to cause the UE to determine the quality indicator based on a confidence level of reporting the position information.

17. The UE of claim 1, wherein, the at least one processor is configured to cause the UE to report the first time instance and the second time instance.

18. A processor for wireless communication, comprising:

at least one controller coupled with at least one memory and configured to cause the at least one processor to:

receive positioning reference signals (PRSs) based on configuration information related to PRS reception;

report channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information comprises: timing information, power information, amplitude information, phase information, or any combination thereof; and

report position related information, wherein, the position related information comprises: position information, Doppler information, time difference information based on the at least one PRS, round trip time (RTT) information based on the at least one PRS, reference signal receiving power (RSRP) information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof;

wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

19. A network equipment (NE) for wireless communication, comprising:

at least one memory; and

at least one processor coupled with the at least one memory and configured to cause the NE to:

transmit positioning reference signals (PRSs) based on configuration information related to PRS reception;

receiving reporting of channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information comprises: timing information, power information, amplitude information, phase information, or any combination thereof; and

receiving reporting of position related information, wherein, the position related information comprises: position information, Doppler information, time difference information based on the at least one PRS, round trip time (RTT) information based on the at least one PRS, reference signal receiving power (RSRP) information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof;

wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

20. A method performed by a user equipment (UE), comprising:

receiving positioning reference signals (PRSs) based on configuration information related to PRS reception;

reporting channel related information based on at least one PRS received on a PRS occasion, wherein, the channel related information comprises: timing information, power information, amplitude information, phase information, or any combination thereof; and

reporting position related information, wherein, the position related information comprises: position information, Doppler information, time difference information based on the at least one PRS, round trip time (RTT) information based on the at least one PRS, reference signal receiving power (RSRP) information based on the at least one PRS, carrier phase information based on the at least one PRS, or any combination thereof;

wherein, the channel related information and the position related information is associated based on a first time instance associated with the PRS occasion and a second time instance associated with the position related information.

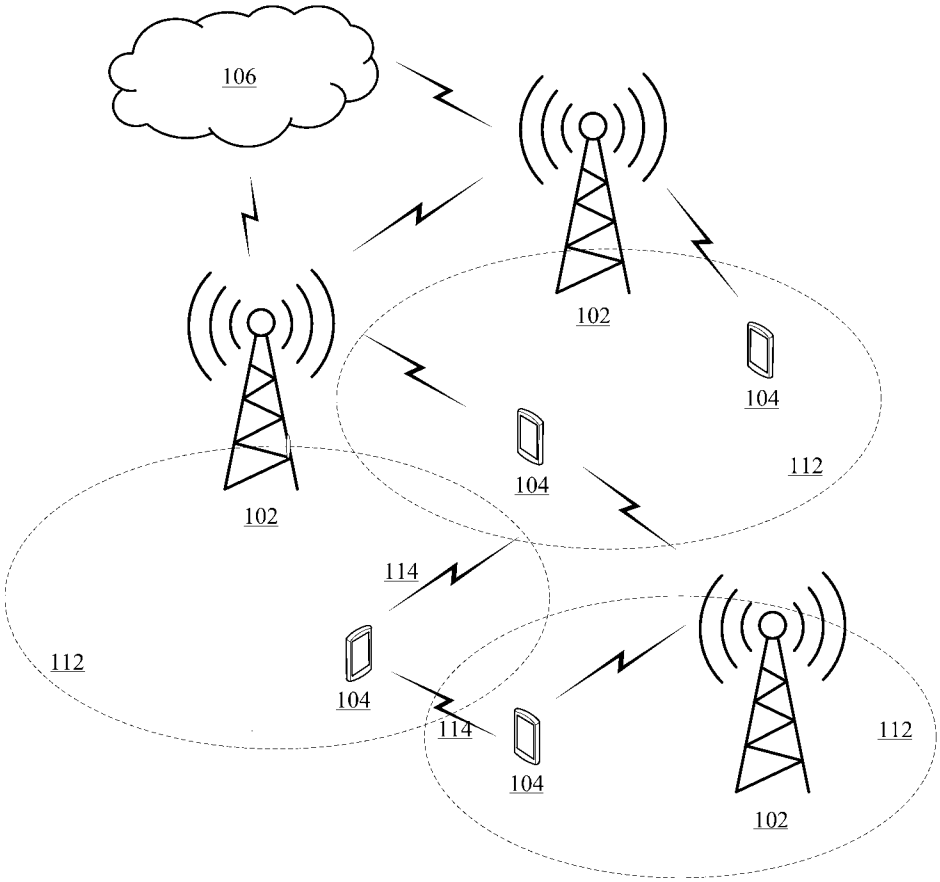


Figure 1

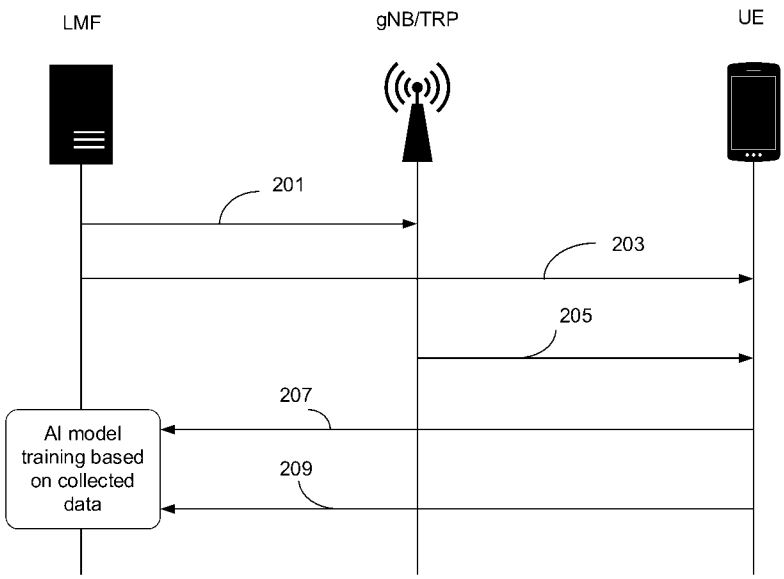


Figure 2

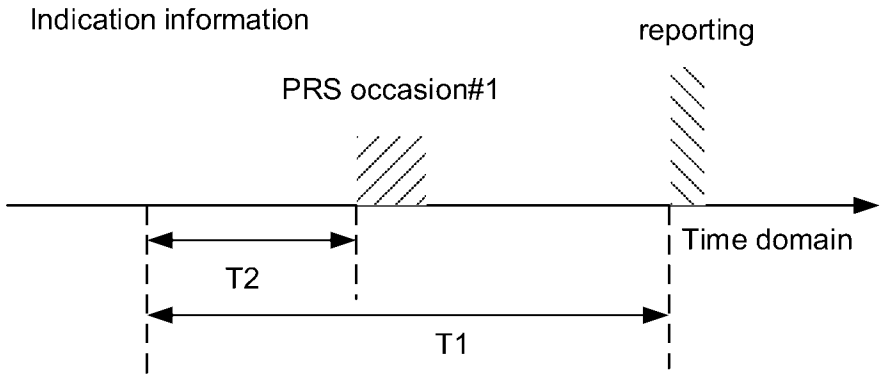


Figure 3

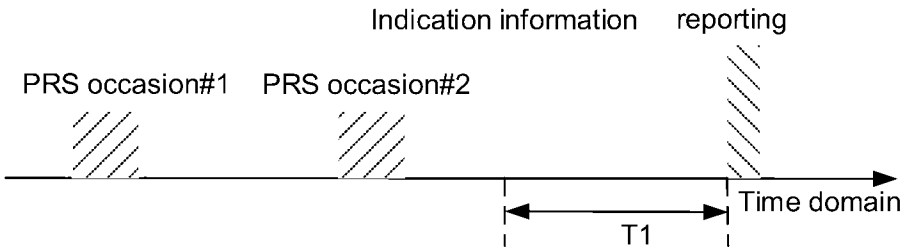


Figure 4

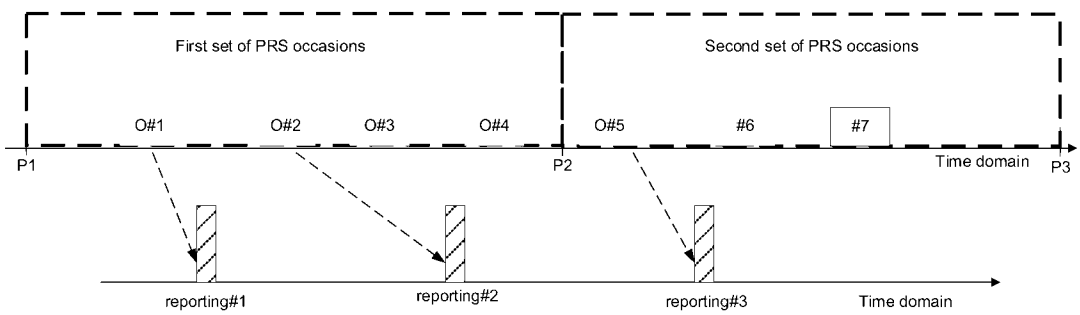


Figure 5

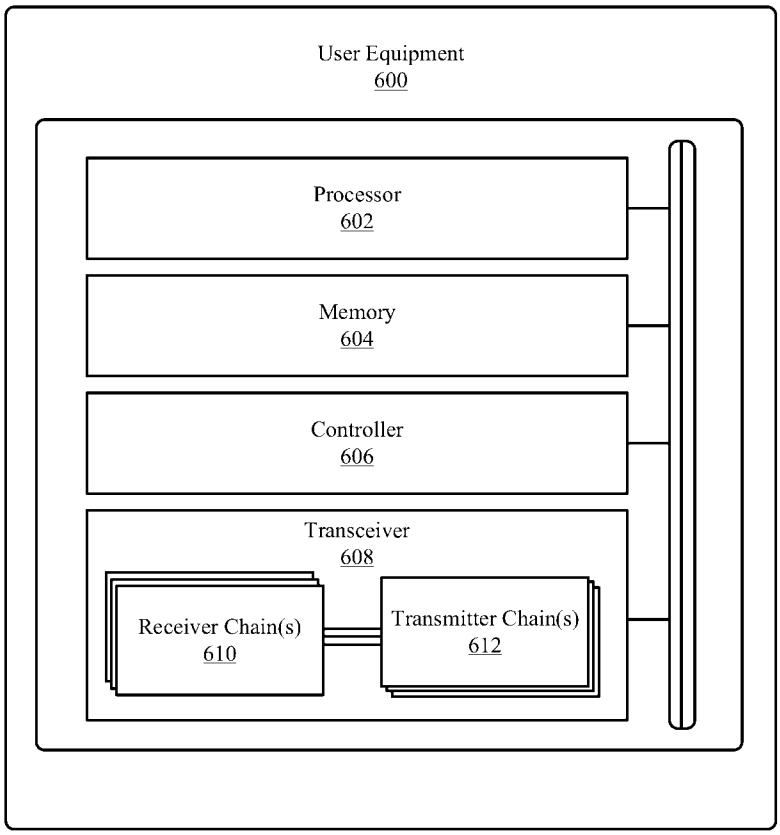


Figure 6

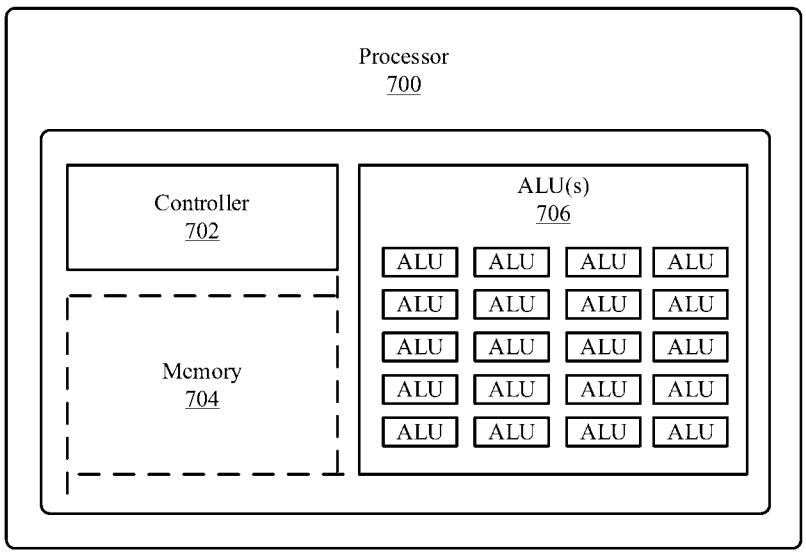


Figure 7

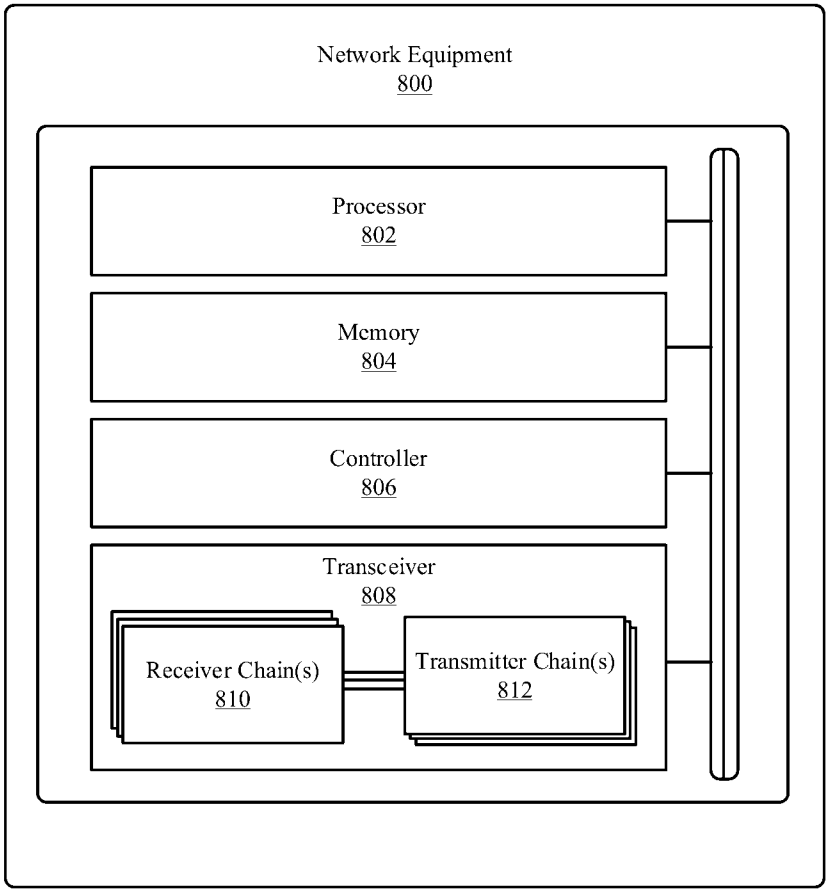

Network Equipment
800
Processor
802
Memory
804
Controller
806
Transceiver
808
Receiver Chain(s)
810
Transmitter Chain(s)
812

Figure 8

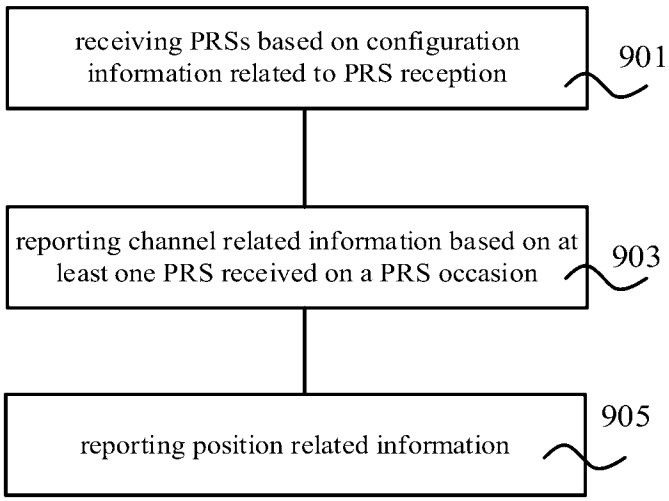


Figure 9

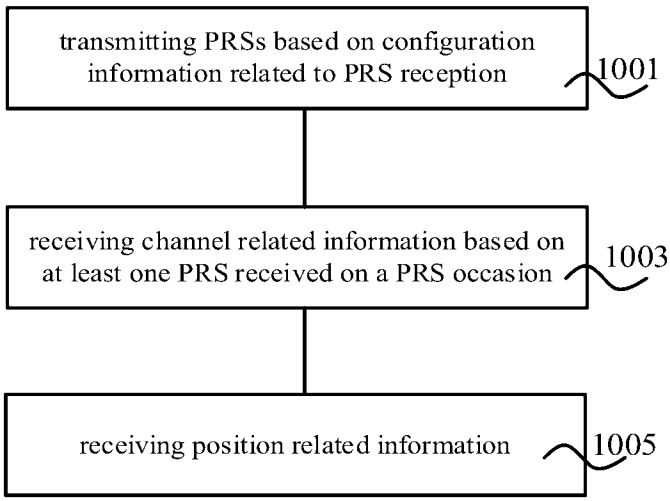


Figure 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/140274

A. CLASSIFICATION OF SUBJECT MATTER

H04W 64/00(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H04W H04L H04B

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)

3GPP,CNTXT,ENTXTC,VEN:position, PRS, occasion, configuration, report, channel, timing, power, amplitude, phase, RTT, Doppler, RSRP.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2023232363 A1 (QUALCOMM INC.) 20 July 2023 (2023-07-20) claims and description, paragraphs 55-125	1-20
A	US 2023102893 A1 (QUALCOMM INC.) 30 March 2023 (2023-03-30) the whole document	1-20
A	CN 112955770 A (QUALCOMM INC.) 11 June 2021 (2021-06-11) the whole document	1-20
A	CN 114071699 A (VIVO MOBILE COMMUNICATION CO., LTD.) 18 February 2022 (2022-02-18) the whole document	1-20
A	ZTE. "Remaining issues on NR DL PRS" *3GPP TSG RAN WG1 Meeting #98, R1-1908307,* 30 August 2019 (2019-08-30), the whole document	1-20

☐ 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
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 August 2024	**28 August 2024**

Name and mailing address of the ISA/CN	Authorized officer
CHINA NATIONAL INTELLECTUAL PROPERTY ADMINISTRATION **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	**GUO,Jing** Telephone No. **(+86) 010-53961671**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/140274

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2023232363	A1	20 July 2023	WO	2023140975	A1	27 July 2023
				CN	118489261	A	13 August 2024
US	2023102893	A1	30 March 2023	WO	2023055488	A1	06 April 2023
				KR	20240071378	A	22 May 2024
				EP	4409987	A1	07 August 2024
				CN	117981414	A	03 May 2024
CN	112955770	A	11 June 2021	WO	2020092719	A2	07 May 2020
				TW	202027544	A	16 July 2020
				US	2020145977	A1	07 May 2020
				EP	3874293	A2	08 September 2021
CN	114071699	A	18 February 2022	WO	2022028467	A1	10 February 2022
				EP	4156797A1	A1	29 March 2023
				US	2023164735	A1	25 May 2023