

METHOD AND APPARATUS OF SUPPORTING POSITIONING RELATED INFORMATION REPORTING

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to technologies of supporting positioning related information reporting.

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: determine time/frequency domain resources, or a reference signal (RS) or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and report the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.

[0005] In some implementations of the methods and apparatuses described herein, the timing related information is associated with multiple paths in time domain.

[0006] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to receive a signaling configuring a granularity of the timing related information.

[0007] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: receive a signaling indicating one or multiple time domain patterns associated with multiple paths, each element of a time domain pattern of the one or multiple time domain patterns corresponding to the timing related information of a corresponding path of the multiple paths; and report the timing related information by reporting a pattern index of the associated pattern.

[0008] In some implementations of the methods and apparatuses described herein, a time domain pattern of the one or multiple time domain patterns is associated with an absolute time domain position of a corresponding path, or associated with a differential time domain position of a corresponding path with respect to a previous path or a predefined boundary.

[0009] In some implementations of the methods and apparatuses described herein, the timing related information is associated with multiple paths, and the at least one processor is configured to cause the UE to report a time domain position of each of the multiple paths.

[0010] In some implementations of the methods and apparatuses described herein, the time domain position is an absolute time domain position, or a differential time domain position with respect to a previous time domain position or a predefined boundary.

[0011] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to receive a signaling indicating a number of the multiple paths.

[0012] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to report a number of the multiple paths.

[0013] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to receive a signaling indicating at least one time domain window.

[0014] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to report part or all indexes of the at least one time domain window.

[0015] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to report at least one time domain position of at least one path within a reported or configured time domain window.

[0016] In some implementations of the methods and apparatuses described herein, each time domain window is associated with a starting position, a duration and a configured or predefined unit.

[0017] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: receive a signaling indicating reporting the timing related information, the power related information, the phase related information, or the combination thereof; and determine that same time/frequency domain resources, or RS or RS set is associated with positioning related information reporting based on the signaling.

[0018] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: receive one or more signaling, each indicating reporting the timing related information, the power related information, the phase related information, or the combination thereof; and determine that same time/frequency domain resources, or RS or RS set is associated with positioning related information reporting indicated by the one or more signaling in the case that the one or more signaling is within a configured or predefined time domain window.

[0019] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: receive one or more signaling, each indicating a time instance of reporting the timing related information, the power related information, the phase related information, or the combination thereof; and determine that same time/frequency domain resources, or RS or RS set is associated with positioning related information reporting indicated by the one or more signaling in the case that reporting time instances indicated by the one or more signaling are within a configured or predefined time domain window.

[0020] In some implementations of the methods and apparatuses described herein, the at least one processor is configured cause the UE to: receive one or more signaling, each indicating a time instance of reporting the timing related information, the power related information, the phase related information, or the combination thereof, wherein a reporting identity is associated with each positioning related information reporting.

[0021] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to determine that same time/frequency domain resources, or RS or RS set is associated with corresponding positioning related information reporting in the case that the reporting identity associated with each reporting of the positioning related information is same.

[0022] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to receive a signaling indicating at least one of time/frequency domain resources, or RS or RS set associated with the positioning related information reporting.

[0023] In some implementations of the methods and apparatuses described herein, the configured or predefined time domain window is based on periodicity of the associated time/frequency domain resources, or RS or RS set.

[0024] 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: determine time/frequency domain resources, or a RS or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and report the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.

[0025] 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 node to: transmit time/frequency domain resources, or a RS or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and receive reporting of the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.

[0026] Some implementations of the methods and apparatuses described herein may further include a method performed by a UE, which includes: determining time/frequency domain resources, or a RS or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and reporting the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] Figure 1 illustrates an example of a wireless communications system in accordance with aspects of the present disclosure.

[0028] Figure 2 is a schematic diagram illustrating an exemplary CIR in accordance with aspects of the present disclosure.

[0029] Figure 3 is a schematic diagram illustrating an exemplary CIR in accordance with aspects of the present disclosure.

[0030] Figure 4 is a schematic diagram illustrating an exemplary procedure of positioning related information reporting under scheme 2-1 in accordance with aspects of the present disclosure.

[0031] Figure 5 is a schematic diagram illustrating an exemplary procedure of positioning related information reporting under scheme 2-2 in accordance with aspects of the present disclosure.

[0032] Figure 6 is a schematic diagram illustrating an exemplary procedure of positioning related information reporting under scheme 2-3 in accordance with aspects of the present disclosure.

[0033] Figure 7 is a schematic diagram illustrating an exemplary procedure of positioning related information reporting under scheme 2-4 in accordance with aspects of the present disclosure.

[0034] Figure 8 illustrates an example of a UE in accordance with aspects of the present disclosure.

[0035] Figure 9 illustrates an example of a processor in accordance with aspects of the present disclosure.

[0036] Figure 10 illustrates an example of a NE in accordance with aspects of the present disclosure.

[0037] Figure 11 illustrates a flowchart of method performed by a UE in accordance with aspects of the present disclosure.

[0038] Figure 12 illustrates a flowchart of method performed by a NE in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0039] For artificial intelligence (AI) (or AI/machine learning (ML)) based positioning, if the AI/ML model is at location management function (LMF) and assisted by UE, e.g., based on downlink (DL) positioning reference signal (PRS) measurement and/or reporting, positioning related information reporting, e.g., channel impulse response (CIR), power delay profile (PDP), and/or delay profile (DP) reporting are necessary. Thus, positioning related information reporting shall be improved to adapt to AI/ML based positioning, wherein, issues such as how to derive the positioning related information for reporting etc., should be solved, which is further related to timing related information reporting and associating (or correlating or linking or the like) at least one of timing related information reporting (or referred to as timing reporting), power related information reporting (or referred to as power reporting) and phase related information reporting (or referred to as phase reporting) of a path.

[0040] At least considering the aforementioned technical problems, aspects of the present disclosure provide technical solutions of supporting positioning related information reporting, e.g., a method and apparatus of supporting positioning related information reporting.

[0041] For example, regarding timing related information reporting, in some implementations of the present application, several patterns will be configured or preconfigured to UE, and UE will report one pattern index indicating the time domain positions of paths. In some other implementations of the present application, UE will report the time domain position of each path by an absolute or differential way. In some yet other implementations of the present application, UE will report the time domain position for each path within a window by bitmap.

[0042] Regarding associating at least one of timing related information reporting, power related information reporting and phase related information reporting of a path, in some implementations of the present application, the triggered or configured timing reporting, power reporting and/or phase reporting are associated by a signaling for triggering or configuring the timing reporting, power reporting and/or phase reporting. In some other

implementations of the present application, the triggered or configured timing reporting, power reporting and/or phase reporting are associated by restricting the signaling for triggering or configuring the timing reporting, power reporting and/or phase reporting within a time domain window. In some yet other implementations of the present application, the triggered or configured timing reporting, power reporting and/or phase reporting are associated by restricting their reporting time instances within a time domain window. In some yet other implementations of the present application, the triggered or configured timing reporting, power reporting and/or phase reporting are associated by the same reporting identity (ID) (or index). In some yet other implementations of the present application, the triggered or configured timing reporting, power reporting and/or phase reporting are associated by configuring associated time/frequency domain resources (e.g., RS occasions), a RS (e.g., a RS ID), or a RS set (e.g., a RS set ID) for measurement for each reporting.

[0043] In short, technical solutions disclosed in the present disclosure will improve the existing positioning technology, increase the accuracy of AI/ML model positioning and facilitate the implementation of AI/ML model positioning.

[0044] Aspects of the present disclosure are described in the context of a wireless communications system.

[0045] 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.

[0046] 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 radio access network (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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] 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 transmission-reception points (TRPs).

[0051] 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.

[0052] 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).

[0053] 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.

[0054] 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., $\mu=0$) 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., $\mu=0$) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., $\mu=1$) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., $\mu=2$) 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., $\mu=3$) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., $\mu=4$) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0055] 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.

[0056] 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., $\mu=0$, $\mu=1$, $\mu=2$, $\mu=3$, $\mu=4$) 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., $\mu=0$) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0057] 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.

[0058] 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., $\mu=0$), which includes 15 kHz subcarrier spacing; a second numerology (e.g., $\mu=1$), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., $\mu=2$), 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., $\mu=2$), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., $\mu=3$), which includes 120 kHz subcarrier spacing.

[0059] In accordance with aspects of the present disclosure, technical solutions of supporting positioning related information reporting, e.g., for AI/ML positioning or the like are proposed based on existing reporting for NR positioning. Exemplary positioning related information is timing related information (e.g., DP), or power related information, or phase related information, or a combination thereof. A combination of timing related information, power related information, and phase related information is various, e.g., being a combination including all of them (e.g., CIR), or a combination of power with phase (e.g., PDP) etc.

[0060] The network side, e.g., a NE will transmit (or configure or indicate) time/frequency domain resources (e.g., PRS occasions), or a RS (e.g., a PRS ID) or a RS set (e.g., a RS set ID) associated with reporting positioning related information to the UE. The time/frequency domain resources (e.g., PRS occasions), or RS (e.g., a PRS ID) or RS set is periodic or aperiodic. Accordingly, in the UE side, UE will receive and determine the time/frequency domain resources, or RS or RS set associated with reporting positioning related information. Then, UE will report the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set. Consistently, the network side will receive the reporting of the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.

[0061] 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). For example, at least for Case 3b, a measurement report of positioning related information contains timing, power and phase information of the channel response. Regarding Case 2b, it is related to UE-assisted/LMF-based positioning with LMF-side model, direct AI/ML positioning. Regarding Case 3b, it is related to NG-RAN node assisted positioning with LMF-side model, direct AI/ML positioning. Meanwhile, for direct AI/ML positioning with LMF-side model, e.g., Cases 2b and 3b, various types of measurement report containing timing, power and/or phase information of the channel response with potential specification impact have been studied for AI/ML based positioning accuracy enhancement. It is found that if the desired measurement report is supported, potential specification impact will include new measurement report or enhancement to existing measurement report, e.g., alignment of sample/path determination.

[0062] Taking CIR as an example, Figure 2 is a schematic diagram illustrating an exemplary CIR in accordance with aspects of the present disclosure.

[0063] As shown in Figure 2, multiple paths, e.g., four paths in time domain, are reported. The CIR will be recovered or constructed in the network side, e.g., by a gNB based on the timing, power (related to amplitude as shown in Figure 2) and phase information of each path in the CIR. Only the timing, power and phase information of each path in the CIR corresponding to the same time instance can be adopted to recover the CIR. Thus, how to report the time instance of each path of the CIR is important for aligned path determination. Besides, how to link the timing reporting, power reporting and/or phase reporting to the same time instance also needs to be solved.

[0064] Regarding timing related information reporting, it is generally related to multiple paths in time domain. The granularity of timing related information is configured to the UE, e.g., by radio resource control (RRC) signaling or other signaling. An exemplary granularity of timing related information, e.g., granularity of time instances of paths (or path time instance) is determined by the sampling rate of RSs in time domain. The granularity may be multiples of duration between adjacent sampling points.

[0065] In accordance with some aspects of the present disclosure, timing related information reporting is based on time domain pattern (or pattern or the like). For example, the network side may indicate one or multiple time domain patterns (preconfigured or predefined by the network) associated with multiple paths by a RRC signaling or other signaling. Each element of a time domain pattern corresponds to the timing related information of a corresponding path. UE will report the timing related information of multiple paths by reporting an associated pattern, e.g., an index of the associated pattern.

[0066] In some implementations of the present disclosure, a time domain pattern is associated with an absolute time domain position of a path, that is, the reference time domain position is a slot boundary, and the absolute time domain position of a path is based on the time domain difference between the slot boundary and the path position. In some other implementations of the present disclosure, a time domain pattern is associated with a differential time domain position of a path, which is with respect to a previous path (or preceding path) or a predefined boundary, e.g., a slot boundary. That is, the reference time domain position is the previous path or the predefined boundary.

[0067] The unit of time (or time unit) for each time domain pattern is one or multiple time domain duration of adjacent samples, which can be configured or predefined. In the case that there are 2048 samples in a duration T, then the duration between two adjacent samples is $T/2048$. The granularity will be one or multiples of $T/2048$. Two exemplary time domain patterns are illustrated as follows.

[0068] One exemplary time domain pattern is (10,40,80,100) with the time unit being one times of the duration between two adjacent samples, e.g. $T/2048$, which means that the reported positioning related information, e.g., CIR has 4 time instances with a non-zero amplitude (or power) associated with 4 paths, and the time domain positions of the 4 paths are the 10th sampling point (i.e. $10 \cdot T/2048$), 40th sampling point (i.e. $40 \cdot T/2048$), 80th sampling point (i.e. $80 \cdot T/2048$), and 100th sampling point (i.e. $100 \cdot T/2048$) respectively.

[0069] The other exemplary time domain pattern is (25,35,65,75,85) with the time unit being 10 times of the duration between two adjacent samples, which means that the reported positioning related information, e.g., CIR has 5 time instances with a non-zero amplitude associated with 5 paths, and the time domain positions of the 5 paths are 250th ($250 \cdot T/2048$),

350th ($350 \cdot T/2048$), 650th ($650 \cdot T/2048$), 750th ($750 \cdot T/2048$), 850th ($850 \cdot T/2048$) sampling point respectively.

[0070] In accordance with some aspects of the present disclosure, timing related information reporting is achieved by UE reporting the time domain position of each path. The time domain position of a path is an absolute time domain position, or a differential time domain position with respect to a previous time domain position or a predefined boundary. For example, a differential time domain position is a differential time domain duration between adjacent paths. Similarly, a time unit may be configured. The time unit can be one or multiples of duration between adjacent samples. The time domain position may be reported based on the time unit and with respect to the time domain position of the previous path.

[0071] Regarding the number of paths to be reported or selected, e.g., N_p , it may be configured by the network side, e.g., by a gNB in some implementations of the present disclosure. In this case, UE will select N_p paths from detected paths and report corresponding time domain positions of the selected N_p paths. In some other implementations of the present disclosure, UE will explicitly report the number of reported or selected paths, or implicitly report the number of reported or selected paths by the number of reported time domain positions, e.g., based on the number of reported differential time domain durations.

[0072] In accordance with some aspects of the present disclosure, timing related information reporting is bitmap based reporting. One or more time domain windows (or window or the like) will be configured by the network side. Each window is associated with a starting position, a duration and a configured or predefined time unit. An exemplary unit of a window is a configured or predefined time unit, a configured or predefined value or one or multiples of a time duration between two adjacent samples. The first one of the one or more windows may start from the slot boundary.

[0073] UE may report at least one window selected from the one or more configured windows, e.g., reporting part or all indexes of the at least one or more configured windows. The selected window(s) may be reported by a bitmap. For example, in the case that there are 8 configured windows in a slot and the first and second windows are selected by the UE, then the bitmap reporting the selected windows is "11000000."

[0074] Paths within a reported or configured window will be adopted (or selected) for positioning related information reporting, e.g., the timing related information reporting. Paths within different windows may be the same or different. UE will report the time domain positions of the paths within a window by a bitmap, wherein each bit of the bitmap indicates whether there is a path within the window for the time domain position corresponding to the bit. For example, each "1" in the bitmap means there is a path; and each "0" in the bitmap means there is no path.

[0075] The number of bits, e.g., N of the bitmap for reporting time domain positions of the paths may be determined by the window duration, e.g., M and the configured or predefined time unit of the window, e.g., D . For example, in the case that the unit for a window is a configured or predefined time unit and is equal to the duration between two adjacent samples, then the number of bits of the bitmap is $N = M + 1$. In the case that the unit for a window duration is a configured or predefined to be D times of time duration of adjacent samples, then the number of bits of the bitmap is $N = M/D + 1$.

[0076] Figure 3 is a schematic diagram illustrating an exemplary CIR in accordance with aspects of the present disclosure.

[0077] Referring to Figure 3, it is assumed that the unit for the shown window is a configured or predefined time duration of adjacent samples (each dash-line in time domain identifies a sample point), then the number of bits of the bitmap is $N = M + 1 = 14$. There are four paths within the window, e.g., 1st path in the third time instance, 2nd path in the fifth time instance, 3rd path in the sixth time instance and the 4th path in the twelfth time instance. Then, the bitmap shown in Figure 3 is "00101100000100," wherein, each "1" in the bitmap means there is a path, and "0" means there is no path.

[0078] Regarding how to link the timing related reporting, power related reporting and phase related reporting to the same time instance to recover the channel status, there is no disclosure or teaching in legacy technologies. In accordance with current NR specification, the reporting related to power, e.g., DL RS received power per path (RSRPP) and the reporting related to phase, e.g., DL RS carrier phase (RSCP) are configured separately.

[0079] In accordance with some aspects of the present disclosure (scheme 2-1), one signaling is used to trigger or configure or indicate positioning related information reporting, and the time/frequency domain resources, or RS or RS set is common or same for the positioning related information reporting indicated by the signaling. In other words, when receiving a signaling indicating (triggering or configuring) reporting the timing related information, the power related information, the phase related information, or the combination thereof, UE will determine that the same time/frequency domain resources, or RS or RS set is associated with each positioning related information reporting indicated by the same signaling.

[0080] Figure 4 is a schematic diagram illustrating an exemplary procedure of positioning related information reporting under scheme 2-1 in accordance with aspects of the present disclosure.

[0081] Referring to Figure 4, it is assumed that there are several PRSs for positioning related information reporting, e.g., PRS#1 and PRS#2. In accordance with scheme 2-1, when a signaling triggering a positioning related information reporting, e.g., timing related information reporting, power related information reporting and phase related information reporting, UE will associate all the timing related information reporting, power related information reporting and phase related information reporting with the same PRS(s), e.g., PRS#1 and PRS#2. Then, UE will transmit a positioning related information reporting including at least one of the timing related information reporting, power related information reporting and phase related information reporting based on the same PRS. Regarding the time instance for reporting of at least one of timing, power or phase related reporting, the reporting can be at same time instance or different time instances.

[0082] In accordance with some aspects of the present disclosure (scheme 2-2), separate signaling will be used for triggering different positioning related information reporting. For the triggering signaling received within the same time domain window (or time domain duration), UE will determine that the same time/frequency domain resources, or RS or RS set is associated with each positioning related information reporting indicated by the separate signaling within the same time domain window. The time domain window is configured or

predefined, which may be a slot or several slots, or based on periodicity of the associated time/frequency domain resources, or RS or RS set.

[0083] Figure 5 is a schematic diagram illustrating an exemplary procedure of positioning related information under scheme 2-2 reporting in accordance with aspects of the present disclosure.

[0084] Referring to Figure 5, it is assumed that there are several PRSs for positioning related information reporting, e.g., PRS#1 and PRS#2. Separate signaling, e.g., Signaling1, Signaling2 and Signaling3 which respectively trigger a timing related information reporting, a power related information reporting and a phase related information reporting, are received in the UE side within a configured or predefined time domain window. Then, UE will associate the timing related information reporting, power related information reporting and phase related information reporting with the same PRSs, e.g., PRS#1 and PRS#2. Then, UE will transmit the timing related information reporting, e.g., reporting1, power related information reporting, e.g., reporting2, and phase related information reporting, e.g., reporting3, based on the same PRSs.

[0085] In accordance with some aspects of the present disclosure (scheme 2-3), similar to scheme 2-2, separate signaling will be used for triggering different positioning related information reporting. Each signaling indicates a time instance of the corresponding reporting. A time domain window (or time domain duration) is configured or predefined, which may be a slot or several slots, or based on periodicity of the associated time/frequency domain resources, or RS or RS set. If the reporting triggered by the separate signaling will happen within the same time domain window, e.g., the reporting time instances indicated by the separate signaling are within the time domain window, UE will determine that the same time/frequency domain resources, or RS or RS set is associated with each positioning related information reporting indicated by the separate signaling.

[0086] Figure 6 is a schematic diagram illustrating an exemplary procedure of positioning related information reporting under scheme 2-3 in accordance with aspects of the present disclosure.

[0087] Referring to Figure 6, it is assumed that there are several PRSs for positioning related information reporting, e.g., PRS#1 and PRS#2. Separate signaling, e.g., Signling1, Signling2 and Signaling3 which respectively trigger a timing related information reporting, a power related information reporting and a phase related information reporting, are received in the UE side. Each of Signling1, Signling2 and Signaling3 indicates a time instance of the triggered reporting, which are within a configured or predefined time domain window. Then, UE will associate the timing related information reporting, power related information reporting and phase related information reporting with the same PRSs, e.g., PRS#1 and PRS#2. Then, UE will transmit the timing related information reporting, e.g., reporting1, power related information reporting, e.g., reporting2, and phase related information reporting, e.g., reporting3, based on the same PRSs.

[0088] In accordance with some aspects of the present disclosure (scheme 2-4), single or separate signaling will be used for triggering different positioning related information reporting. However, there is no restriction on the time domain position of the triggering signaling and the triggered reporting. Each triggered reporting will be associated with a reporting ID configured by the network side, e.g., by a gNB. The signaling configuring the reporting ID may be the same or different from that triggering the reporting. UE will determine that the same time/frequency domain resources, or RS or RS set is associated with the positioning related information reporting with the same reporting ID.

[0089] Figure 7 is a schematic diagram illustrating an exemplary procedure of positioning related information reporting under scheme 2-4 in accordance with aspects of the present disclosure.

[0090] Referring to Figure 7, it is assumed that there are several time/frequency domain resources for positioning related information reporting, e.g., PRS occasion#1 and PRS occasion#2. Separate signaling, e.g., Signling1, Signling2 and Signaling3 which respectively trigger a timing related information reporting, a power related information reporting and a phase related information reporting, are received in the UE side. Each of Signling1, Signling2 and Signaling3 indicates a time instance of the triggered reporting. The timing related information reporting, power related information reporting and phase related information reporting are configured with the same reporting ID, e.g., #1. Then, UE will associate the

timing related information reporting, power related information reporting and phase related information reporting with the same time/frequency domain resources, e.g., PRS occasion#1 and PRS occasion#2. Then, UE will transmit the timing related information reporting, power related information reporting and phase related information reporting, all identified as reporting#1, based on the same time/frequency domain resources.

[0091] In accordance with some aspects of the present disclosure (scheme 2-5), single or separate signaling will be used for triggering different positioning related information reporting. There is no restriction on the time domain position of the triggering signaling and the reporting. The time/frequency domain resources, or RS or RS set associated with the positioning related information reporting will be directly configured to the UE, e.g., by the signaling triggering the reporting, so that the positioning related information reporting will be associated or combined together in the network if the corresponding reporting is based on the same RS.

[0092] Persons skilled in the art should well know that although the technical solutions illustrated herein, are mainly in view of multiple paths, they are also adapted to cases of one path.

[0093] Figure 8 illustrates an example of a UE 800 in accordance with aspects of the present disclosure. The UE 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.

[0094] 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.

[0095] 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 UE 800 to perform various functions of the present disclosure.

[0096] 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 UE 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.

[0097] In some implementations, the processor 802 and the memory 804 coupled with the processor 802 may be configured to cause the UE 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 UE 800 in accordance with examples as disclosed herein. The UE 800 may be configured to support a means for determining time/frequency domain resources, or a RS or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and a means for reporting the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.

[0098] The controller 806 may manage input and output signals for the UE 800. The controller 806 may also manage peripherals not integrated into the UE 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.

[0099] In some implementations, the UE 800 may include at least one transceiver 808. In some other implementations, the UE 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.

[0100] 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.

[0101] 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.

[0102] Figure 9 illustrates an example of a processor 900 in accordance with aspects of the present disclosure. The processor 900 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 900 may include a controller 902 configured to perform various operations in accordance with examples as described herein. The processor 900 may optionally include at least one

memory 904, which may be, for example, an L1/L2/L3 cache. Additionally, or alternatively, the processor 900 may optionally include one or more arithmetic-logic units (ALUs) 906. 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).

[0103] The processor 900 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 900) 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).

[0104] The controller 902 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 900 to cause the processor 900 to support various operations in accordance with examples as described herein. For example, the controller 902 may operate as a control unit of the processor 900, generating control signals that manage the operation of various components of the processor 900. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0105] The controller 902 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 904 and determine subsequent instruction(s) to be executed to cause the processor 900 to support various operations in accordance with examples as described herein. The controller 902 may be configured to track memory address of instructions associated with the memory 904. The controller 902 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 902 may be configured to interpret the instruction and determine

control signals to be output to other components of the processor 900 to cause the processor 900 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 902 may be configured to manage flow of data within the processor 900. The controller 902 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 900.

[0106] The memory 904 may include one or more caches (e.g., memory local to or included in the processor 900 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementations, the memory 904 may reside within or on a processor chipset (e.g., local to the processor 900). In some other implementations, the memory 904 may reside external to the processor chipset (e.g., remote to the processor 900).

[0107] The memory 904 may store computer-readable, computer-executable code including instructions that, when executed by the processor 900, cause the processor 900 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 902 and/or the processor 900 may be configured to execute computer-readable instructions stored in the memory 904 to cause the processor 900 to perform various functions. For example, the processor 900 and/or the controller 902 may be coupled with or to the memory 904, the processor 900, the controller 902, and the memory 904 may be configured to perform various functions described herein. In some examples, the processor 900 may include multiple processors and the memory 904 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.

[0108] The one or more ALUs 906 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 906 may reside within or on a processor chipset (e.g., the processor 900). In some other implementations, the one or more ALUs 906 may reside external to the processor chipset (e.g., the processor 900). One or more ALUs 906 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 906 may receive input operands and an operation code, which determines

an operation to be executed. One or more ALUs 906 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 906 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 906 to handle conditional operations, comparisons, and bitwise operations.

[0109] The processor 900 may support wireless communication in accordance with examples as disclosed herein. The processor 900 may be configured to or operable to support a means for determining time/frequency domain resources, or a RS or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and a means for reporting the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.

[0110] Figure 10 illustrates an example of a NE 1000 in accordance with aspects of the present disclosure. The NE 1000 may include a processor 1002, a memory 1004, a controller 1006, and a transceiver 1008. The processor 1002, the memory 1004, the controller 1006, or the transceiver 1008, 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.

[0111] The processor 1002, the memory 1004, the controller 1006, or the transceiver 1008, 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.

[0112] The processor 1002 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 1002 may be configured to operate the memory 1004. In some other implementations, the memory 1004 may be integrated into the processor 1002.

The processor 1002 may be configured to execute computer-readable instructions stored in the memory 1004 to cause the NE 1000 to perform various functions of the present disclosure.

[0113] The memory 1004 may include volatile or non-volatile memory. The memory 1004 may store computer-readable, computer-executable code including instructions when executed by the processor 1002 cause the NE 1000 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such the memory 1004 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.

[0114] In some implementations, the processor 1002 and the memory 1004 coupled with the processor 1002 may be configured to cause the NE 1000 to perform one or more of the functions described herein (e.g., executing, by the processor 1002, instructions stored in the memory 1004). For example, the processor 1002 may support wireless communication at the NE 1000 in accordance with examples as disclosed herein. The NE 1000 may be configured to support a means for transmitting time/frequency domain resources, or a RS or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and a means for receiving reporting of the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.

[0115] The controller 1006 may manage input and output signals for the NE 1000. The controller 1006 may also manage peripherals not integrated into the NE 1000. In some implementations, the controller 1006 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 1006 may be implemented as part of the processor 1002.

[0116] In some implementations, the NE 1000 may include at least one transceiver 1008. In some other implementations, the NE 1000 may have more than one transceiver 1008. The

transceiver 1008 may represent a wireless transceiver. The transceiver 1008 may include one or more receiver chains 1010, one or more transmitter chains 1012, or a combination thereof.

[0117] A receiver chain 1010 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 1010 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 1010 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 1010 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 1010 may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0118] A transmitter chain 1012 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 1012 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 1012 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 1012 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0119] Figure 11 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.

[0120] At 1101, the method may include determining time/frequency domain resources, or a RS or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof. The operations of 1101 may be performed in accordance with examples as described herein. In some

implementations, aspects of the operations of 1101 may be performed by a UE as described with reference to Figure 8.

[0121] At 1103, the method may include reporting the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set. The operations of 1103 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1103 may be performed by a UE as described with reference to Figure 8.

[0122] 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.

[0123] Figure 12 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.

[0124] At 1201, the method may include transmitting time/frequency domain resources, or a RS or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof. The operations of 1201 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1201 may be performed by a NE as described with reference to Figure 10.

[0125] At 1203, the method may include receiving reporting of the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set. The operations of 1203 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1203 may be performed by a NE as described with reference to Figure 10.

[0126] 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.

[0127] 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:
 - determine time/frequency domain resources, or a reference signal (RS) or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and
 - report the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.
2. The UE of claim 1, wherein, the timing related information is associated with multiple paths in time domain.
3. The UE of claim 1, wherein, the at least one processor is configured to cause the UE to receive a signaling configuring a granularity of the timing related information.
4. The UE of claim 1, wherein, the at least one processor is configured to cause the UE to:
 - receive a signaling indicating one or multiple time domain patterns associated with multiple paths, each element of a time domain pattern of the one or multiple time domain patterns corresponding to the timing related information of a corresponding path of the multiple paths; and
 - report the timing related information by reporting a pattern index of the associated pattern.

5. The UE of claim 1, wherein, the timing related information is associated with multiple paths, and the at least one processor is configured to cause the UE to report a time domain position of each of the multiple paths.

6. The UE of claim 5, wherein, the time domain position is an absolute time domain position, or a differential time domain position with respect to a previous time domain position or a predefined boundary.

7. The UE of claim 5, wherein, the at least one processor is configured to cause the UE to report a number of the multiple paths.

8. The UE of claim 1, wherein, the at least one processor is configured to cause the UE to receive a signaling indicating at least one time domain window.

9. The UE of claim 8, wherein, the at least one processor is configured to cause the UE to report part or all indexes of the at least one time domain window.

10. The UE of claim 7 or claim 8, wherein, the at least one processor is configured to cause the UE to report at least one time domain position of at least one path within a reported or configured time domain window.

11. The UE of claim 8, wherein, each time domain window is associated with a starting position, a duration and a configured or predefined unit.

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

receive a signaling indicating reporting the timing related information, the power related information, the phase related information, or the combination thereof; and

determine that same time/frequency domain resources, or RS or RS set is associated with positioning related information reporting based on the signaling.

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

receive one or more signaling, each indicating reporting the timing related information, the power related information, the phase related information, or the combination thereof; and

determine that same time/frequency domain resources, or RS or RS set is associated with positioning related information reporting indicated by the one or more signaling in the case that the one or more signaling is within a configured or predefined time domain window.

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

receive one or more signaling, each indicating a time instance of reporting the timing related information, the power related information, the phase related information, or the combination thereof; and

determine that same time/frequency domain resources, or RS or RS set is associated with positioning related information reporting indicated by the one or more signaling in the case that reporting time instances indicated by the one or more signaling are within a configured or predefined time domain window.

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

receive one or more signaling, each indicating a time instance of reporting the timing related information, the power related information, the phase related information, or the combination thereof wherein a reporting identity is associated with each positioning related information reporting; and

determine that same time/frequency domain resources, or RS or RS set is associated with corresponding positioning related information reporting in the case that the reporting identity associated with each reporting of the positioning related information is same.

16. The UE of claim 1, wherein, the at least one processor is configured to cause the UE to receive a signaling indicating at least one of time/frequency domain resources, or RS or RS set associated with the positioning related information reporting.

17. The UE of claim 13 or 14, wherein, the configured or predefined time domain window is based on periodicity of the associated time/frequency domain resources, or RS or RS set.

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:

determine time/frequency domain resources, or a reference signal (RS) or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and

report the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.

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 time/frequency domain resources, or a reference signal (RS) or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and

receive reporting of the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.

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

determining time/frequency domain resources, or a reference signal (RS) or a RS set associated with reporting positioning related information, wherein the positioning related information includes timing related information, power related information, phase related information, or a combination thereof; and

reporting the positioning related information determined based on the associated time/frequency domain resources, or RS or RS set.