

Description

Title of Invention: 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 a signaling indicating a reporting of positioning related assistant information; and report positioning related assistant information associated with one or more uplink (UL) reference signal (RS) transmissions based on the received signaling.
- [0005] In some implementations of the methods and apparatuses described herein, the positioning related assistant information comprises time of arrival (TOA) , line of sight (LOS) probability, UE position or any combination thereof.
- [0006] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: report the positioning related assistant information at same starting time as the one or more UL RS transmissions; or report the positioning related assistant information later than the one or more UL RS transmissions.
- [0007] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: report the positioning related assistant information associated with the one or more UL RS transmissions with a list, wherein the list includes one or more elements, each associated with the one or more UL RS transmissions respectively.
- [0008] In some implementations of the methods and apparatuses described herein, the signaling indicates the one or more UL RS transmissions.
- [0009] In some implementations of the methods and apparatuses described herein, time-frequency resources for the one or more UL RS transmissions and the reporting of the positioning related assistant information are indicated by the signaling, or preconfigured, and there is an offset between a time domain start position of the one or more UL RS transmissions and a slot boundary or time domain position of reception of the signaling.
- [0010] In some implementations of the methods and apparatuses described herein, time-frequency resources for the reporting of the positioning related assistant information are based on time-frequency resources for a configured grant physical uplink shared channel (PUSCH) .
- [0011] In some implementations of the methods and apparatuses described herein, the one or more UL RSs refer to UL RS (s) within a UL RS set or repetitions of a UL RS set containing UL RS (s) .
- [0012] In some implementations of the methods and apparatuses described herein, a number of UL RS transmissions is configured, or is determined by a duration between reception of the signaling and the reporting of the assistant information, or is determined by a configured duration between adjacent UL RS transmissions.

- [0013] In some implementations of the methods and apparatuses described herein, the reporting of the positioning related assistant information is associated with a last UL RS transmission before the reporting of the positioning related assistant information by a predefined or configured threshold, a configured UL RS transmission, or a performed or to be performed UL RS transmission
- [0014] In some implementations of the methods and apparatuses described herein, reporting of the positioning related assistant information is associated with multiple UL RS transmissions, and wherein, a first one or a last one of the multiple UL RS transmissions is a last UL RS transmission before the reporting of the positioning related assistant information by a predefined or configured threshold, a configured UL RS transmission, or a performed or to be performed UL RS transmission.
- [0015] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE: report a quality indicator associated with the positioning related assistant information.
- [0016] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE: report a timer related to validity of the positioning related assistant information.
- [0017] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the UE to: determine a priority of the positioning related assistant information based on an associated UL RS identity (ID) , an associated transmit-receive points (TRP) ID, whether reporting of the positioning related assistant information being periodic or aperiodic, a reporting metric of the positioning related assistant information, or an associated cell ID, or any combination thereof.
- [0018] 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 a signaling indicating a reporting of positioning related assistant information; and report positioning related assistant information associated with one or more UL RS transmissions based on the received signaling.
- [0019] 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: receive UL RS transmissions from a UE; receive positioning related assistant information from the UE or from a location management function (LMF) ; and determine association between the positioning related assistant information and one or more UL RS transmissions of the received UL RS transmissions.

- [0020] In some implementations of the methods and apparatuses described herein, a duration between reception of the UL RS transmissions and reception of the positioning related assistant information, time-frequency resources for the positioning related assistant information, and a number of elements of the positioning related assistant information is configured.
- [0021] In some implementations of the methods and apparatuses described herein, the one or more UL RSs associated with the positioning related assistant information is later than reception of the UL RS transmission by a first duration, and earlier than reception of the positioning related assistant information by a second duration.
- [0022] In some implementations of the methods and apparatuses described herein, a starting position or ending position of the one or more UL RSs associated with the positioning related assistant information is configured or predefined.
- [0023] In some implementations of the methods and apparatuses described herein, the one or more UL RSs associated with the positioning related assistant information are indexed based on: a time domain resource of an associated UL RS, a frequency domain resource of the associated UL RS, code domain resource of the associated UL RS, a sequence identity of the associated UL RS, or a port index of the associated UL RS, or any combination thereof.
- [0024] In some implementations of the methods and apparatuses described herein, a mapping order of the time domain resource, the frequency domain resource, the code domain resource, the sequence identity, or the port index, or any combination thereof is configured or predefined.
- [0025] In some implementations of the methods and apparatuses described herein, the positioning related assistant information is associated with a TRP index.
- [0026] In some implementations of the methods and apparatuses described herein, the at least one processor is configured to cause the NE to: determine the TRP index based on a timing advance group (TAG) index, a UL RS sequence index, a UL RS time-frequency resource, or a serving cell identity, or an identity for generating a UL RS sequence.
- [0027] Some implementations of the methods and apparatuses described herein may further include a method performed by a UE, which includes: receiving a signaling indicating a reporting of positioning related assistant information; and reporting positioning related assistant information associated with one or more UL RS transmissions based on the received signaling.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0028] Figure 1 illustrates an example of a wireless communications system in accordance with aspects of the present disclosure.

- [0029] Figure 2 illustrates an exemplary data collection procedure in a case that the AI/ML model is at gNB side in accordance with aspects of the present disclosure.
- [0030] Figures 3a, 3b and 3c respectively illustrate an exemplary scenario of triggering UL RS transmission (s) and positioning related assistant information reporting by one signaling under Scheme 1-1 in accordance with aspects of the present disclosure.
- [0031] Figure 4 illustrate an exemplary scenario of separate indicating UL RS transmission (s) and reporting positioning related assistant information under Scheme 1-2 in accordance with aspects of the present disclosure.
- [0032] Figure 5a illustrates an example of associating positioning related assistant information and UL RSs under Scheme 2 in accordance with aspects of the present disclosure.
- [0033] Figure 5b illustrates another example of associating positioning related assistant information and UL RSs under Scheme 2 in accordance with aspects of the present disclosure.
- [0034] Figure 6 illustrates an example of a UE in accordance with aspects of the present disclosure.
- [0035] Figure 7 illustrates an example of a processor in accordance with aspects of the present disclosure.
- [0036] Figure 8 illustrates an example of a NE in accordance with aspects of the present disclosure.
- [0037] Figure 9 illustrates a flowchart of method performed by a UE in accordance with aspects of the present disclosure.
- [0038] Figure 10 illustrates a flowchart of method performed by a NE in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

- [0039] Regarding 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) 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. Issues related to time stamp and quality indicator associated with ground truth label and measurement, e.g., how to determine the association between channel measurements and positioning related assistant information etc., in the case that AI/ML model (s) is at gNB side should be solved.

- [0040] 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.
- [0041] For example, in accordance with aspects of the present disclosure, UE will receive UL RS, e.g., sounding reference signal (SRS) transmission configuration from gNB side (or the like) or from LMF (or the like) . UE will transmit UL RSs to the gNB side or the like based on the UL RS transmission configuration. UE will also receive a signaling indicating a reporting of positioning related assistant information, e.g., from the gNB side or from LMF side. Exemplary positioning related assistant information include TOA, LOS probability (e.g., LOS probability of UE with respect to a TRP) , UE position, or any combination thereof (e.g., TOA and LOS probability, or LOS probability and UE position etc.) . Based on the received signaling, UE will report the positioning related assistant information to the gNB side or LMF. In the case that UE reports the positioning related assistant information to the LMF, the LMF will transmit the positioning related assistant information to the gNB. The gNB side will determine the association between the positioning related assistant information and one or more UL RS transmissions among the received UL RS transmissions. Accordingly, the gNB can determine the association between the positioning related assist information and the channel related information based on measurement of the UL RS. The channel related information based on UL RS can be at least one of channel impulse response (CIR) , power delay profile (PDP) , and delay profile (DP) . Accordingly, the gNB could accurately train the AI/ML model with the collected data, e.g., the positioning related assistant information associated with one or more UL RSs and the channel related information associated with the UL RS.
- [0042] 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. In addition, although the collected data, e.g., the positioning related assistant information 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.
- [0043] Aspects of the present disclosure are described in the context of a wireless communication system.
- [0044] 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.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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) .

[0050] 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.

[0051] 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) .

- [0052] 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.
- [0053] 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.
- [0054] 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.
- [0055] 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.

- [0056] 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.
- [0057] 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.
- [0058] Regarding AI/ML based positioning, there is a case that the AI/ML model is at gNB side, e.g., AI/ML assisted positioning case 3a, where channel measurement is based on UL RSs at gNB side and output of the AI/ML model is positioning related assistant information (or referred to as assistant information), e.g., TOA, or LOS probability or UE position etc.
- [0059] Figure 2 illustrates an exemplary data collection procedure in a case that the AI/ML model is at gNB side in accordance with aspects of the present disclosure.

- [0060] Referring to Figure 2, in step 201, UE will transmit UL RSs, e.g. SRSs (or referred to as SRS resources) to gNB side based on UL RS transmission configuration, and gNB will receive the UL RSs based on UL RS reception configuration. Either the UL RS transmission configuration or UL RS reception configuration may be configured and/or indicated by the gNB or LMF. For example, the LMF may configure and transmit the UL RS transmission configuration to UE, and configure and transmit the UL RS reception configuration to the gNB. Then, channel measurements, e.g., CIR, PDP, and/or DP etc. measured based on UL RSs are available at gNB side by the UL RS reception.
- [0061] UE may receive a signaling indicating (or triggering) a reporting of positioning related assistant information, which is associated with one or more UL RS transmissions to the gNB. The gNB may configure and transmit the indication or trigger signaling indicating a reporting of positioning related assistant information by itself, or configure and/or transmit the indication or trigger signaling based on configuration information on positioning related assistant information reporting from LMF. In some other cases, the LMF may configure and transmit the indication or trigger signaling directly to the UE.
- [0062] Based on the indication signaling, UE may report the positioning related assistant information to the gNB in step 203, e.g., via physical uplink control channel (PUCCH) or physical uplink shared channel (PUSCH) in some implementations of the present disclosure. In some other implementations of the present disclosure, UE may report the positioning related assistant information to the LMF in step 205a. In the case that the positioning related assistant information is reported to the LMF, the LMF will transmit the positioning related assistant information received from the UE separately or together with the positioning related assistant information received from other UE (s) to the gNB in step 205b.
- [0063] Either in the case of reporting to the gNB side or in the cases of reporting to the LMF, the reporting of positioning related assistant information is associated with one or more UL RS transmissions. UE may report the positioning related assistant information at the same starting time as the one or more UL RS transmissions, or report the positioning related assistant information later than the one or more UL RS transmissions. In the case that the positioning related assistant information is associated with a quality indicator, UE will report the associated quality indicator to the gNB or LMF. In the case that the positioning related assistant information is associated with a timer related to the validity of the positioning related assistant information, UE will also report the associated timer to the gNB or LMF.
- [0064] In step 207, the gNB may perform AI/ML model training with the collected data, e.g., the positioning related assistant information from the UE or from the LMF, and

the channel related information associated with the UL RS. For data collection of AI/ML model training, the gNB should be aware of the positioning related assistant information corresponding to each channel measurement performed based on UL RSs. That is, the gNB will determine the association (or mapping or the like) between channel measurement based on UL RS and the positioning related assistant information. In the case that the reporting of positioning related assistant information is associated with only one UL RS transmission, the positioning related assistant information e.g., TOA or LOS probability is related to the time instance of the UL RS transmission. In the case that the positioning related assistant information is reported by a list, each element in the list, which corresponds to an element of (or a piece of, or an item of or the like) positioning related assistant information, is associated with one UL RS transmission.

- [0065] In step 209, the gNB may transmit the output of the AI/ML model to the LMF for inference, so that the LMF could calculate or estimate the UE position with improved accuracy.
- [0066] Persons skilled in the art should well know that the gNB side and LMF side are defined based on legacy 3GPP release. As 3GPP evolves, the gNB and LMF may also evolve into other terms, and thus the protection scope of the present disclosure should not be unduly limit to the exemplary implementations illustrated with gNB side and LMF side and should also consider the equivalent entities.
- [0067] More details of the present disclosure will be illustrated in the following respectively in view of cases that UE reports the positioning related assistant information to gNB or the like (Scheme 1) and cases that UE reports the positioning related assistant information to LMF or the like (Scheme 2) .
- [0068] In accordance with aspects of the present disclosure, under Scheme 1, the signaling, which indicates a reporting of positioning related assistant information, may also indicate or trigger one or more UL RS transmissions associated with the reporting (Scheme 1-1) . The one or more UL RS transmissions may refer to one more UL RSs within a UL RS set, or one or more repetitions of a UL RS set containing UL RS (s) . An example of such a signaling is an SRS request.
- [0069] Time-frequency resources for the one or more UL RS transmissions and the reporting of the positioning related assistant information can be determined by various manners. For example, the time-frequency resources for the one or more UL RS transmissions and the reporting of the positioning related assistant information may be indicated by the signaling, or be preconfigured (e.g., there is an offset between a time domain start position of the one or more UL RS transmissions and a slot boundary or time domain position of the reception of the signaling) . In another example, the time-frequency resources for the reporting of the positioning related assistant information may be

based on time-frequency resources for a configured grant (CG) PUSCH, which may carry the positioning related assistant information.

- [0070] Figures 3a, 3b and 3c respectively illustrate an exemplary scenario of triggering UL RS transmission (s) and positioning related assistant information reporting by one signaling under Scheme 1-1 in accordance with aspects of the present disclosure.
- [0071] Firstly, referring to Figures 3a and 3b, one trigger signaling triggers one SRS transmission and one reporting of positioning related assistant information. In Figure 3a, the positioning related assistant information, which is associated with the triggered SRS transmission will be reported or transmitted later than the SRS transmission, while in Figure 3b, the positioning related assistant information, which is associated with the triggered SRS transmission will be reported or transmitted at the same starting position in time domain as the SRS transmission.
- [0072] Referring to Figure 3c, one trigger signaling which triggers one reporting of positioning related assistant information, may also trigger multiple UL RS transmissions, e.g., 4 SRS transmissions, SRS#1, SRS#2, SRS#3 and SRS#4. Positioning related assistant information, which is associated with SRS#1, SRS#2, SRS#3 and SRS#4 will be reported later than the triggered 4 SRS transmissions. The reporting of the positioning related assistant information associated with SRS#1, SRS#2, SRS#3 and SRS#4 may be a list with four elements of positioning related assistant information, which respectively associate with (or mapping to, or correspond to, or the like) SRS#1, SRS#2, SRS#3 and SRS#4.
- [0073] More specifically, in accordance with some aspects of the present disclosure (Scheme 1-1-1), gNB may transmit a signaling, e.g., by downlink control information (DCI) simultaneously triggering a reporting of positioning related assistant information and UL RS transmission, e.g., SRS transmission.
- [0074] Under Scheme 1-1-1, in some implementations of the present disclosure, the time-frequency resources for the UL RS transmission and positioning related assistant information reporting may be pre-configured by high layer signaling, e.g., radio resource control (RRC) signaling or indicated by the signaling triggering the reporting of positioning related assistant information. For example, the time-frequency resource for PUSCH carrying positioning related assistant information is preconfigured to be the nearest CG type 1 PUSCH satisfying a timeline requirement, that is, the triggered positioning related assistant information reporting will later than the SRS transmission by a predefined or configured duration. In addition, there may be multiple configurations for CG type 1 PUSCH. Different CG type 1 PUSCHs may have different BWP IDs, starting symbols, ending symbols, and durations etc. UE will select one CG type 1 PUSCH from the multiple PUSCHs to carry the positioning related assistant information. For example, UE may first select CG type 1 PUSCH (s) with

the same BWP ID as the triggered UL RS from the multiple PUSCHs, and if there is more than one selected PUSCH with the same BWP ID as the triggered UL RS, UE will select a PUSCH with the earliest or earlier starting symbol of the more than one selected PUSCH for reporting or transmitting the positioning related assistant information. The positioning related assistant information may also be transmitted by the PUSCH indicated by the signaling triggering the reporting of positioning related assistant information, e.g., the DCI.

- [0075] In some other implementations of the present disclosure, the time-frequency resources for the UL RS transmission and positioning related assistant information reporting may be indicated by the signaling indicating the reporting of positioning related assistant information, which may be a DCI. For example, UL RS, e.g., SRS request field or information element (IE) may also be included in a scheduling DCI for indicating the positioning related assistant information reporting or used as a trigger DCI to trigger CG 2 PUSCH carrying the positioning related assistant information.
- [0076] In some yet other implementations of the present disclosure, the time-frequency resources for the UL RS transmission and positioning related assistant information reporting may be determined with respect to the signaling triggering the reporting of positioning related assistant information, or with respect to an absolute time domain boundary. In the case of being determined is similar to with respect to the trigger signaling, it is similar to aperiodic CSI reporting and may be deemed as aperiodic reporting. In the case of being determined is similar to with respect to with respect to the trigger signaling, it is similar to configured grant PUSCH and may be deemed as periodic reporting.
- [0077] In accordance with some other aspects of the present disclosure (Scheme 1-1-2), gNB may transmit a signaling simultaneously triggering a reporting of positioning related assistant information and multiple UL RS transmissions. The time-frequency resources for the reporting of positioning related assistant information reporting is the same as Scheme 1-1-1, and thus will not repeat. Only the time-frequency resources for the UL RS transmissions will be specifically illustrated in the following.
- [0078] The multiple UL RS transmissions may be a SRS resource set containing multiple SRS resources. In this case, legacy SRS configuration can work. However, in some cases, the multiple UL RS transmissions may be repetitions of one or more SRSs or a SRS resource set with one or more SRSs, e.g., multiple repetitions of a single SRS or a SRS resource set contains a single SRS resource. It is the same for other UL RS (s). Considering that, aspects of the present disclosure also provide novel UL RS configurations to determine the time-frequency resources for UL RS transmissions (also works for one UL RS transmission).

- [0079] For example, the number of UL RS transmissions associated with reporting of positioning related assistant information may be configured. Since the UL RS transmissions are one to one associated with elements of positioning related assistant information, the number of UL RS transmissions associated with positioning related assistant information reporting may be indirectly configured by a configured element number of the positioning related assistant information in the reporting.
- [0080] In some implementations of the present disclosure, high layer signaling, e.g., a RRC signaling may preconfigure possible (or available or the like) time-frequency resources for UL RSs, and thus the gNB or LMF will be aware the suitable number that can be configured. Simultaneous transmission of downlink RS/channel and UL RS, e.g., SRS may be not possible, and in this case the time-frequency resources for configured UL RSs should avoid overlap with DL slots or symbols etc. In some other implementations of the present disclosure, the time-frequency resources for configured UL RSs are determined based on the duration between reception of the trigger signaling and the reporting of the positioning related assistant information, which may be further in view of time division duplex (TDD) configuration. Similarly, in the case of simultaneous transmission of downlink RS/channel and UL RS, e.g., SRS being impossible, the time-frequency resources for configured UL RSs should avoid overlap with DL slots or symbols etc.
- [0081] For another example, there may be a configured duration between adjacent UL RS transmissions. Accordingly, the time-frequency resources for UL RS transmissions will be determined, which may be further in combination with TDD configuration. In the case of simultaneous transmission of downlink RS/channel and UL RS, e.g., SRS being impossible, the time-frequency resources for configured UL RSs should avoid overlap with DL slot or symbol etc.
- [0082] In accordance with some aspects of the present disclosure (Scheme 1-2) , the signaling indicating a reporting of positioning related assistant information will not indicate UL RS transmission (s) , that is, UL RS transmission (s) is indicated separately from the reporting of positioning related assistant information. Similarly, the number of UL RS transmission associated with positioning related assistant information will be configured.
- [0083] In the case that the number of UL RS transmission is one, only positioning related assistant information associated with the one UL RS transmission will be triggered and reported. An example of such a UL RS transmission is a last (or nearest) UL RS transmission before the reporting of the positioning related assistant information by a predefined or configured threshold (e.g., a time to allow UE to prepare the reporting) , a configured UL RS transmission (e.g., a configured SRS) , or a performed or to be

performed UL RS transmission (e.g., a SRS that has been transmitted or reported to gNB by UE, or is to be transmitted or reported to gNB by UE) .

- [0084] In the case that the number of UL RS transmission associated with positioning related assistant information is multiple, e.g., $N > 1$, positioning related assistant information associated with the multiple UL RS transmissions will be triggered and reported. Each item of positioning related assistant information is associated with a corresponding one of the multiple UL RS transmissions. In the case that the reporting of positioning related assistant information is a list, each element of the list is corresponding to a corresponding one of the multiple UL RS transmission. The multiple RS transmissions will be selected or determined based on the first or last UL RS and the number of UL RS transmissions associated with positioning related assistant information, which is similar to the case that on one UL RS transmission is configured under Scheme 1-2. For example, the first one or the last one of the multiple UL RS transmissions is the last UL RS transmission before the reporting of the positioning related assistant information by a predefined or configured threshold (e.g., a time that allows UE to prepare the reporting) , a configured UL RS transmission, or a performed or to be performed UL RS transmission.
- [0085] Figure 4 illustrate an exemplary scenario of separate indicating UL RS transmission (s) and reporting positioning related assistant information under Scheme 1-2 in accordance with aspects of the present disclosure.
- [0086] Referring to Figure 4, a signaling indicating a reporting of positioning related assistant information is received between SRS#1 and SRS#2. It is assumed that the number of UL RS transmission associated with positioning related assistant information reporting is configured to be 4. The first one of the four UL RS transmissions, e.g., SRS#3 is first determined based on one of the aforementioned manners, e.g., being configured. Then, SRS#3, SRS#4, SRS#5 and SRS#6 are determined as the four UL RS transmissions associated with the reporting of positioning related assistant information. Alternatively, the last one of the four UL RS transmissions, e.g., SRS#6 is first determined based on one of the aforementioned manners, e.g., being the last UL RS transmission before the reporting of the positioning related assistant information by a predefined or configured threshold. Then, SRS#3, SRS#4, SRS#5 and SRS#6 are determined as the four UL RS transmissions associated with the reporting of positioning related assistant information.
- [0087] In some cases, the reporting of positioning related assistant information sent to the gNB may overlap with other kind (s) of CSI reporting. Dropping may happen when the contents (or size) of the CSI reporting exceed the channel restriction based on priorities of the reported contents. Regarding priority of positioning related assistant information, it may be determined based on the whole reporting of the

positioning related assistant information, that is all the positioning related assistant information in the same reporting (e.g., in the same list) has the same priority. In some other implementations of the present disclosure, priority of positioning related assistant information may be based on each item of positioning related assistant information associated with one corresponding UL RS transmission. In some other implementations of the present disclosure, priority of each item of positioning related assistant information may be based on priority of both the whole positioning related assistant information reporting and the item of positioning related assistant information.

- [0088] Given that, exemplary priority of the positioning related assistant information in a CSI reporting may be determined based on an associated UL RS ID, an associated TRP ID, whether reporting of the positioning related assistant information is periodic or aperiodic, a reporting metric of the positioning related assistant information (e.g. TOA, or LOS probability etc.), an associated cell ID, or any combination thereof.
- [0089] Regarding Scheme 2, positioning related assistant information reporting to LMF from UE is similar to Scheme 1, and thus will not repeat. LMF will transmit the received positioning related assistant information to the gNB, e.g., by a list. Similarly, each element of the list is corresponding to a UL RS transmission or RS (in the case of repetitions of the same UL RS, refer to a specific repetition of the UL RS) .
- [0090] In some cases, the LMF may gather positioning related assistant information of multiple UEs associated with the same gNB and then transmitted the gathered positioning related assistant information to gNB side together. For a single UE, different UL RSs, e.g., different SRS resources may be time division multiplexed (TDMed) , while UL RSs for different UEs may be differentiated by different time domain resources, frequency domain resources, code domain resources, or different sequences (e.g., different sequence ID) , ports (e.g., port indexes) , or any combination thereof. Regarding a sequence ID, it may be a scrambling ID or an index to generate a UL RS sequence, e.g., a SRS sequence.
- [0091] Indexing (or a mapping order or the like) among multiple UL RS resources associated with positioning related assistant information will be configured or predefined based on the aforementioned various domains, sequences and/or ports etc. For example, one or more UL RSs associated with the positioning related assistant information may be indexed based on: a time domain resource of an associated UL RS, a frequency domain resource of the associated UL RS, code domain resource of the associated UL RS, a sequence identity of the associated UL RS, or a port index of the associated UL RS, or any combination thereof (e.g., time domain resource (s) first, frequency domain resource (s) second, then followed by code domain resource (s) , then followed by sequence ID (s) , and then followed by port index (s)) .

- [0092] The LMF can transmit or indicate the positioning related assistant information in various manners. Accordingly, gNB side will determined the positioning related assistant information and associated UL RSs in various manners.
- [0093] For example, in some implementations of the present disclosure, gNB may determine the positioning related assistant information based on implicit configuration of UL RS reception at gNB side.
- [0094] An exemplary UL RS reception configuration may configure, preconfigure or predefine the following information: a duration between reception of UL RS at gNB side from UE and reception of positioning related assistant information at gNB side from LMF, time-frequency resources for positioning related assistant information reporting, and the number, e.g., $M \geq 1$ of elements of positioning related assistant information for reception at gNB side.
- [0095] There may be multiple, e.g., $N \geq M$ available or alternative UL RSs to be associated with the positioning related assistant information. The N available UL RSs to be associated with the positioning related assistant information are later than reception of the UL RS transmission by a first duration (or first threshold) , and earlier than reception of the positioning related assistant information by a second duration (or a second threshold) . Exemplary first duration and second duration will be respectively determined based on time for transmission of the positioning related assistant information from UE to LMF and preparation at LMF side. M UL RSs associated with the positioning related assistant information will be determined or selected from the N available UL RSs. In the case that $M=N$, the M UL RSs associated with the positioning related assistant information will be the N available UL RSs. In the case that $M < N$, the M UL RSs associated with the positioning related assistant information will be determined or selected from the N available UL RSs based on configured or predefined rules. For example, the M UL RSs will be selected based on the starting position (or the first one) of the N available UL RSs or the ending position (or the last one) of the N available UL RSs.
- [0096] Figure 5a illustrates an example of associating positioning related assistant information and UL RSs under Scheme 2 in accordance with aspects of the present disclosure.
- [0097] Referring to Figure 5a, based on a configured or predefined duration between the reception of UL RS at gNB side from UE and reception of positioning related assistant information at gNB side from LMF, e.g., D_0 , SRS#5 to SRS#20 are available SRS resources to be associated with positioning related assistant information in view of the first configured or predefined duration later than reception of UL RS transmission, e.g., D_1 and the second configured or predefined duration earlier than reception of the positioning related assistant information, e.g., D_2 . It is assumed that the number

of UL RSs is 12, which is smaller than the available UL RSs determined by D1 and D2. Accordingly, if the 12 UL RSs are selected from the starting position of the available UL RSs, then SRS#5 to SRS#16 will be the 12 SRS resources associated with positioning related assistant information. If the 12 UL RSs are selected from the ending position of the available UL RSs, then SRS#9 to SRS#20 will be the 12 SRS resources associated with positioning related assistant information.

- [0098] In some other implementations of the present disclosure, the LMF may transmit the positioning related assistant information to gNB by directly configuring the reception of the positioning related assistant information and corresponding UL RSs. For example, the LMF may configure time-frequency resources for the reception of the positioning related assistant information, and configure associated UL RS to each element in the list of positioning related assistant information, e.g., indicating the number of associated UL RSs and indicating a starting position or ending position of the associated UL RS or the time/frequency/code domain resource of the UL RS, index of the UL RS or the sequence ID of the UL RS, etc.
- [0099] Figure 5b illustrates another example of associating positioning related assistant information and UL RSs under Scheme 2 in accordance with aspects of the present disclosure.
- [0100] Referring to Figure 5b, the LMF may indicate the reception of positioning related assistant information at gNB, indicate the number of UL RSs, e.g., 12 and indicate a starting position of the UL RSs, e.g., SRS#5 or ending position of the UL RSs, e.g., SRS#20. Similarly, based on the starting position, SRS#5 to SRS#16 will be the 12 SRS resources associated with positioning related assistant information, and based on the ending position, SRS#9 to SRS#20 will be the 12 SRS resources associated with positioning related assistant information.
- [0101] In some cases, the positioning related assistant information and associated UL RSs may be for different TRPs, even if they are associated with a single UE. Thus, it is necessary to differentiate the positioning related assistant information for different TRPs by indicating the TRP index associated with the positioning related assistant information. For example, the associated TRP index will be reported from UE to LMF and also from LMF to gNB. Exemplary TRP index may be based on a TAG index, a UL RS sequence index, a UL RS time-frequency resource, or a serving cell identity, or an identity for generating a UL RS sequence (e.g., a scrambling ID or an index to generate SRS sequence) .
- [0102] 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.

- [0103] 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.
- [0104] 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.
- [0105] 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.
- [0106] 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 a signaling indicating a reporting of positioning related assistant information, and means for reporting positioning related assistant information associated with one or more UL RS transmissions based on the received signaling.
- [0107] 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.

- [0108] 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.
- [0109] 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.
- [0110] 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.
- [0111] 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) .

- [0112] 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) .
- [0113] 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.
- [0114] 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.
- [0115] 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) .

- [0116] 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.
- [0117] 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.
- [0118] 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 a signaling indicating a reporting of positioning related assistant information, and means for reporting positioning related assistant information associated with one or more UL RS transmissions based on the received signaling.
- [0119] 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.

- [0120] 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.
- [0121] 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.
- [0122] 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.
- [0123] 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 receiving UL RS transmissions from a UE, means for receiving positioning related assistant information from the UE or from a LMF; and means for determining association between the positioning related assistant information and one or more UL RS transmissions of the received UL RS transmissions.
- [0124] 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.

- [0125] 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.
- [0126] 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.
- [0127] 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.
- [0128] 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.
- [0129] At step 901, the method may include receiving a signaling indicating a reporting of positioning related assistant information. The operations of step 901 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 901 may be performed by a UE as described with reference to Figure 6.

- [0130] At step 903, the method may include reporting positioning related assistant information associated with one or more UL RS transmissions based on the received signaling. The operations of step 903 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 903 may be performed by a UE as described with reference to Figure 6.
- [0131] 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.
- [0132] 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.
- [0133] At step 1001, the method may include receiving UL RS transmissions from a UE. The operations of step 1001 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 1001 may be performed by a NE as described with reference to Figure 8.
- [0134] At step 1003, the method may include receiving positioning related assistant information from the UE or from an LMF. The operations of step 1003 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 1003 may be performed by a NE as described with reference to Figure 8.
- [0135] At step 1005, the method may include determining association between the positioning related assistant information and one or more UL RS transmissions of the received UL RS transmissions. The operations of step 1005 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 1005 may be performed by a NE as described with reference to Figure 8.
- [0136] 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.
- [0137] 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

- [Claim 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 a signaling indicating a reporting of positioning related assistant
information; and
report positioning related assistant information associated with one
or more uplink (UL) reference signal (RS) transmissions based on the
received signaling.
- [Claim 2] The UE of claim 1, wherein, the positioning related assistant
information comprises time of arrival (TOA) , line of sight (LOS)
probability, UE position or any combination thereof.
- [Claim 3] The UE of claim 1, wherein, the at least one processor is configured to
cause the UE to:
report the positioning related assistant information at same starting time
as the one or more UL RS transmissions; or
report the positioning related assistant information later than the one or
more UL RS transmissions.
- [Claim 4] The UE of claim 1, wherein, the at least one processor is configured to
cause the UE to:
report the positioning related assistant information associated with the
one or more UL RS transmissions with a list, wherein the list includes
one or more elements, each associated with the one or more UL RS
transmissions respectively.
- [Claim 5] The UE of claim 1, wherein, the signaling indicates the one or more UL
RS transmissions.
- [Claim 6] The UE of claim 5, wherein, time-frequency resources for the one or
more UL RS transmissions and the reporting of the positioning related
assistant information are indicated by the signaling, or preconfigured,
and there is an offset between a time domain start position of the one or
more UL RS transmissions and a slot boundary or time domain position
of reception of the signaling.
- [Claim 7] The UE of claim 5, wherein, the one or more UL RS refer to UL RS (s)
within a UL RS set or repetitions of a UL RS set containing UL RS (s) .
- [Claim 8] The UE of claim 5, wherein, a number of UL RS transmissions
is configured, or is determined by a duration between reception

of the signaling and the reporting of the assistant information, or is determined by a configured duration between adjacent UL RS transmissions.

[Claim 9] The UE of claim 1, wherein, the reporting of the positioning related assistant information is associated with a last UL RS transmission before the reporting of the positioning related assistant information by a predefined or configured threshold, a configured UL RS transmission, or a performed or to be performed UL RS transmission.

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[Claim 10] The UE of claim 1, wherein, reporting of the positioning related assistant information is associated with multiple UL RS transmissions, and wherein, a first one or a last one of the multiple UL RS transmissions is a last UL RS transmission before the reporting of the positioning related assistant information by a predefined or configured threshold, a configured UL RS transmission, or a performed or to be performed UL RS transmission.

[Claim 11] The UE of claim 1, wherein, the at least one processor is configured to cause the UE: report a quality indicator associated with the positioning related assistant information.

[Claim 12] The UE of claim 1, wherein, the at least one processor is configured to cause the UE to:
determine a priority of the positioning related assistant information based on an associated UL RS identity (ID) , an associated transmit-receive points (TRP) ID, whether reporting of the positioning related assistant information being periodic or aperiodic, a reporting metric of the positioning related assistant information, or an associated cell ID, or any combination thereof.

[Claim 13] 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 a signaling indicating a reporting of positioning related assistant information; and
report positioning related assistant information associated with one or more uplink (UL) reference signal (RS) transmissions based on the received signaling.

[Claim 14] 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:
 receive uplink (UL) reference signal (RS) transmissions from a user equipment (UE) ;
 receive positioning related assistant information from the UE or from a location management function (LMF) ; and
 determine association between the positioning related assistant information and one or more UL RS transmissions of the received UL RS transmissions.

- [Claim 15] The NE of claim 14, wherein, a duration between reception of the UL RS transmissions and reception of the positioning related assistant information, time-frequency resources for the positioning related assistant information, and a number of elements of the positioning related assistant information is configured.
- [Claim 16] The NE of claim 14, wherein, the one or more UL RSs associated with the positioning related assistant information is later than reception of the UL RS transmission by a first duration, and earlier than reception of the positioning related assistant information by a second duration.
- [Claim 17] The NE of claim 14, wherein, the one or more UL RSs associated with the positioning related assistant information are indexed based on: a time domain resource of an associated UL RS, a frequency domain resource of the associated UL RS, code domain resource of the associated UL RS, a sequence identity of the associated UL RS, or a port index of the associated UL RS, or any combination thereof.
- [Claim 18] The NE of claim 17, wherein, a mapping order of the time domain resource, the frequency domain resource, the code domain resource, the sequence identity, or the port index, or any combination thereof is configured or predefined.
- [Claim 19] The NE of claim 14, wherein, the positioning related assistant information is associated with a TRP index, and the at least one processor is configured to cause the NE to:
 determine the TRP index based on a timing advance group (TAG) index, a UL RS sequence index, a UL RS time-frequency resource, or a serving cell identity, or an identity for generating a UL RS sequence.
- [Claim 20] A method performed by a user equipment (UE) , comprising:
 receiving a signaling indicating a reporting of positioning related assistant information; and

reporting positioning related assistant information associated with one or more uplink (UL) reference signal (RS) transmissions based on the received signaling.