

DEVICES AND METHODS FOR DATA COLLECTION

[0001] The present disclosure relates to wireless communications, and more specifically to data collection.

BACKGROUND

[0002] With the development of communication technology, artificial intelligence/machine learning (AI/ML) technology has been introduced to optimize physical layer operation for some use cases. For example, channel state information (CSI) feedback compression, CSI time domain prediction, beam spatial domain prediction, beam time domain prediction, AI/ML assisted positioning estimation, direct AI/ML positioning, and so on.

[0003] For use cases of AI based positioning, location management function (LMF) collects training data from a user equipment (UE) to train an AI model, and the AI model may be a LMF-sided model or a UE-sided model. For use cases of AI based CSI/beam management (BM)/positioning, gNB collects training data from UE to train an AI model, and the AI model may be a gNB-sided model or a UE-sided model. However, there are some issues for data collection which need to be addressed.

SUMMARY

[0004] The present disclosure relates to methods, apparatuses, and systems that support data collection, especially, data collection for AI/ML training considering mobility.

[0005] Some implementations of the method and devices described herein include, receiving, from a first network device, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and performing a measurement on a reference signal associated with data collection for model training based on the at least one measurement configuration. In this way, the data collection may not be interrupted when the the user equipment moving across the at least one network device.

[0006] Some implementations of the method and devices described herein may further include transmitting, to a second network device among the at least one network device, first information indicating that a session of the data collection is triggered, wherein the second network device serves the user equipment.

[0007] Some implementations of the method and devices described herein may further include transmitting the first information via a radio resource control (RRC) message.

[0008] Some implementations of the method and devices described herein may further include receiving, from the second network device, a first configuration of a radio bearer for the user equipment.

[0009] Some implementations of the method and devices described herein may further include transmitting, to one of the second network device or the first network device, a first request for the at least one measurement configuration.

[0010] Some implementations of the method and devices described herein may further include receiving, from the second network device, the at least one measurement configuration, wherein one or more measurement configurations among the at least one measurement configuration are transmitted by one or more network devices among the at least one network device other than the second network device in response to receiving the first request from the second network device.

[0011] Some implementations of the method and devices described herein may further include receiving, from the second network device, a second configuration of a radio bearer for the user equipment, wherein the second configuration is transmitted, via a handover response, by a third network device among the at least one network device.

[0012] Some implementations of the method and devices described herein may further include transmitting collected data to the first network device.

[0013] Some implementations of the method and devices described herein may further include receiving, from the second network device, a third configuration for transmitting the collected data for model training associated with artificial intelligence/machine learning (AI/ML) based positioning or channel state information compression, channel state information prediction, or beam prediction.

[0014] Some implementations of the method and devices described herein may further include receiving, from the third network device, a second request for the collected data that has not been transmitted after handover to the third network device.

[0015] Some implementations of the method and devices described herein may further include transmitting, to the third network device, one of the collected data that has not been transmitted or the trace information associated with the collected data.

[0016] Some implementations of the method and devices described herein may further include discarding the collected data that has not been transmitted in the event that the second request is not received within a time period.

[0017] In some implementations of the method and devices described herein, the at least one measurement configuration may comprise one of the following: a type of the reference signal; resource information for the reference signal; a type of a ground truth; validity information indicating validity time of a session of the data collection; or area information indicating an area where the user equipment performs the data collection.

[0018] In some implementations of the method and devices described herein, the area information may comprise one of the following: one or more identities (IDs) of one or more cell; one or more IDs of one or more zones associated with geographical coordinates; one or more IDs of one or more areas associated with a list of cells; one or more tracking area codes (TACs) associated with a list of cells; or one or more tracking area identifiers (TAIs) associated with a list of cells.

[0019] In some implementations of the method and devices described herein, the first information may comprise one of the following: an indication that the session of the data collection is triggered by the first network device; the session of the data collection is carried out via a long term evolution (LTE) positioning protocol (LPP) message over a control plane (CP); the session of the data collection is carried out via an LPP message over a user plane (UP); area information indicating an area where the user equipment performs the data collection; or validity information indicating validity time of the session of the data collection.

[0020] In some implementations of the method and devices described herein, the first request may comprise one of the following: a type of the reference signal requested by the user equipment; validity information indicating validity time of the session of the data

collection; or area information indicating an area where the user equipment performs the data collection.

[0021] In some implementations of the method and devices described herein, the second configuration may be transmitted in the event that the third network device receives, from the second network device, a handover request to hand over the user equipment to the third network device.

[0022] In some implementations of the method and devices described herein, the handover request may comprise one of the following: an indication that the session of the data collection is triggered by the first network device; the session of the data collection is carried out via an LPP message over a CP; the session of the data collection is carried out via an LPP message over a UP; area information indicating an area where the user equipment performs the data collection; or validity information indicating validity time of the session of the data collection.

[0023] In some implementations of the method and devices described herein, one of the first configuration or the second configuration may comprise one of the following: a signaling radio bearer (SRB) configured for the user equipment in the event that the session of the data collection is carried out via an LPP message over a CP; or a data radio bearer (DRB) configured for the user equipment in the event that the session of the data collection is carried out via an LPP message over a UP.

[0024] In some implementations of the method and devices described herein, the collected data may be transmitted to the first network device in the event that the user equipment is within the area after handover to the third network device.

[0025] In some implementations of the method and devices described herein, the third configuration may comprise one of the following: a period for transmitting the collected data; a period for logging the measurement; an event that trigger transmitting the collected data; an event that trigger logging the measurement; an indication that the user equipment is not to discard the collected data that has not been transmitted; or trace information comprising a trace reference or a trace recording session reference.

[0026] In some implementations of the method and devices described herein, the handover request may further comprise one of the following: an indication that the user

equipment is configured not to discard the collected data that has not been transmitted; or the trace information.

[0027] In some implementations of the method and devices described herein, the collected data that has not been transmitted may be further transmitted from the third network device to the second network device.

[0028] In some implementations of the method and devices described herein, the time period comprises one of the following: a preconfigured time period after the collected data is generated; a period of an inactivity timer; or a period of a timer configured by the second network device.

[0029] Some implementations of the method and devices described herein include transmitting, to a user equipment, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and receiving, from the user equipment, collected data of the user equipment. In this way, the data collection may not be interrupted when the the user equipment moving across the at least one network device.

[0030] Some implementations of the method and devices described herein may further include transmitting, to a second network device among the at least one network device, first information indicating that a session of the data collection is triggered, wherein the second network device serves the user equipment.

[0031] Some implementations of the method and devices described herein may further include transmitting, to the at least one network device, a first request for at least one measurement configuration determined by the at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and receiving, from the at least one network device, the at least one measurement configuration.

[0032] Some implementations of the method and devices described herein may further include receiving, from the user equipment, a request for the at least one measurement configuration.

[0033] In some implementations of the method and devices described herein, the at least one measurement configuration may comprise one of the following: a type of a reference signal associated with positioning; resource information for the reference signal;

a type of a ground truth; validity information indicating validity time of a session of the data collection; or area information indicating an area where the user equipment performs the data collection.

[0034] In some implementations of the method and devices described herein, the area information may comprise one of the following: one or more identities (IDs) of one or more cell; one or more IDs of one or more zones associated with geographical coordinates; one or more IDs of one or more areas associated with a list of cells; one or more tracking area codes (TACs) associated with a list of cells; or one or more tracking area identifiers (TAIs) associated with a list of cells.

[0035] In some implementations of the method and devices described herein, the first information may comprise one of the following: an indication that the session of the data collection is triggered by the first network device; the session of the data collection is carried out via a long term evolution (LTE) positioning protocol (LPP) message over a control plane (CP); the session of the data collection is carried out via an LPP message over a user plane (UP); area information indicating an area where the user equipment performs the data collection; or validity information indicating validity time of the session of the data collection.

[0036] In some implementations of the method and devices described herein, the request may comprise one of the following: a type of the reference signal requested by the user equipment; validity information indicating validity time of the session of the data collection; or area information indicating an area where the user equipment performs the data collection.

[0037] In some implementations of the method and devices described herein, the first information may be transmitted via new radio (NR) positioning protocol A (NRPPa) message.

[0038] Some implementations of the method and devices described herein include, transmitting, to a third network device, a handover request that includes first information associated data collection for beam prediction, wherein the second network device and the third network device are located in an area where a user equipment performs data collection; and receiving, from the third network device, a handover response comprising a radio resource control (RRC) configuration for a handover procedure. In this way, beam

prediction may be used for the handover procedure to improve communication performance.

[0039] Some implementations of the method and devices described herein may further include transmitting, to the third network device, a first request associated with the data collection of the user equipment.

[0040] Some implementations of the method and devices described herein may further include transmitting, to the user equipment, the RRC configuration; and receiving, from the third network device, the beam measurements after the user equipment is handed over from the second network device to the third network device.

[0041] Some implementations of the method and devices described herein may further include receiving, from the third network device, a second request associated with data collection of the user equipment.

[0042] In some implementations of the method and devices described herein, the first request may comprise one of the following: an indication requesting the third network device to provide beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device; identities (IDs) of the beam measurements; a duration for the user equipment to perform the beam measurements; a duration for the user equipment to log the beam measurements; a duration for the user equipment to transmit the beam measurements; a period for performing the beam measurements; a period for logging the beam measurements; a period for transmitting the beam measurements; second information associated with at least one beam requested by the second network device to be measured; or a type of the beam measurements requested by the second network device.

[0043] In some implementations of the method and devices described herein, the type may comprise one of the following: indexes of a first number of beams with stronger reference signal received powers (RSRPs) among multiple beams of the third network device; indexes of one or more beams with one or more RSRPs above a first thresholdsecond network device.

[0044] In some implementations of the method and devices described herein, the first information may comprise one of the following: identities (IDs) of the beam

measurements; an ID of a target cell to which the user equipment is to be handed over; or third information of a beam prediction.

[0045] In some implementations of the method and devices described herein, the third information of a beam prediction may comprise one of the following: an index associated with a beam predicted to have a strongest RSRP among multiple beams of the second network device; a list of a second number of beams with stronger RSRPs among multiple beams of the second network device; a list of at least one beam predicted to have at least one RSRP above a second threshold; at least one value representing likelihood associated with at least one predicted beam; at least one predicted beam measurement associated with at least one predicted beam; or a predicted value of stay time of the at least one predicted beam.

[0046] In some implementations of the method and devices described herein, the first information may further comprise one of the following: second information associated with at least one beam to be measured in the event that the first request does not include the second information; or a type of the beam measurements in the event that the first request does not include the type.

[0047] In some implementations of the method and devices described herein, the RRC configuration may comprise one of the following: a first configuration for the user equipment to perform a random access to a target cell with a predicted beam having a strongest RSRP among multiple beams of the third network device; a second configuration for the user equipment to perform the beam measurement based on the handover request and a first request; a third configuration for the user equipment to log the beam measurement based on the handover request and a first request; or a fourth configuration for the user equipment to transmit the beam measurement based on the handover request and a first request.

[0048] In some implementations of the method and devices described herein, the second request may comprise one of the following: an indication requesting the second network device to provide historical beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device; a duration, wherein the second network device is requested to provide historical beam measurements within the duration before the user equipment is handed over from the second network device to the third network device; a type of the historical beam

measurements requested by the third network device; an ID of a target cell to which the user equipment is to be handed over; or an ID of a source cell from which the user equipment is to be handed over.

[0049] In some implementations of the method and devices described herein, the historical beam measurements may be transmitted to the third network device via the handover request; or the historical beam measurements may be transmitted to the third network device after the handover finishes.

[0050] In some implementations of the method and devices described herein, the first information may further comprise one of the following: time stamps of the historical beam measurements; or values of stay time of one or more beams of the historical beam measurements.

[0051] Some implementations of the method and devices described herein include, receiving, from a second network device, a handover request that includes first information associated data collection for beam prediction, wherein the second network device and the third network device are located in an area where a user equipment performs data collection; and transmitting, to the second network device, a handover response comprising a radio resource control (RRC) configuration for a handover procedure. In this way, the data collection may not be interrupted when the the user equipment moving across the at least one network device.

[0052] Some implementations of the method and devices described herein may further include receiving, from the third network device, a first request associated with the data collection of the user equipment.

[0053] Some implementations of the method and devices described herein may further include receiving, from the user equipment, the beam measurements after the user equipment is handed over from the second network device to the third network device; and transmitting, to the second network device, the beam measurements.

[0054] Some implementations of the method and devices described herein may further include transmitting, to the second network device, a second request associated with data collection of the user equipment.

[0055] In some implementations of the method and devices described herein, the first request may comprise one of the following: an indication requesting the third network

device to provide beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device; identities (IDs) of the beam measurements; a duration for the user equipment to perform the beam measurements; a duration for the user equipment to log the beam measurements; a duration for the user equipment to transmit the beam measurements; a period for performing the beam measurements; a period for logging the beam measurements; a period for transmitting the beam measurements; second information associated with at least one beam requested by the second network device to be measured; or a type of the beam measurements requested by the second network device.

[0056] In some implementations of the method and devices described herein, the type may comprise one of the following: indexes of a first number of beams with stronger reference signal received powers (RSRPs) among multiple beams of the third network device; indexes of one or more beams with one or more RSRPs above a first threshold; RSRPs of the one or more beams; RSRPs of available beams for the beam measurements; or a RSRP of a beam indicated by the second network device.

[0057] In some implementations of the method and devices described herein, the first information comprises one of the following: identities (IDs) of the beam measurements; an ID of a target cell to which the user equipment is to be handed over; or third information of a beam prediction requested by the second network device.

[0058] In some implementations of the method and devices described herein, the third information of a beam prediction may comprise one of the following: an index associated with a beam predicted to have a strongest RSRP among multiple beams of the third network device; a list of at least one beam predicted to have at least one RSRP above a second threshold; at least one value representing likelihood associated with at least one predicted beam; at least one predicted beam measurement associated with at least one predicted beam; or a predicted value of stay time of the at least one predicted beam.

[0059] In some implementations of the method and devices described herein, the handover response may further comprise one of the following: second information associated with at least one beam to be measured in the event that the first request does not include the second information; or a type of the beam measurements in the event that the first request does not include the type.

[0060] In some implementations of the method and devices described herein, the RRC configuration may comprise one of the following: a first configuration for the user equipment to perform a random access to a target cell with a predicted beam having a strongest RSRP among multiple beams of the third network device; a second configuration for the user equipment to perform the beam measurement based on the handover request and a first request; a third configuration for the user equipment to log the beam measurement based on the handover request and a first request; or a fourth configuration for the user equipment to transmit the beam measurement based on the handover request and a first request.

[0061] In some implementations of the method and devices described herein, the second request may comprise one of the following: an indication requesting the second network device to provide historical beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device; a duration, wherein the second network device is requested to provide historical beam measurements within the duration before the user equipment is handed over from the second network device to the third network device; a type of the historical beam measurements requested by the third network device; an ID of a target cell to which the user equipment is to be handed over; or an ID of a source cell from which the user equipment is to be handed over.

[0062] In some implementations of the method and devices described herein, the historical beam measurements may be transmitted to the third network device via the handover request; or the historical beam measurements may be transmitted to the third network device after the handover finishes.

[0063] In some implementations of the method and devices described herein, the first information may further comprise one of the following: time stamps of the historical beam measurements; or values of stay time of one or more beams of the historical beam measurements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0064] FIG. 1 illustrates an example of a wireless communications system that supports data collection in accordance with aspects of the present disclosure.

[0065] FIG. 2A illustrates an example signaling chart illustrating an example process in accordance with aspects of the present disclosure.

[0066] FIG. 2B illustrates another example signaling chart illustrating an example process in accordance with aspects of the present disclosure.

[0067] FIG. 3 illustrates an example process of sending collected training data in accordance with aspects of the present disclosure.

[0068] FIG. 4 illustrates an example process in accordance with aspects of the present disclosure.

[0069] FIG. 5 illustrates another example process in accordance with aspects of the present disclosure.

[0070] FIG. 6 illustrates yet another example process in accordance with aspects of the present disclosure.

[0071] FIG. 7 illustrates yet another example process in accordance with aspects of the present disclosure.

[0072] FIG. 8 illustrates yet another example process in accordance with aspects of the present disclosure.

[0073] FIG. 9 illustrates an example of a device that support data collection in accordance with aspects of the present disclosure.

[0074] FIG. 10 illustrates an example of a processor that support data collection in accordance with aspects of the present disclosure.

[0075] FIG. 11 illustrates a flowchart of a method that supports data collection in accordance with aspects of the present disclosure.

[0076] FIG. 12 illustrates a flowchart of a method that supports data collection in accordance with aspects of the present disclosure.

[0077] FIG. 13 illustrates a flowchart of a method that supports data collection in accordance with aspects of the present disclosure.

[0078] FIG. 14 illustrates a flowchart of a method that supports data collection in accordance with aspects of the present disclosure.

[0079] Throughout the drawings, the same or similar reference numerals represent the same or similar elements.

DETAILED DESCRIPTION

[0080] Principles of the present disclosure will now be described with reference to some embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein may be implemented in various manners other than the ones described below.

[0081] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0082] References in the present disclosure to “one embodiment,” “an example embodiment,” “an embodiment,” “some embodiments,” and the like indicate that the embodiment(s) described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases do not necessarily refer to the same embodiment(s). Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0083] It shall be understood that although the terms “first” and “second” or the like may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another element. For example, a first element could also be termed as a second element, and similarly, a second element could also be termed as a first element, without departing from the scope of embodiments. As used herein, the term “and/or” includes any and all combinations of one or more of the listed terms.

[0084] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a,” “an” and “the” are intended to include the plural forms as

well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises”, “comprising”, “has”, “having”, “includes” and/or “including”, when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

[0085] As used herein, the term “communication network” refers to a network following any suitable communication standards, such as, 5G new radio (NR), Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), Narrow Band Internet of Things (NB-IoT), and so on. Further, the communications between a user equipment and a network device in the communication network may be performed according to any suitable generation communication protocols, including but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G) communication protocols, and/or any other protocols either currently known or to be developed in the future. Embodiments of the present disclosure may be applied in various communication systems. Given the rapid development in communications, there will also be future type communication technologies and systems in which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned systems.

[0086] As used herein, the term “network device” generally refers to a node in a communication network via which a user equipment can access the communication network and receive services therefrom. The network device may refer to a base station (BS) or an access point (AP), for example, a node B (NodeB or NB), a radio access network (RAN) node, an evolved NodeB (eNodeB or eNB), a NR NB (also referred to as a gNB), a Remote Radio Unit (RRU), a radio header (RH), an infrastructure device for a V2X (vehicle-to-everything) communication, a transmission and reception point (TRP), a reception point (RP), a remote radio head (RRH), a relay, an integrated access and backhaul (IAB) node, a low power node such as a femto BS, a pico BS, and so forth, depending on the applied terminology and technology. The network device may further refer to a network function (NF) in the core network, for example, a SMF, an AMF, a PCF, a UPF or devices with same function in future network architectures, and so forth.

[0087] As used herein, the term “user equipment (UE)” generally refers to any end device that may be capable of wireless communications. By way of example rather than a limitation, a user equipment may also be referred to as a communication device, a terminal device, an end user device, a subscriber station (SS), an unmanned aerial vehicle (UAV), a portable subscriber station, a mobile station (MS), or an access terminal (AT). The user equipment may include, but is not limited to, a mobile phone, a cellular phone, a smart phone, a voice over IP (VoIP) phone, a wireless local loop phone, a tablet, a wearable user equipment, a personal digital assistant (PDA), a portable computer, a desktop computer, an image capture user equipment such as a digital camera, a gaming user equipment, a music storage and playback appliance, a vehicle-mounted wireless user equipment, a wireless endpoint, a mobile station, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), a USB dongle, a smart device, wireless customer-premises equipment (CPE), an Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device (for example, a remote surgery device), an industrial device (for example, a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless networks, and the like. In the following description, the terms: “user equipment,” “communication device,” “terminal,” “user equipment” and “UE,” may be used interchangeably.

[0088] FIG. 1 illustrates an example of a wireless communications system 100 that supports data collection in accordance with aspects of the present disclosure. The wireless communications system 100 may include one or more network entities 102 (also referred to as network equipment (NE)), one or more UEs 104, a core network 106, and a packet data network 108. 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 5G network, such as an NR 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. 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.

[0089] The one or more network entities 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the network entities 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a radio access network (RAN), a base transceiver station, an access point, a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. A network entity 102 and a UE 104 may communicate via a communication link 110, which may be a wireless or wired connection. For example, a network entity 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

[0090] A network entity 102 may provide a geographic coverage area 112 for which the network entity 102 may support services (e.g., voice, video, packet data, messaging, broadcast, etc.) for one or more UEs 104 within the geographic coverage area 112. For example, a network entity 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, a network entity 102 may be moveable, for example, a satellite associated with a non-terrestrial network. 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 112 may be associated with different network entities 102. Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0091] The one or more UEs 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 mobile device, a wireless device, a remote device, a remote unit, a handheld device, or a subscriber 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. In some implementations, a UE 104 may be stationary in the wireless communications system 100. In some other implementations, a UE 104 may be mobile in the wireless communications system 100.

[0092] The one or more UEs 104 may be devices in different forms or having different capabilities. Some examples of UEs 104 are illustrated in FIG. 1. A UE 104 may be capable of communicating with various types of devices, such as the network entities 102, other UEs 104, or network equipment (e.g., the core network 106, the packet data network 108, a relay device, an integrated access and backhaul (IAB) node, or another network equipment), as shown in FIG. 1. Additionally, or alternatively, a UE 104 may support communication with other network entities 102 or UEs 104, which may act as relays in the wireless communications system 100.

[0093] A UE 104 may also be able to support wireless communication directly with other UEs 104 over a communication link 114. 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.

[0094] A network entity 102 may support communications with the core network 106, or with another network entity 102, or both. For example, a network entity 102 may interface with the core network 106 through one or more backhaul links 116 (e.g., via an S1, N2, N2, or another network interface). The network entities 102 may communicate with each other over the backhaul links 116 (e.g., via an X2, Xn, or another network interface). In some implementations, the network entities 102 may communicate with each other directly (e.g., between the network entities 102). In some other implementations, the network entities 102 may communicate with each other or indirectly (e.g., via the core network 106). In some implementations, one or more network entities 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).

[0095] In some implementations, a network entity 102 may be configured in a disaggregated architecture, which may be configured to utilize a protocol stack physically or logically distributed among two or more network entities 102, such as an integrated access backhaul (IAB) network, an open RAN (O-RAN) (e.g., a network configuration sponsored by the O-RAN Alliance), or a virtualized RAN (vRAN) (e.g., a cloud RAN (C-RAN)). For example, a network entity 102 may include one or more of a central unit (CU), a distributed unit (DU), a radio unit (RU), a RAN Intelligent Controller (RIC) (e.g., a Near-Real Time RIC (Near-RT RIC), a Non-Real Time RIC (Non-RT RIC)), a Service Management and Orchestration (SMO) system, or any combination thereof.

[0096] An RU may also be referred to as a radio head, a smart radio head, a remote radio head (RRH), a remote radio unit (RRU), or a transmission reception point (TRP). One or more components of the network entities 102 in a disaggregated RAN architecture may be co-located, or one or more components of the network entities 102 may be located in distributed locations (e.g., separate physical locations). In some implementations, one or more network entities 102 of a disaggregated RAN architecture may be implemented as virtual units (e.g., a virtual CU (VCU), a virtual DU (VDU), a virtual RU (VRU)).

[0097] Split of functionality between a CU, a DU, and an RU may be flexible and may support different functionalities depending upon which functions (e.g., network layer functions, protocol layer functions, baseband functions, radio frequency functions, and any combinations thereof) are performed at a CU, a DU, or an RU. For example, a functional split of a protocol stack may be employed between a CU and a DU such that the CU may support one or more layers of the protocol stack and the DU may support one or more different layers of the protocol stack. In some implementations, the CU may host upper protocol layer (e.g., a layer 3 (L3), a layer 2 (L2)) functionality and signaling (e.g., Radio Resource Control (RRC), service data adaptation protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU may be connected to one or more DUs or RUs, and the one or more DUs or RUs may host lower protocol layers, such as a layer 1 (L1) (e.g., physical (PHY) layer) or an L2 (e.g., radio link control (RLC) layer, medium access control (MAC) layer) functionality and signaling, and may each be at least partially controlled by the CU 160.

[0098] Additionally, or alternatively, a functional split of the protocol stack may be employed between a DU and an RU such that the DU may support one or more layers of the protocol stack and the RU may support one or more different layers of the protocol stack. The DU may support one or multiple different cells (e.g., via one or more RUs). In some implementations, a functional split between a CU and a DU, or between a DU and an RU may be within a protocol layer (e.g., some functions for a protocol layer may be performed by one of a CU, a DU, or an RU, while other functions of the protocol layer are performed by a different one of the CU, the DU, or the RU).

[0099] A CU may be functionally split further into CU control plane (CU-CP) and CU user plane (CU-UP) functions. A CU may be connected to one or more DUs via a midhaul communication link (e.g., F1, F1-c, F1-u), and a DU may be connected to one or more RUs via a fronthaul communication link (e.g., open fronthaul (FH) interface). In some implementations, a midhaul communication link or a fronthaul communication link may be implemented in accordance with an interface (e.g., a channel) between layers of a protocol stack supported by respective network entities 102 that are in communication via such communication links.

[0100] The core network 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The core network 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 network entities 102 associated with the core network 106.

[0101] The core network 106 may communicate with the packet data network 108 over one or more backhaul links 116 (e.g., via an S1, N2, N2, or another network interface). The packet data network 108 may include an application server 118. In some implementations, one or more UEs 104 may communicate with the application server 118. A UE 104 may establish a session (e.g., a protocol data unit (PDU) session, or the like)

with the core network 106 via a network entity 102. The core network 106 may route traffic (e.g., control information, data, and the like) between the UE 104 and the application server 118 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 core network 106 (e.g., one or more network functions of the core network 106).

[0102] In the wireless communications system 100, the network entities 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 network entities 102 and the UEs 104 may support different resource structures. For example, the network entities 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the network entities 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 network entities 102 and the UEs 104 may support various frame structures (i.e., multiple frame structures). The network entities 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0103] 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.

[0104] 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.

[0105] 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.

[0106] 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 network entities 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 network entities 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

network entities 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

[0107] 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.

[0108] “Lay1 (L1)” refers to the physical layer, which is mainly used to provide wireless physical channels for transmission of high-level services. In the present disclosure, “L1 measurement” refers to any of the following which may be useful to train an AI/ML model: CSI compression, CSI prediction, beam prediction, positioning.

[0109] In the CSI compression, for UE side type1 training and UE-first type3 training, L1 measurement may refer to ground-truth CSI from NW in scalar quantization and/or codebook-based quantization (e.g., e-type II like), or the assisted information for categorizing the data for the purpose of differentiating characteristics of data due to specific configuration, scenarios, site, etc. For network (NW) first training in training collaboration type 3, L1 measurement may refer to CSI generation model training dataset (e.g., raw channel or the eigenvector as model input and latent space vector before or after quantization as model output), assisted information for categorizing the data for the purpose of differentiating characteristics of data due to specific configuration, scenarios, site, etc. For UE side proxy model training in monitoring, L1 measurement may refer to proxy model training dataset (e.g., the latent space vector after quantization as proxy model input and the target CSI to be recovered as proxy model output) or assisted information for categorizing the data for the purpose of differentiating characteristics of data due to specific configuration, scenarios, site, etc.

[0110] In the CSI prediction, L1 measurement may refer to consecutive CSI (i.e., historical CSI and future CSI), and the type of CSIs includes raw channel matrices, PMIs, or eigen vectors, etc. L1 measurement may further refer to assistance information for model management e.g., site/scenario/dataset related information.

[0111] In the beam prediction, for set B, L1 measurement may refer to L1-RSRP measurement based on Set B or a subset of set B. For the label data, L1 measurement may refer to L1-RSRP measurement based on set A or a subset of set A, partial L1-RSRP measurement based on set A or a subset of set A and beam indicator, or top-k beam indicator. For time related information, L1 measurement may refer to timestamps. For assistance information includes one or more from, L1 measurement may refer to site/scenarios/dataset related information (e.g. dataset ID), gNB-side related assistance information, or UE-side related assistance information.

[0112] In the positioning, for measurement type, L1 measurement may refer to channel impulse response (CIR), power delay profile (PDP), delay profile (DP), downlink positioning reference signal (DL-PRS) RSRP, DL-PRS RSRPP, UL SRS RSRP, UL SRS RSRPP, downlink reference signal time difference (DL-RSTD), UE Rx-Tx time difference, gNB Rx-Tx time difference, uplink relative time of arrival (UL-RTOA), uplink angle of arrival (UL-AoA), downlink angle-of-departure (DL-AoD), SSB RSRP, or CSI-RS RSRP. For label type, L1 measurement may refer to location coordinate, timing estimation, light of sight (LOS), or non-line of sight (NLOS). For assistance information, L1 measurement may refer to time stamp, quality indicator or reference signal (RS) configuration.

[0113] “Layer3 (L3)” refers to the network layer, which includes the RRC sublayer in the access layer and mobility management (MM) and call control (CC) in the non-access layer. In the present disclosure, “L3 measurements” refers to radio resource management (RRM) measurements which filtered by a Layer3 filter and reported to a gNB with a RRC message in the legacy.

[0114] AI/ML technology has been introduced to optimize physical layer operation, which also known as AI for air interface. For use cases of AI based positioning, LMF collects training data from a UE to train an AI model, and the AI model may be a LMF-sided model or a UE-sided model. For use cases of AI based CSI/BM/positioning, gNB collects training data from UE to train an AI model, and the AI model may be a gNB-sided model or a UE-sided model. However, the factor of UE mobility has not yet been considered in the data collection procedure. There are some issues for data collection which need to be addressed.

[0115] In the first issue, for the AI based positioning, depending on the scalability of the AI model, LMF may want to train an AI model that is capable of AI based positioning (e.g., fingerprinting) in a certain area consists of a list of cells. LMF may collect the data from one or multiple UEs, and the data collection in this scenario (ideally) should not be interrupted due to UE mobility as long as UE is within the area. The above mentioned is not supported by the legacy procedure of the data collection.

[0116] In the second issue, assuming the UE is configured by the source gNB to report the training data (e.g., a set of logged L1 measurements) to source gNB periodically, it could happen that when UE is handed over to another gNB. There are still logged L1 measurements in the buffer which should be but has not yet been transmitted to the source gNB. It is not clear that whether or how to transfer the logged L1 measurements to the source gNB.

[0117] In the third issue, in future releases, besides predicted cell level link quality, the source gNB may also predict a best beam after the UE is handed over to a target gNB when a source gNB makes handover decision. In this way, the source gNB will hand over the UE to the cell with better predicted beam quality when two cells have equal (predicted) link quality. The target gNB may also make use of the beam prediction result to configure the UE to perform the random access via the best predicted beam in the handover command. In addition, L1/L2 Triggered Mobility (LTM) decision may be decided, and the UE may be configured to connect to another cell via the predicted best beam in the LTM command media access control (MAC) control element (CE). The above mentioned is not supported by the legacy procedure of the data collection.

[0118] In the fourth issue, in future releases, the target gNB itself may make the best beam prediction and configure the UE to perform the random access via the best predicted beam in the handover command to be sent to UE. However, the above mentioned is not supported by the legacy procedure of the data collection.

[0119] In view of the above discussions, some embodiments of the present disclosure provide a solution for data collection. In one aspect of the solution of the present disclosure, a user equipment receives, from a first network device, at least one measurement configuration determined by at least one network device, and the at least one measurement configuration is associated with data collection for model training; and performs a measurement on a reference signal associated with data collection for model

training based on the at least one measurement configuration. In this way, the user equipment may be configured to ensure continuous training data collection when UE is moving across cells or gNBs. Therefore, the performance of communication is improved. Principles and implementations of embodiments of the present disclosure will be described in detail below with reference to FIGS. 2A-14.

[0120] FIG. 2A illustrates a signaling chart illustrating an example process 200A in accordance with aspects of the present disclosure. The process 200A may involve the user equipment 201 and the first network device 202. The user equipment 201 in Fig. 2A may be an example of UE 104 in FIG. 1. The first network device 202 in Fig. 2A may be an example of network entity 102 or core network 106 in FIG. 1 or. It would be appreciated that although the process 200A is applied to in the communication environment 100 of FIG. 1, this process may be likewise applied to other communication scenarios with similar issues.

[0121] In the process 200A, the first network device 202 transmits 205 at least one measurement configuration 207 determined by at least one network device to the user equipment 201. The at least one measurement configuration is associated with data collection for model training. The first network device may receive the at least one measurement configuration from at least one network device. The at least one network device may be located in an area where the user equipment 201 preforms data collection. It is to be understood that the first network device 202 may be a location management function (LMF) when the model training is used for a AI based positioning model, and the first network device 202 may be a gNB when the model training is used for AI based CSI or beam management.

[0122] Alternatively or additionally, the first network device 202 may transmit a request for at least one measurement configuration to the at least one network device. The at least one measurement configuration is determined by the at least one network device, and the at least one measurement configuration is associated with data collection for model training. Then the first network device 202 may receive the at least one measurement configuration from the at least one network device. In another words, the first network device 202 may collect the measurement configurations for multiple network devices in the area where the user equipment 201 preforms data collection, then

the first network device 202 may transmit the measurement configurations to the user equipment.

[0123] In some embodiments, the at least one measurement configuration may comprise a type of the reference signal, resource information for the reference signal, a type of a ground truth, validity information indicating validity time of a session of the data collection, area information indicating an area where the user equipment performs the data collection, or any combination of two or more of the above-mentioned items.

[0124] For example, the at least one measurement configuration may comprise the type of the user equipment 201 needs to measure, for example, the PRS or SSB or CSI-RS or other DL reference signal within the area. Optionally and additionally, the at least one measurement configuration may comprise the resource information (i.e., to measure at what time and frequency resource) of the PRS or SSB or other DL reference signal within the area. The resource information may be collected from gNBs by LMF within the area in advance and then the resource information may be provided to UE. An example of time and frequency information may include comb size (M, N) in terms of number of symbols M with comb-N pattern, RE offset, slot offset, periodicity, configured transmission bandwidth, which may be associated to set of resources, e.g., DL-PRS resources.

[0125] In an example, the at least one measurement configuration may comprise intermediate ground truth labels related to a combination of radio access technology (RAT)-dependent measurements and UE/PRU location based on UE/PRU location.

[0126] In another example, the at least one measurement configuration may comprise time-based validity information indicating the validity of the data collection session based on a timer/expiry timer/validity time/measurement response time associated with the received DL-PRS positioning assistance data. Data collection performed upon expiration or outside the validity time or not within the measurement response time may be up to the LMF to decide whether to use such data for training or inference. Alternatively, the LMF may explicitly end the data collection session or implicitly end the session based on an inactivity timer or when the UE moves out of the desired area.

[0127] Alternatively or additionally, the area information may comprise: one or more identities (IDs) of one or more cell, one or more IDs of one or more zones associated with geographical coordinates, one or more IDs of one or more areas associated with a list of

cells, one or more tracking area codes (TACs) associated with a list of cells, one or more tracking area identifiers (TAIs) associated with a list of cells, or any combination of two or more of the above-mentioned items.

[0128] For example, the area information can be in any form of the following: one or multiple cells each is represented by a cell ID (e.g., PCI or CGI or ARFCN or combination thereof); one or multiple zones each is represented by a zone ID, and the zone ID is associated with a certain geographical area, calculated from geographical coordinates; one or multiple areas each is represented by an area ID, and the area ID is associated with a list of cells. The association is predefined or preconfigured by the NW; one or multiple location area codes, tracking area codes (TACs), or tracking area identifiers (TAIs), e.g., consisting of several cells grouped together to form tracking area.

[0129] Additionally, the user equipment 201 may transmit first information indicating that a session of the data collection is triggered to a second network device among the at least one network device, and the second network device serves the user equipment. Alternatively or additionally, the first network device 202 may transmit the first information to the second network device. The second network device may be a serving gNB of the user equipment 20 that can provide services to the user equipment 201.

[0130] In addition, if the first information is transmitted by the user equipment 201, the first information is transmitted via a radio resource control (RRC) message. If the first information is transmitted by the first network device 202, the first information is transmitted via a new radio (NR) positioning protocol A (NRPPa) message.

[0131] In some embodiments, the first information may comprise: an indication that the session of the data collection is triggered by the first network device, the session of the data collection is carried out via a long term evolution (LTE) positioning protocol (LPP) message over a control plane (CP), the session of the data collection is carried out via an LPP message over a user plane (UP), area information indicating an area where the user equipment performs the data collection, validity information indicating validity time of the session of the data collection, or any combination of two or more of the above-mentioned items.

[0132] For example, the NRPPa message or RRC message may include: an indication implying the LMF has triggered a data collection session from the user equipment 201; information of if the data collection session is carried out via LPP over CP or over UP;

area information (as explained above) related to an area-based training data collection; time-based criteria of the assistance data used to derive the measurements for data collection; or any combination of two or more of the above-mentioned items.

[0133] Alternatively or additionally, the user equipment 201 may receive a first configuration of a radio bearer for the user equipment from the second network device.

[0134] In some embodiments, the user equipment 201 may receive a second configuration of a radio bearer for the user equipment from the second network device. The second configuration is transmitted by a third network device among the at least one network device via a handover response. The third network device may be a target gNB that the user equipment 20 may handover to.

[0135] Additionally, the second configuration is transmitted in the event that the third network device receives a handover request from the second network device to hand over the user equipment 201 to the third network device. In another words, the second network device may transmit the handover request to the third network device. If the handover request is accepted by the third network device, third network device may transmit the second configuration via a handover request acknowledge message.

[0136] Additionally, the handover request may comprise: an indication that the session of the data collection is triggered by the first network device, the session of the data collection is carried out via an LPP message over a CP, the session of the data collection is carried out via an LPP message over a UP, area information indicating an area where the user equipment performs the data collection, validity information indicating validity time of the session of the data collection, or any combination of two or more of the above-mentioned items.

[0137] In an example, the handover request may comprise: an indication implying LMF has triggered a data collection session from UE; information of if the data collection session is carried out via LPP over CP or over UP; area information (as explained above) related to an area-based training data collection; time-based criteria of the assistance data used to derive the measurements for data collection.

[0138] In some embodiments, if the session of the data collection is carried out via an LPP message over a CP, the first configuration or the second configuration may comprise a signaling radio bearer (SRB) configured for the user equipment 201. In some

embodiments, if the session of the data collection is carried out via an LPP message over a UP, the first configuration or the second configuration may comprise a data radio bearer (DRB) configured for the user equipment.

[0139] In an example, the first network device 202 may be the LMF, the first network device 202 may initiate a training data collection by a generating and sending a LPP message to UE via CP or UP. If the LPP message is transmitted to UE via CP, the LPP message is carried in network attached storage (NAS) via a signaling radio bearer (SRB). If the LPP message is transmitted to UE via UP, the LPP message is carried as regular data via a data radio bearer (DRB). In another example, the first network device 202 may be a gNB, and the first network device 202 may transmit at least one measurement configuration via a RRC message.

[0140] In an example, if the data collection session is carried out via a LPP message over a CP, serving gNB will configure a SRB4 or SBR5 or a new SRB at the user equipment 201 in the case of they are not configured yet. In an example, if the data collection session is carried out via a LPP message over a UP, serving gNB will configure a dedicated DRB with a specific priority lower than other DRBs.

[0141] Continuing with reference to FIG. 2, after receiving 210 the at least one measurement configuration from the first network device 202, the user equipment 201 performs 215 a measurement on a reference signal associated with data collection for model training based on the at least one measurement configuration 207. Then the user equipment 201 transmits 220 collected data 223 of the user equipment 201 to the first network device 202. Correspondingly, the first network device 202 receives 225 the collected data of the user equipment 201.

[0142] In addition, the user equipment 201 may transmit collected data to the first network device. Alternatively or additionally, the collected data is transmitted to the first network device in the event that the user equipment is within the area after handover to the third network device. For example, if an area-based data collection is configured, e.g., the area information is provided, UE the user equipment 201 may first check if the user equipment 201 is still within the area after being handed over to another cell/gNB, and continue collecting and reporting the requested training data if the user equipment 201 is still within the area.

[0143] In some embodiments, the user equipment 201 may transmit a first request for the at least one measurement configuration to the second network device or the first network device 202. Correspondingly, the second network device or the first network device 202 may receive the first request from the user equipment 201. The AI/ML model for positioning may be located on the user equipment side, and the user equipment 201 may collect data without transmit the collected data to a gNB. For example, the user equipment 201 may send an LPP message to LMF or a RRC requesting message to a serving gNB.

[0144] Alternatively or additionally, the user equipment 201 may receive the at least one measurement configuration from the second network device. One or more measurement configurations among the at least one measurement configuration may be transmitted by one or more network devices among the at least one network device other than the second network device in response to receiving the first request from the second network device. In another words, the second network device may transmit the first request to the third network device. If the first request is accepted by the third network device, the third network device may transmit one or more measurement configurations to the second network device. Then the second network device transmit the at least one measurement configuration to the user equipment 201.

[0145] For instance, the LMF or the serving gNB may provide the requested PRS/SSB/other reference signaling configuration to UE accordingly. If area information is provided in the first request for area-based data collection, the LMF or the serving gNB may coordinate with other gNBs within the area to collect the requested PRS/SSB/other reference signaling configuration within the area. In an example, the LMF may request the PRS/SSB/other reference signalling configuration from other gNBs via NRPPa procedures. In an example, the serving gNB may request the PRS/SSB/other reference signalling configuration from other gNBs via Xn AP procedure. The LMF or the serving gNB may also indicate the area information for area-based data collection, such that the other gNB will provide the PRS/SSB/other reference signaling configuration within the area accordingly.

[0146] Additionally, the first request may comprise a type of the reference signal requested by the user equipment, validity information indicating validity time of the session of the data collection, area information indicating an area where the user

equipment performs the data collection, or any combination of two or more of the above-mentioned items.

[0147] For example, due to different AI/ML models may have different requirements of input, e.g., some AI/ML models use SSB, some AI/ML models use PRS. the first request may comprise an indication requesting the LMF or a serving gNB to provide a PRS, SSB or other reference signaling configuration for UE to measure and train an AI model by UE itself (e.g., by reusing the exiting LPP *RequestAssistanceData* message). Such request for NW configures and provides the configuration related to the reference signaling which a specific AIML model requires as input.

[0148] An example of time and frequency information may include comb size (M, N) in terms of number of symbols M with comb-N pattern, RE offset, slot offset, periodicity, configured transmission bandwidth, which may be associated to set of resources, e.g., DL-PRS resources. The measurement result of the PRS, SSB, CSI-RS, or other reference signaling will be used as training data for AI model by UE itself, and is not expected to be reported to LMF or any gNB. The implementations of area information and validity information may be the same as above.

[0149] In some embodiments, the user equipment 201 may receive a third configuration from the second network device. The third configuration may be used for transmitting the collected data for model training associated with artificial intelligence/machine learning (AI/ML) based positioning or channel state information compression, channel state information prediction, or beam prediction.

[0150] In an example, the user equipment 201 may be configured by the serving gNB to perform training data collection and report for AI/ML model training for AI based CSI/BM. Upon handover and UE being detached from the serving gNB, there could be logged training data buffered in the UE which has not been sent to the serving gNB yet.

[0151] FIG. 3 illustrates an example process 300 of sending collected training data in accordance with aspects of the present disclosure. As illustrated in the FIG. 3, the user equipment 201 may be configured with a periodicity of sending collected training data to gNB. Between two reports, user equipment 201 may be configured to log multiple instances of L1 measurements or L3 measurements. It could happen that the user equipment 201 has few instances logged and handover is triggered before the user equipment 201 reporting them to the serving gNB. In this case, due to those instances

could be valuable samples measured at the cell edge, it could be beneficial for the serving gNB to still get the logged but not yet reported measurement instances after handover.

[0152] The second network device (i.e., the serving gNB) may configure the user equipment 201 to perform L1/L3 measurements logging and report the logged measurement instances to the serving gNB via RRC signaling, then the serving gNB may generate and send a *RRCReconfiguration* message to the user equipment 201.

[0153] Additionally, the third configuration may comprise a period for transmitting the collected data, a period for logging the measurement, an event that trigger transmitting the collected data, an event that trigger logging the measurement, an indication that the user equipment is not to discard the collected data that has not been transmitted, trace information comprising a trace reference or a trace recording session reference, or any combination of two or more of the above-mentioned items.

[0154] In some embodiments, the handover request may further comprise an indication that the user equipment is configured not to discard the collected data that has not been transmitted, the trace information, or any combination of two or more of the above-mentioned items.

[0155] For example, the *RRCReconfiguration* message may include: periodicity/event for reporting, periodicity/event for measurement logging, an indication implying that the user equipment should not discard any logged measurements in the buffer that has not yet been transmitted; the trace information, e.g., trace reference or trace recording session reference in the event that the training data collected from the user equipment will be eventually sent to operations administration and maintenance (OAM), or any combination of two or more of the above-mentioned items.

[0156] Alternatively or additionally, the user equipment 201 may receive a second request for the collected data that has not been transmitted after handover to the third network device. The second request may be transmitted from the third network device.

[0157] In an example, after the user equipment 201 is handed over and connected to the other gNB (i.e., the third network device), the other gNB may trigger a UE information procedure to retrieve any possible logged L1/L3 measurements at the UE which has not yet been transmitted. The other gNB may generate and transmit a *UEInformationRequest* message to UE, which includes an indication requesting any logged L1/L3 measurement

results that UE has not yet transmitted. It is to be understood that the other gNB may be the same as the serving gNB, then the handover between the second network device and the third network device may be intra-gNB handover. The other gNB may be different from the serving gNB, then the handover of the user equipment 201 may be inter-gNB handover.

[0158] Additionally, the user equipment 201 may transmit at least one of the collected data that has not been transmitted or the trace information associated with the collected data to the third network device. For example, if any logged L1/L3 measurements available at UE, UE will generate the respond a *UEInformationResponse* message to the other gNB. The *UEInformationResponse* message may include the logged L1/L3 measurements that has not transmitted yet. If configured in the third configuration, *UEInformationResponse* message may further include the associated trace information, e.g., trace reference or trace recording session reference.

[0159] In addition, the collected data that has not been transmitted may be further transmit from the third network device to the second network device. For example, the other gNB may transmit the received logged L1/L3 measurements to the (old) serving gNB via a XnAP message, and the other gNB may further transmit the received logged L1/L3 measurements to the OAM with associated trace information.

[0160] If the second request is not received within a time period, the user equipment 201 may discard the collected data that has not been transmitted. Additionally, the time period may comprise: a preconfigured time period after the collected data is generated, a period of an inactivity timer, a period of a timer configured by the second network device, or any combination of two or more of the above-mentioned items.

[0161] For instance, the time period can be a defined time period (e.g., 48 hours) after the collected data has been generated, a defined inactivity timer for a period of time, or a timer configured by the serving gNB, e.g., expiration timer.

[0162] FIG. 2B illustrates a signaling chart illustrating an example process 200B in accordance with aspects of the present disclosure. The process 200B may involve the second network device 203 and the third network device 204. The second network device 203 in Fig. 2B may be an example of network entity 102 in FIG. 1. The third network device 204 in Fig. 2B may be an example of network entity 102 in FIG. 1. It would be appreciated that although the process 200B is applied to in the communication

environment 100 of FIG. 1, this process may be likewise applied to other communication scenarios with similar issues.

[0163] In the process 200B, the second network device 203 transmits 230 a handover request 237 to the third network device 204. The handover request includes first information associated data collection for beam prediction, wherein the second network device and the third network device are located in an area where a user equipment performs data collection.

[0164] The second network device 203 may be a source gNB that provides services to the user equipment, and the third network device 204 may be a target gNB to which the user equipment may switch. Upon deciding to handover the user equipment to the target gNB, the source gNB may send a HANDOVER REQUEST message to the target gNB.

[0165] In some embodiments, the second network device 203 may transmit a first request associated with the data collection of the user equipment to the third network device 204. The AI/ML model for best beam prediction may be located on the second network device side, and the second network device 203 may collect data from the third network device 204. Before the handover of the user equipment, the source gNB may trigger a data collection reporting initiation procedure and send a DATA COLLECTION REQUEST message to the target gNB.

[0166] Additionally, the first request may comprise: an indication requesting the third network device to provide beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device, IDs of the beam measurements, a duration for the user equipment to perform the beam measurements, a duration for the user equipment to log the beam measurements, a duration for the user equipment to transmit the beam measurements, a period for performing the beam measurements, a period for logging the beam measurements, a period for transmitting the beam measurements, second information associated with at least one beam requested by the second network device to be measured, a type of the beam measurements requested by the second network device, or any combination of two or more of the above-mentioned items. On the other side of the communication, the third network device 204 may receive the first request from the third network device.

[0167] Additionally, the type may comprise: indexes of a first number of beams with stronger reference signal received powers (RSRPs) among multiple beams of the third network device, indexes of one or more beams with one or more RSRPs above a first threshold of the second network device, or a combination of the above-mentioned items.

[0168] In an example, the DATA COLLECTION REQUEST may include: an indication requesting the target gNB to provide L1/L3 beam measurements after the handover; time duration, the target gNB should configure the UE to measure/log/report the L1/L3 beam measurements within the time duration; periodicity of the reporting; periodicity of the measurement/log instances; information related to specific beams to measure, e.g., SSB index; information related to the type of measurements, e.g., indexes of top K beams with strongest RSRP among multiple beams, or RSRPs of the top K beams, RSRPs of all available beams, or RSRPs of specific beams; measurement IDs of the L1/L3 beam measurements; or any combination of two or more of the above-mentioned items.

[0169] In some embodiments, the first information may comprise: IDs of the beam measurements, an ID of a target cell to which the user equipment is to be handed over, third information of a beam prediction, or any combination of two or more of the above-mentioned items. For example, the HANDOVER REQUEST message includes: the measurement IDs that contained in the corresponding DATA COLLECTION REQUEST message, a target cell ID, beam prediction information, or any combination of two or more of the above-mentioned items.

[0170] Additionally, the third information of the beam prediction may comprise: an index associated with a beam predicted to have a strongest RSRP among multiple beams of the second network device, a list of a second number of beams with stronger RSRPs among multiple beams of the second network device, a list of at least one beam predicted to have at least one RSRP above a second threshold, at least one value representing likelihood associated with at least one predicted beam, at least one predicted beam measurement associated with at least one predicted beam, a predicted value of stay time of the at least one predicted beam, or any combination of two or more of the above-mentioned items.

[0171] For instance, for the target cell, the beam prediction information be the form of: the predicted best beam (e.g., SSB index), a list of possible predicted best beams (e.g.,

SSB index); a possibility value (e.g., 0-100) representing the likelihood associated with each predicted best beam (described above), the predicted L1/L3 measurements (e.g., RSRP) associated with each predicted best beam, a predicted time of stay value of the user equipment in the predicted best beam, or any combination of two or more of the above-mentioned items.

[0172] Alternatively or additionally, if the first request does not include the second information, the first information may further comprise second information associated with at least one beam to be measured, e.g., SSB index. Alternatively, if the first request does not include the type, the first information may further comprise a type of the beam measurements, e.g., indexes of top K beams, or RSRPs of Top K beams, or RSRPs of all available beams, or RSRPs of specific beams.

[0173] In some embodiments, the third network device 204 may transmit a second request associated with data collection of the user equipment to the second network device 203. Correspondingly, the second network device 203 may receive the second request from the third network device 204. The AI/ML model for best beam prediction may be located on the third network device side, the third network device 204 may collect data from the second network device 203. For example, the target gNB may collect training data from source gNB for best beam prediction, e.g., for the serving beam selection at the beginning phase after handover execution. Before the handover, the target gNB triggers a data collection reporting initiation procedure and sends a DATA COLLECTION REQUEST message to the source gNB.

[0174] Additionally, the second request may comprise: an indication requesting the second network device to provide historical beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device, a duration, wherein the second network device is requested to provide historical beam measurements within the duration before the user equipment is handed over from the second network device to the third network device, a type of the historical beam measurements requested by the third network device, an ID of a target cell to which the user equipment is to be handed over, an ID of a source cell from which the user equipment is to be handed over, or any combination of two or more of the above-mentioned items.

[0175] In an example, the DATA COLLECTION REQUEST includes: an indication requesting the source gNB to provide historical L1/L3 beam measurement of the UE when triggering a handover; time duration, source gNB should provide the historical L1/L3 beam measurement of the UE within the time duration before handover; information related to the type of measurements, e.g., serving beam index, indexes of top K beams, or RSRPs of the top K beams, or RSRPs of all available beams, or RSRP of specific beams; a cell A ID, if the user equipment is handed over from source gNB to cell A of target gNB, the cell A of target gNB is the target cell; a cell B ID, if UE is handed over from cell B of source gNB to the target gNB, the cell B is the source cell; or any combination of two or more of the above-mentioned items.

[0176] In addition, the historical beam measurements may be transmitted to the third network device 204 via the handover request. For example, upon deciding to handover a UE to the target gNB, the source gNB sends a HANDOVER REQUEST message to the target gNB. The HANDOVER REQUEST message may include the historical L1/L3 beam measurements as requested. Each historical L1/L3 beam measurement instance may be associated with a time stamp of measurement. For serving beam, time of stay value may also be provided in the HANDOVER REQUEST message.

[0177] Alternatively, the historical beam measurements may be transmitted to the third network device after the handover finishes. For example, the source gNB may send the historical L1/L3 beam measurements to the target gNB after the handover is finished, and the historical L1/L3 beam measurements may be send via a DATA COLLECTION UPDATE message.

[0178] Alternatively or additionally, the first information may further comprise: time stamps of the historical beam measurements, values of stay time of one or more beams of the historical beam measurements, or a combination of the above-mentioned items.

[0179] After receiving 240 the handover request 237 from the second network device 203, the third network device 204 transmits 250 a handover response 257 to the second network device 203. The handover response 247 comprises a radio resource control (RRC) configuration for a handover procedure. Correspondingly, the second network device 203 receives 260 the handover response 247 from the third network device 204. In other words, the target gNB may make use of the predicted best beam to configure the user equipment to random access the target gNB via the predicted best beam.

[0180] In some embodiments, the RRC configuration may comprise: a first configuration for the user equipment to perform a random access to a target cell with a predicted beam having a strongest RSRP among multiple beams of the third network device, a second configuration for the user equipment to perform the beam measurement based on the handover request and a first request, a third configuration for the user equipment to log the beam measurement based on the handover request and a first request, a fourth configuration for the user equipment to transmit the beam measurement based on the handover request and a first request, or any combination of two or more of the above-mentioned items.

[0181] For instance, the target gNB may configure the user equipment to perform random access to the target cell via the predicted best beam. the target gNB may configure the user equipment to perform L1/L3 beam measurement/log/report as requested by the source gNB in the DATA COLLECTION REQUEST or DATA COLLECTION HANDOVER REQUEST message.

[0182] Alternatively or additionally, the second network device 203 may transmit the RRC configuration to the user equipment. After the user equipment is handed over from the second network device to the third network device, the second network device 203 may receive the beam measurements from the third network device 204.

[0183] On the other side of the communication, the third network device 204 may receive the beam measurements after the user equipment is handed over from the second network device 203 to the third network device 204. Alternatively, the third network device 204 may transmit the beam measurements to the second network device 203. For example, the target gNB may further send the L1/L3 beam measurements to the source gNB via a DATA COLLECTION UPDATE message.

[0184] Through the embodiments of the process 200A and the process 200B, the user equipment may be configured to ensure continuous training data collection when UE is moving across cells or gNBs. If the training data report is interrupted due to UE mobility and the user equipment has logged measurements in the buffer which has not yet been transmitted to the serving gNB upon handover, the user equipment may keep the logged measurements (i.e., not discard them) and send it to the other gNB after handover. In addition, the serving gNB may collection training data for best beam prediction from the target gNB. The target gNB may also collect training data for best beam prediction from

the source gNB. It is to be understood that the embodiments of the process 200A and the process 200B may be used separately or combined.

[0185] FIG. 4 illustrates an example process 400 in accordance with aspects of the present disclosure. The process 400 may involve a UE 401, a LMF 402, a serving gNB 403 and other gNB 404. The UE 401 in Fig. 4 may be an example of UE 104 in FIG. 1 or the user equipment 201 in FIG. 2A. The LMF 402 in Fig. 4 may be an example of core network 106 in FIG. 1 or the first network device 202 in FIG. 2A. The serving gNB 403 in Fig. 4 may be an example of the network entity 102 in FIG. 1. The other gNB 404 may be an example of the network entity 102 in FIG. 1. It is understood that the process 400 can be considered as a more specific example of the process 200A in FIG. 2A.

[0186] In the process 400, the training data collection from UE 401 is initiated and configured by LMF 402, the training data is sent from UE 401 to LMF 402. The training data may be used for AIML model training at the LMF side.

[0187] At 410, LMF 402 initiates a training data collection by generating and sending a LPP data collection configuration message to UE 401 via CP or UP. The LPP message may comprise: information related to the training data requested by the LMF 402, area information, area information that UE 401 collects the requested training data when UE 401 is within the area also known as area-based data collection, or a combination of the above-mentioned items. Correspondingly, UE 401 receives the LPP data collection configuration message from LMF 402.

[0188] The information indicating a data collection is triggered is generated and transmitted by one of LMF 402 or UE 401. At 415, LMF 402 generates the information and transmits the information to serving gNB 403. At 420, UE 401 generates the information and transmits the information to serving gNB 403. The information is carried by a RRC message in the case of the information is transmitted by UE 401, and the information is carried by a NRPPa message in the case of the information is transmitted by LMF 402.

[0189] At 425, after knowing a training data collection session has been initiated at the UE, serving gNB configures a dedicated radio bearer for the training data collection. The dedicated radio bearer is indicated to UE 401 by a RRC configuration. The dedicated radio bearer could be configured with a specific priority lower than SRB1 or regular DRBs.

[0190] At 430, UE 401 starts collecting and reporting the requested training data via LPP as configured by LMF. UE 401 transmits a LPP data collection report to LMF 402, the LPP data collection report includes ground truth and relevant L1 measurements. Correspondingly, LMF 402 receives the LPP data collection report from UE 401.

[0191] At 435, for inter-gNB handover, serving gNB 403 wants to handover UE 401 to other gNB 404 and sends a HANDOVER REQUEST message via Xn interface to the other gNB 404.

[0192] At 440, after receiving the HANDOVER REQUEST message from serving gNB 403, other gNB 404 responds with HANDOVER REQUEST ACKNOWLEDGE message to the serving gNB 403. The HANDOVER REQUEST ACKNOWLEDGE message includes a RRC configuration which UE 401 applies when accessing the other gNB 404, and the RRC configuration may include configuration of a dedicated radio bearer for the training data collection. The dedicated radio bearer could be configured with a specific priority lower than SRB1 or regular DRBs.

[0193] At 445, UE 401 receives a RRC configuration including dedicated radio bearer configuration from serving gNB 403.

[0194] At 450, after handover from serving gNB 403 and access to the other gNB 404, UE 401 continues to collect the requested training data and report to LMF 402 via LPP as previously configured by LMF 402 without re-initiating a new LPP session.

[0195] In general, for LMF-side model training for AI based positioning, in order to perform training data collection for AI based positioning considering mobility, UE is configured to ensure continuous training data collection when UE is moving across gNBs or cells.

[0196] FIG. 5 illustrates another example process 500 in accordance with aspects of the present disclosure. The process 500 may involve a UE 501, a LMF/serving gNB 502 and other gNB 503. The UE 501 in Fig. 5 may be an example of UE 104 in FIG. 1 or the user equipment 201 in FIG. 2A. The other gNB 503 may be an example of the network entity 102 in FIG. 1. It is understood that the process 500 can be considered as a more specific example of the process 200A in FIG. 2A.

[0197] At 510, UE 501 sends an LPP/RRC message to LMF/serving gNB 502. The LPP/RRC message requests a reference signaling configuration for data collection. The

LPP/RRC message may include an indication requesting PRS/SSB, other reference signaling configuration area information for area-based data collection, or a combination of the above-mentioned items.

[0198] At 520, LMF/serving gNB 502 provides the requested PRS/SSB/other reference signaling configuration to UE 501 accordingly. If area information at 510 is provided for area-based data collection, LMF/ serving gNB 502 may coordinate with other gNBs 503 within the area to collect the requested PRS/SSB/other reference signaling configuration within the area. At 515, after receiving the LPP/RRC message, LMF/serving gNB 502 may forward the information comprised in the LPP/RRC message to other gNB 503. LMF may request the PRS/SSB/other reference signalling configuration from other gNBs 503 via NRPPa message. Serving gNB may request the PRS/SSB/other reference signalling configuration from other gNBs 503 via Xn AP message. LMF/serving gNB 502 may also indicate the area information for area-based data collection, such that the other gNB 503 will provide the PRS/SSB/other reference signaling configuration within the area accordingly.

[0199] Based on the provided configuration from LMF/serving gNB 502, UE 501 starts measuring the PRS/SSB/other reference signaling.

[0200] In general, for UE-side model training for AI based positioning, in order to perform training data collection for AI based positioning considering mobility, the training data collection is conducted by the UE itself with assistance from LMF or serving gNB.

[0201] FIG. 6 illustrates another example process 600 in accordance with aspects of the present disclosure. The process 600 may involve a UE 601, a serving gNB 602 and other gNB 603. The UE 601 in Fig. 6 may be an example of UE 104 in FIG. 1 or the user equipment 201 in FIG. 2A. The serving gNB 603 in Fig. 6 may be an example of the network entity 102 in FIG. 1. The other gNB 603 may be an example of the network entity 102 in FIG. 1.

[0202] In the process 600, assuming UE 601 is configured by serving gNB 602 to perform training data collection and training data collection report for AIML model training for AI based CSI/BM. Upon handover and UE 601 being detached from serving gNB 602, there could be logged training data buffered in the UE 601 which has not been sent to the serving gNB 602 yet.

[0203] At 610, serving gNB 602 transmits a data collection configuration to UE 601, and the data collection configuration comprises an indication of not to discard collected data after handover. Serving gNB 602 generates and sends a *RRCReconfiguration* message (i.e., the data collection configuration) to UE 601 to configure the UE 601 to perform L1/L3 measurements logging and report the logged measurement instances to the serving gNB 602 via RRC signaling. Alternatively, if the training data collected from UE 601 will be eventually sent to OAM, the data collection configuration may also include the trace information, e.g., trace reference or trace recording session reference.

[0204] At 615, for inter-gNB handover, serving gNB 602 transmits a handover request message to other gNB 603, e.g., using a new Xn application protocol (XnAP) information element (IE) in the handover request message. The handover request message comprises an indication implying UE 601 has been configured to collect and report L1/L3 measurements to the serving gNB 602. Then the other gNB 603 could understand UE 601 may have some logged L1/L3 measurements in its buffer which is useful for the source gNB 602. Alternatively, if the training data collected from UE 601 will be eventually sent to OAM, the handover request message may also include the trace information.

[0205] At 620, after receiving the handover request message from serving gNB 602, other gNB 603 transmits a handover request acknowledge to serving gNB 602.

[0206] At 625, UE 601 initiates a random access procedure to handover to other gNB 603.

[0207] At 630, after connecting to other gNB 603, other gNB 603 generates and transmits a UE information request message to UE, which includes an indication requesting any logged L1/L3 measurement results that UE has not yet transmitted. Additionally or alternatively, prior to receiving the UE information request message (i.e., before 630), UE 601 may indicate to other gNB 603 via a signaling that the logged measurements are available on UE 601 side.

[0208] At 635, if any logged L1/L3 measurements available at UE 601, UE 601 generates and transmits a UE information response message to other gNB 603. The UE information response message includes the logged L1/L3 measurements that has not transmitted yet. Alternatively, if the trace information is transmitted at 610, the UE information response message may also include the associated trace information, e.g., trace reference or trace recording session reference.

[0209] At 640, for inter-gNB handover, i.e., other gNB 603 is different from the serving gNB 602, other gNB 603 transmits the received logged L1/L3 measurements to the serving gNB 602 via a XnAP message. Alternatively, other gNB 603 may transmits the received logged L1/L3 measurements to the OAM with the associated trace information.

[0210] Additionally or alternatively, if the logged L1/L3 measurements buffered at UE 601 is not retrieved by other gNB 603 after handover to other gNB 603, UE 601 will discard the logged L1/L3 measurements after some time period.

[0211] In general, in order to solve training data report interruption due to UE mobility, when UE is configured by the serving gNB to measure, log and report certain L1/L3 measurements to serving gNB in RRC connected state, and if UE has logged measurements in the buffer which has not yet been transmitted to the serving gNB upon handover, UE will keep the logged measurements (i.e., not discard them) and send it to the other gNB after handover. The other gNB may further forward the logged measurements from UE to the (old) serving gNB or to OAM.

[0212] FIG. 7 illustrates another example process 700 in accordance with aspects of the present disclosure. The process 700 may involve a UE 701, a source gNB 702 and target gNB 703. The UE 701 in Fig. 7 may be an example of UE 104 in FIG. 1. The source gNB 702 in Fig. 7 may be an example of the network entity 102 in FIG. 1 or the second network device 203 in FIG. 2B. The target gNB 703 may be an example of the network entity 102 in FIG. 1 or the third network device 204 in FIG. 2B. It is understood that the process 700 can be considered as a more specific example of the process 200B in FIG. 2B.

[0213] At 710, source gNB 702 transmits a data collection request message to target gNB 703 to trigger a data collection reporting initiation procedure. The data collection request message comprises an indication requesting the target gNB 703 to provide L1/L3 beam measurements after the handover. The data collection request message may further comprise: at least one measurement ID, i.e., at least one ID of at least one beam measurement, a time duration during which target gNB 703 should configure the UE 701 to measure/log/report the L1/L3 beam measurements, periodicity of the reporting, periodicity of the measurement/log instances, information related to specific beams to measure, e.g., SSB index, information related to the type of measurements, e.g., top K

beam index, or RSRP of Top K beams, or RSRP of all available beams, or RSRP of specific beams, or any combination of two or more of the above-mentioned items.

[0214] At 715, if the data collection request is accepted by the target gNB 703, the target gNB 703 transmits a data collection response message to source gNB 702.

[0215] At 720, upon deciding to handover UE 701 to target gNB 703, source gNB 702 transmits a handover request message to target gNB 703. The handover request message includes at least one measurement ID, a UE ID, a target cell ID, a list of possible predicted best beams with possibility, additional information of beams to be measured after handover, or any combination of two or more of the above-mentioned items.

[0216] Target gNB 703 may make use of the predicted best beam to configure the UE 701 to initiate random access to the target gNB 703 via the best beam. At 725, target gNB 703 transmits a handover request acknowledge message to the source gNB 702. The handover request acknowledge message generated by the target gNB 703 may include the RRC reconfiguration for UE 701 to execute handover, the target gNB 703 may configure the UE 701 to measure specific beams.

[0217] At 730, the source gNB 702 forwards the RRC reconfiguration to the UE 701. At 735, the UE 701 performs random access to the target gNB 703. At 740, after successful handover, UE 701 performs the L1/L3 beam measurement, logs the L1/L3 beam measurement and transmits L1 or L3 message comprising L1/L3 beam measurement result to the target gNB 703 as configured.

[0218] At 745, the target gNB 703 transmits a data collection update message to the source gNB 702. The data collection message may comprise the requested L1/L3 beam measurements after handover. The data collection message may further comprise at least one measurement ID, a UE ID, or a combination of the above-mentioned items.

[0219] In general, in the scenario of a source gNB collects training data for best beam prediction for handover decision, for inter-gNB handover, the source gNB will in advance configure a data collection request associated with a measurement ID requesting the target gNB to provide the requested certain L1/L3 beam measurement of the UE to be handed over after the successful handover. The target gNB may configure the UE to measure the requested L1/L3 beam measurements accordingly after handover and transmit the measurement results back to the source gNB.

[0220] FIG. 8 illustrates another example process 800 in accordance with aspects of the present disclosure. The process 800 may involve a source gNB 801 and target gNB 802. The source gNB 801 in Fig. 8 may be an example of the network entity 102 in FIG. 1 or the second network device 203 in FIG. 2B. The target gNB 802 may be an example of the network entity 102 in FIG. 1 or the third network device 204 in FIG. 2B. It is understood that the process 800 can be considered as a more specific example of the process 200B in FIG. 2B.

[0221] At 810, before handover of a UE, the target gNB 802 triggers a data collection reporting initiation procedure and transmits a data collection request message to the source gNB 801. The data collection request message comprises at least one measurement ID, a request for L1/L3 beam measurement before the handover, or a combination of the above-mentioned items.

[0222] At 815, if data collection request is accepted by the source gNB 801, the source gNB 801 transmits a data collection response message to the target gNB 802.

[0223] At 820, upon deciding to handover a UE to the target gNB 802, the source gNB 801 sends a handover request message to the target gNB 802. The handover request message comprises a UE ID, a target cell ID, historical L1/L3 beam measurement as requested.

[0224] At 825, the target gNB 802 transmits a handover request acknowledge message to the source gNB 801.

[0225] In general, the target gNB could collect training data from source gNB for best beam prediction. The best beam prediction may be used for the serving beam selection at the beginning phase after handover execution.

[0226] FIG. 9 illustrates an example of a device 900 that supports data collection in accordance with aspects of the present disclosure. The device 900 may be an example of the user equipment 201, the first network device 202, the second network device 203 or the third network device 204 as described herein. The device 900 may support wireless communication with one or more network entities 102, UEs 104, or any combination thereof. The device 900 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 902, a memory 904, a transceiver 906, and, optionally, an I/O controller 908. 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).

[0227] The processor 902, the memory 904, the transceiver 906, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. For example, the processor 902, the memory 904, the transceiver 906, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0228] In some implementations, the processor 902, the memory 904, the transceiver 906, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA) or other programmable logic device, a discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure. In some implementations, the processor 902 and the memory 904 coupled with the processor 902 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 902, instructions stored in the memory 904).

[0229] For example, the processor 902 may support wireless communication at the device 900 in accordance with examples as disclosed herein. The processor 902 may be configured to operable to support a means for receiving, from a first network device, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and means for performing a measurement on a reference signal associated with data collection for model training based on the at least one measurement configuration. The processor 902 may be configured to operable to support a means for other implementations of method 1100.

[0230] For example, the processor 902 may support wireless communication at the device 900 in accordance with examples as disclosed herein. The processor 902 may be configured to operable to support a means for receiving, from a first network device, at least one measurement configuration determined by at least one network device, wherein

the at least one measurement configuration is associated with data collection for model training; and means for transmitting, to a user equipment, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and means for receiving, and from the user equipment, collected data of the user equipment. The processor 902 may be configured to operable to support a means for other implementations of method 1200.

[0231] For example, the processor 902 may support wireless communication at the device 900 in accordance with examples as disclosed herein. The processor 902 may be configured to operable to support a means for receiving, from a first network device, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and means for transmitting, to a third network device, a handover request that includes first information associated data collection for beam prediction, wherein the second network device and the third network device are located in an area where a user equipment performs data collection; and means for receiving, from the third network device, a handover response comprising a radio resource control (RRC) configuration for a handover procedure. The processor 902 may be configured to operable to support a means for other implementations of method 1300.

[0232] For example, the processor 902 may support wireless communication at the device 900 in accordance with examples as disclosed herein. The processor 902 may be configured to operable to support a means for receiving, from a first network device, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and means for receiving, from a second network device, a handover request that includes first information associated data collection for beam prediction, wherein the second network device and the third network device are located in an area where a user equipment performs data collection; and means for transmitting, to the second network device, a handover response comprising a radio resource control (RRC) configuration for a handover procedure. The processor 902 may be configured to operable to support a means for other implementations of method 1300.

[0233] The processor 902 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some implementations, the processor 902 may be configured to operate a memory array using a memory controller. In some other implementations, a memory controller may be integrated into the processor 902. The processor 902 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 904) to cause the device 900 to perform various functions of the present disclosure.

[0234] The memory 904 may include random access memory (RAM) and read-only memory (ROM). The memory 904 may store computer-readable, computer-executable code including instructions that, when executed by the processor 902 cause the device 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. In some implementations, the code may not be directly executable by the processor 902 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 904 may include, among other things, a basic I/O system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0235] The I/O controller 908 may manage input and output signals for the device 900. The I/O controller 908 may also manage peripherals not integrated into the device 900. In some implementations, the I/O controller 908 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 908 may utilize an operating system such as iOS®, ANDROID®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In some implementations, the I/O controller 908 may be implemented as part of a processor, such as the processor 906. In some implementations, a user may interact with the device 900 via the I/O controller 908 or via hardware components controlled by the I/O controller 908.

[0236] In some implementations, the device 900 may include a single antenna 910. However, in some other implementations, the device 900 may have more than one antenna 910 (i.e., multiple antennas), including multiple antenna panels or antenna arrays,

which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver 906 may communicate bi-directionally, via the one or more antennas 910, wired, or wireless links as described herein. For example, the transceiver 906 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 906 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 910 for transmission, and to demodulate packets received from the one or more antennas 910. The transceiver 906 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0237] A transmit chain may be configured to generate and transmit signals (e.g., control information, data, packets). The transmit chain 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 transmit chain 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 transmit chain may also include one or more antennas 910 for transmitting the amplified signal into the air or wireless medium.

[0238] A receive chain may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receive chain may include one or more antennas 910 for receive the signal over the air or wireless medium. The receive chain may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receive chain 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 receive chain may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0239] FIG. 10 illustrates an example of a processor 1000 that supports data collection in accordance with aspects of the present disclosure. The processor 1000 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 1000 may include a controller 1002

configured to perform various operations in accordance with examples as described herein. The processor 1000 may optionally include at least one memory 1004. Additionally, or alternatively, the processor 1000 may optionally include one or more arithmetic-logic units (ALUs) 1000. 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).

[0240] The processor 1000 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 1000) 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).

[0241] The controller 1002 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 1000 to cause the processor 1000 to support various operations in accordance with examples as described herein. For example, the controller 1002 may operate as a control unit of the processor 1000, generating control signals that manage the operation of various components of the processor 1000. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0242] The controller 1002 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 1004 and determine subsequent instruction(s) to be executed to cause the processor 1000 to support various operations in accordance with examples as described herein. The controller 1002 may be configured to track memory address of instructions associated with the memory 1004. The controller 1002 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 1002 may be configured to interpret the

instruction and determine control signals to be output to other components of the processor 1000 to cause the processor 1000 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 1002 may be configured to manage flow of data within the processor 1000. The controller 1002 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 1000.

[0243] The memory 1004 may include one or more caches (e.g., memory local to or included in the processor 1000 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 1004 may reside within or on a processor chipset (e.g., local to the processor 1000). In some other implementations, the memory 1004 may reside external to the processor chipset (e.g., remote to the processor 1000).

[0244] The memory 1004 may store computer-readable, computer-executable code including instructions that, when executed by the processor 1000, cause the processor 1000 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 1002 and/or the processor 1000 may be configured to execute computer-readable instructions stored in the memory 1004 to cause the processor 1000 to perform various functions (e.g., functions or tasks supporting transmit power prioritization). For example, the processor 1000 and/or the controller 1002 may be coupled with or to the memory 1004, the processor 1000, the controller 1002, and the memory 1004 may be configured to perform various functions described herein. In some examples, the processor 1000 may include multiple processors and the memory 1004 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.

[0245] The one or more ALUs 1000 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 1000 may reside within or on a processor chipset (e.g., the processor 1000). In some other implementations, the one or more ALUs 1000 may reside external to the processor chipset (e.g., the processor 1000). One or more ALUs 1000 may perform one or more computations such as addition, subtraction, multiplication, and division on data.

For example, one or more ALUs 1000 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 1000 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 1000 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 1000 to handle conditional operations, comparisons, and bitwise operations.

[0246] The processor 1000 may support wireless communication in accordance with examples as disclosed herein. The processor 1002 may be configured to or operable to support a means for receiving, from a first network device, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and means for performing a measurement on a reference signal associated with data collection for model training based on the at least one measurement configuration.

[0247] FIG. 11 illustrates a flowchart of a method 1100 that supports data collection in accordance with aspects of the present disclosure. The operations of the method 1100 may be implemented by a device or its components as described herein. For example, the operations of the method 1100 may be performed by a UE 104 as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0248] At 1105, the method includes receive, from a first network device, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training. The operations of 1105 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1105 may be performed by a device as described with reference to FIG. 1.

[0249] At 1110, the method includes performing a measurement on a reference signal associated with data collection for model training based on the at least one measurement configuration. The operations of 1110 may be performed in accordance with examples as

described herein. In some implementations, aspects of the operations of 1110 may be performed by a device as described with reference to FIG. 1.

[0250] In some embodiment, the at least one measurement configuration may comprise one of the following: a type of the reference signal; resource information for the reference signal; a type of a ground truth; validity information indicating validity time of a session of the data collection; or area information indicating an area where the user equipment performs the data collection.

[0251] In some embodiment, the area information may comprise one of the following: one or more identities (IDs) of one or more cell; one or more IDs of one or more zones associated with geographical coordinates; one or more IDs of one or more areas associated with a list of cells; one or more tracking area codes (TACs) associated with a list of cells; or one or more tracking area identifiers (TAIs) associated with a list of cells.

[0252] In some embodiment, the method may further include transmitting, via the transceiver and to a second network device among the at least one network device, first information indicating that a session of the data collection is triggered, wherein the second network device serves the user equipment.

[0253] In some embodiment, the first information may comprise one of the following: an indication that the session of the data collection is triggered by the first network device; the session of the data collection is carried out via a long term evolution (LTE) positioning protocol (LPP) message over a control plane (CP); the session of the data collection is carried out via an LPP message over a user plane (UP); area information indicating an area where the user equipment performs the data collection; or validity information indicating validity time of the session of the data collection.

[0254] In some embodiment, the first information may be transmitted via a radio resource control (RRC) message.

[0255] In some embodiment, the method may further include receiving, from the second network device, a first configuration of a radio bearer for the user equipment.

[0256] In some embodiment, the method may further include transmitting, to one of the second network device or the first network device, a first request for the at least one measurement configuration.

[0257] In some embodiment, the method may further include receiving, from the second network device, the at least one measurement configuration, wherein one or more measurement configurations among the at least one measurement configuration are transmitted by one or more network devices among the at least one network device other than the second network device in response to receiving the first request from the second network device.

[0258] In some embodiment, the first request may comprise one of the following: a type of the reference signal requested by the user equipment; validity information indicating validity time of the session of the data collection; or area information indicating an area where the user equipment performs the data collection.

[0259] In some embodiment, the method may further include receiving, from the second network device, a second configuration of a radio bearer for the user equipment, wherein the second configuration is transmitted, via a handover response, by a third network device among the at least one network device.

[0260] In some embodiment, the second configuration may be transmitted in the event that the third network device receives, from the second network device, a handover request to hand over the user equipment to the third network device.

[0261] In some embodiment, the handover request may comprise one of the following: an indication that the session of the data collection is triggered by the first network device; the session of the data collection is carried out via an LPP message over a CP; the session of the data collection is carried out via an LPP message over a UP; area information indicating an area where the user equipment performs the data collection; or validity information indicating validity time of the session of the data collection.

[0262] In some embodiment, one of the first configuration or the second configuration may comprise one of the following: a signaling radio bearer (SRB) configured for the user equipment in the event that the session of the data collection is carried out via an LPP message over a CP; or a data radio bearer (DRB) configured for the user equipment in the event that the session of the data collection is carried out via an LPP message over a UP.

[0263] In some embodiment, the method may further include transmitting, via the transceiver, collected data to the first network device.

[0264] In some embodiment, the collected data may be transmitted to the first network device in the event that the user equipment is within the area after handover to the third network device.

[0265] In some embodiment, the method may further include receiving, from the second network device, a third configuration for transmitting the collected data for model training associated with artificial intelligence/machine learning (AI/ML) based positioning or channel state information compression, channel state information prediction, or beam prediction.

[0266] In some embodiment, the third configuration comprises one of the following: a period for transmitting the collected data; a period for logging the measurement; an event that trigger transmitting the collected data; an event that trigger logging the measurement; an indication that the user equipment is not to discard the collected data that has not been transmitted; or trace information comprising a trace reference or a trace recording session reference.

[0267] In some embodiment, the handover request may further comprise one of the following: an indication that the user equipment is configured not to discard the collected data that has not been transmitted; or the trace information.

[0268] In some embodiment, the method may further include receiving, from the third network device, a second request for the collected data that has not been transmitted after handover to the third network device.

[0269] In some embodiment, the method may further include transmitting, to the third network device, one of the collected data that has not been transmitted or the trace information associated with the collected data.

[0270] In some embodiment, the collected data that has not been transmitted may be further transmitted from the third network device to the second network device.

[0271] In some embodiment, the method may further include discarding the collected data that has not been transmitted in the event that the second request is not received within a time period.

[0272] In some embodiment, the time period may comprise one of the following: a preconfigured time period after the collected data is generated; a period of an inactivity timer; or a period of a timer configured by the second network device.

[0273] FIG. 12 illustrates a flowchart of a method 1200 that supports data collection in accordance with aspects of the present disclosure. The operations of the method 1200 may be implemented by a device or its components as described herein. For example, the operations of the method 1200 may be performed by a first network entity 102 or a core network 106 as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0274] At 1205, the method includes transmitting, via the transceiver and to a user equipment, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training. The operations of 1205 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 905 may be performed by a device as described with reference to FIG. 1.

[0275] At 1210, the method includes receiving, via the transceiver and from the user equipment, collected data of the user equipment. The operations of 1210 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1210 may be performed by a device as described with reference to FIG. 1.

[0276] In some embodiment, the at least one measurement configuration may comprise one of the following: a type of a reference signal associated with positioning; resource information for the reference signal; a type of a ground truth; validity information indicating validity time of a session of the data collection; or area information indicating an area where the user equipment performs the data collection.

[0277] In some embodiment, the area information may comprise one of the following: one or more identities (IDs) of one or more cell; one or more IDs of one or more zones associated with geographical coordinates; one or more IDs of one or more areas associated with a list of cells; one or more tracking area codes (TACs) associated with a list of cells; or one or more tracking area identifiers (TAIs) associated with a list of cells.

[0278] In some embodiment, the method may further include transmitting, via the transceiver and to a second network device among the at least one network device, first information indicating that a session of the data collection is triggered, wherein the second network device serves the user equipment.

[0279] In some embodiment, the first information may comprise one of the following: an indication that the session of the data collection is triggered by the first network device; the session of the data collection is carried out via a long term evolution (LTE) positioning protocol (LPP) message over a control plane (CP); the session of the data collection is carried out via an LPP message over a user plane (UP); area information indicating an area where the user equipment performs the data collection; or validity information indicating validity time of the session of the data collection.

[0280] In some embodiment, the method may further include transmitting, via the transceiver and to the at least one network device, a first request for at least one measurement configuration determined by the at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and receiving, from the at least one network device, the at least one measurement configuration.

[0281] In some embodiment, the method may further include receiving, via the transceiver and from the user equipment, a request for the at least one measurement configuration.

[0282] In some embodiment, the request may comprise one of the following: a type of the reference signal requested by the user equipment; validity information indicating validity time of the session of the data collection; or area information indicating an area where the user equipment performs the data collection.

[0283] In some embodiment, the first information may be transmitted via new radio (NR) positioning protocol A (NRPPa) message.

[0284] FIG. 13 illustrates a flowchart of a method 1300 that supports data collection in accordance with aspects of the present disclosure. The operations of the method 1300 may be implemented by a device or its components as described herein. For example, the operations of the method 1300 may be performed by a second network entity 103 as described herein. In some implementations, the device may execute a set of instructions

to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0285] At 1305, the method includes transmitting, via the transceiver and to a third network device, a handover request that includes first information associated data collection for beam prediction, wherein the second network device and the third network device are located in an area where a user equipment performs data collection. The operations of 1305 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1305 may be performed by a device as described with reference to FIG. 1.

[0286] At 1310, the method includes receiving, from the third network device, a handover response comprising a radio resource control (RRC) configuration for a handover procedure. The operations of 1310 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1310 may be performed by a device as described with reference to FIG. 1.

[0287] In some embodiment, the method may further include transmitting, via the transceiver and to the third network device, a first request associated with the data collection of the user equipment.

[0288] In some embodiment, the first request may comprise one of the following: an indication requesting the third network device to provide beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device; identities (IDs) of the beam measurements; a duration for the user equipment to perform the beam measurements; a duration for the user equipment to log the beam measurements; a duration for the user equipment to transmit the beam measurements; a period for performing the beam measurements; a period for logging the beam measurements; a period for transmitting the beam measurements; second information associated with at least one beam requested by the second network device to be measured; or a type of the beam measurements requested by the second network device.

[0289] In some embodiment, the type may comprise one of the following: indexes of a first number of beams with stronger reference signal received powers (RSRPs) among multiple beams of the third network device; indexes of one or more beams with one or more RSRPs above a first thresholdsecond network device.

[0290] In some embodiment, the first information may comprise one of the following: identities (IDs) of the beam measurements; an ID of a target cell to which the user equipment is to be handed over; or third information of a beam prediction.

[0291] In some embodiment, the third information of a beam prediction may comprise one of the following: an index associated with a beam predicted to have a strongest RSRP among multiple beams of the second network device; a list of a second number of beams with stronger RSRPs among multiple beams of the second network device; a list of at least one beam predicted to have at least one RSRP above a second threshold; at least one value representing likelihood associated with at least one predicted beam; at least one predicted beam measurement associated with at least one predicted beam; or a predicted value of stay time of the at least one predicted beam.

[0292] In some embodiment, the first information may further comprise one of the following: second information associated with at least one beam to be measured in the event that the first request does not include the second information; or a type of the beam measurements in the event that the first request does not include the type.

[0293] In some embodiment, the RRC configuration may comprise one of the following: a first configuration for the user equipment to perform a random access to a target cell with a predicted beam having a strongest RSRP among multiple beams of the third network device; a second configuration for the user equipment to perform the beam measurement based on the handover request and a first request; a third configuration for the user equipment to log the beam measurement based on the handover request and a first request; or a fourth configuration for the user equipment to transmit the beam measurement based on the handover request and a first request.

[0294] In some embodiment, the method may further include transmitting, via the transceiver and to the user equipment, the RRC configuration; and receiving, via the transceiver and from the third network device, the beam measurements after the user equipment is handed over from the second network device to the third network device.

[0295] In some embodiment, the method may further include receiving, via the transceiver and from the third network device, a second request associated with data collection of the user equipment.

[0296] In some embodiment, the second request may comprise one of the following: an indication requesting the second network device to provide historical beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device; a duration, wherein the second network device is requested to provide historical beam measurements within the duration before the user equipment is handed over from the second network device to the third network device; a type of the historical beam measurements requested by the third network device; an ID of a target cell to which the user equipment is to be handed over; or an ID of a source cell from which the user equipment is to be handed over.

[0297] In some embodiment, the historical beam measurements may be transmitted to the third network device via the handover request; or the historical beam measurements may be transmitted to the third network device after the handover finishes.

[0298] In some embodiment, the first information further may comprise one of the following: time stamps of the historical beam measurements; or values of stay time of one or more beams of the historical beam measurements.

[0299] FIG. 14 illustrates a flowchart of a method 1400 that supports data collection in accordance with aspects of the present disclosure. The operations of the method 1400 may be implemented by a device or its components as described herein. For example, the operations of the method 1400 may be performed by a third network entity 104 as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0300] At 1405, the method includes receiving, via the transceiver and from a second network device, a handover request that includes first information associated data collection for beam prediction, wherein the second network device and the third network device are located in an area where a user equipment performs data collection. The operations of 1405 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1405 may be performed by a device as described with reference to FIG. 1.

[0301] At 1410, the method includes transmit, via the transceiver and to the second network device, a handover response comprising a radio resource control (RRC)

configuration for a handover procedure. The operations of 1410 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1410 may be performed by a device as described with reference to FIG. 1.

[0302] In some embodiment, the method may further include receiving, via the transceiver and from the third network device, a first request associated with the data collection of the user equipment.

[0303] In some embodiment, the first request may comprise one of the following: an indication requesting the third network device to provide beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device; identities (IDs) of the beam measurements; a duration for the user equipment to perform the beam measurements; a duration for the user equipment to log the beam measurements; a duration for the user equipment to transmit the beam measurements; a period for performing the beam measurements; a period for logging the beam measurements; a period for transmitting the beam measurements; second information associated with at least one beam requested by the second network device to be measured; or a type of the beam measurements requested by the second network device.

[0304] In some embodiment, the type may comprise one of the following: indexes of a first number of beams with stronger reference signal received powers (RSRPs) among multiple beams of the third network device; indexes of one or more beams with one or more RSRPs above a first threshold; RSRPs of the one or more beams; RSRPs of available beams for the beam measurements; or a RSRP of a beam indicated by the second network device.

[0305] In some embodiment, the first information may comprise one of the following: identities (IDs) of the beam measurements; an ID of a target cell to which the user equipment is to be handed over; or third information of a beam prediction requested by the second network device.

[0306] In some embodiment, the third information of a beam prediction may comprise one of the following: an index associated with a beam predicted to have a strongest RSRP among multiple beams of the third network device; a list of at least one beam predicted to have at least one RSRP above a second threshold; at least one value representing likelihood associated with at least one predicted beam; at least one predicted

beam measurement associated with at least one predicted beam; or a predicted value of stay time of the at least one predicted beam.

[0307] In some embodiment, the handover response may further comprise one of the following: second information associated with at least one beam to be measured in the event that the first request does not include the second information; or a type of the beam measurements in the event that the first request does not include the type.

[0308] In some embodiment, the RRC configuration may comprise one of the following: a first configuration for the user equipment to perform a random access to a target cell with a predicted beam having a strongest RSRP among multiple beams of the third network device; a second configuration for the user equipment to perform the beam measurement based on the handover request and a first request; a third configuration for the user equipment to log the beam measurement based on the handover request and a first request; or a fourth configuration for the user equipment to transmit the beam measurement based on the handover request and a first request.

[0309] In some embodiment, the method may further include receiving, via the transceiver and from the user equipment, the beam measurements after the user equipment is handed over from the second network device to the third network device; and transmitting, via the transceiver and to the second network device, the beam measurements.

[0310] In some embodiment, the method may further include transmitting, via the transceiver and to the second network device, a second request associated with data collection of the user equipment.

[0311] In some embodiment, the second request comprises one of the following: an indication requesting the second network device to provide historical beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device; a duration, wherein the second network device is requested to provide historical beam measurements within the duration before the user equipment is handed over from the second network device to the third network device; a type of the historical beam measurements requested by the third network device; an ID of a target cell to which the user equipment is to be handed over; or an ID of a source cell from which the user equipment is to be handed over.

[0312] In some embodiment, the historical beam measurements may be transmitted to the third network device via the handover request; or the historical beam measurements may be transmitted to the third network device after the handover finishes.

[0313] In some embodiment, the first information may further comprise one of the following: time stamps of the historical beam measurements; or values of stay time of one or more beams of the historical beam measurements.

[0314] It should be noted that the methods described herein describes possible implementations, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible. Further, aspects from two or more of the methods may be combined.

[0315] The various illustrative blocks and components described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, a CPU, an FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration).

[0316] The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope of the disclosure and appended claims. For example, due to the nature of software, functions described herein may be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations.

[0317] 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. By way of example, non-transitory computer-readable media may include RAM, ROM, electrically erasable programmable ROM (EEPROM), flash memory, compact disk (CD) ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other non-transitory medium that may be used to carry or store desired program code means in the form of instructions or data structures and that may be accessed by a general-purpose or special-purpose computer, or a general-purpose or special-purpose processor.

[0318] As used herein, including in the claims, 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.

[0319] 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 comprising:
a processor; and
a transceiver coupled to the processor,
wherein the processor is configured to:
receive, via the transceiver and from a first network device, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and
perform a measurement on a reference signal associated with data collection for model training based on the at least one measurement configuration.
2. The user equipment of claim 1, wherein the at least one measurement configuration comprises one of the following:
a type of the reference signal;
resource information for the reference signal;
a type of a ground truth;
validity information indicating validity time of a session of the data collection;
or
area information indicating an area where the user equipment performs the data collection.
3. The user equipment of claim 1, wherein the processor is further configured to:
transmit, via the transceiver and to a second network device among the at least one network device, first information indicating that a session of the data collection is triggered, wherein the second network device serves the user equipment.
4. The user equipment of claim 3, wherein the first information comprises one of the following:

an indication that the session of the data collection is triggered by the first network device;

the session of the data collection is carried out via a long term evolution (LTE) positioning protocol (LPP) message over a control plane (CP);

the session of the data collection is carried out via an LPP message over a user plane (UP);

area information indicating an area where the user equipment performs the data collection; or

validity information indicating validity time of the session of the data collection.

5. The user equipment of claim 1, wherein the processor is further configured to:

receive, from the second network device, a second configuration of a radio bearer for the user equipment, wherein the second configuration is transmitted, via a handover response, by a third network device among the at least one network device.

6. The user equipment of claim 5, wherein the second configuration is transmitted in the event that the third network device receives, from the second network device, a handover request to hand over the user equipment to the third network device.

7. The user equipment of claim 6, wherein the handover request comprises one of the following:

an indication that the session of the data collection is triggered by the first network device;

the session of the data collection is carried out via an LPP message over a CP;

the session of the data collection is carried out via an LPP message over a UP;

area information indicating an area where the user equipment performs the data collection; or

validity information indicating validity time of the session of the data collection.

8. The user equipment of claim 5, wherein one of the first configuration or the second configuration comprises one of the following:

a signaling radio bearer (SRB) configured for the user equipment in the event that the session of the data collection is carried out via an LPP message over a CP; or
a data radio bearer (DRB) configured for the user equipment in the event that the session of the data collection is carried out via an LPP message over a UP.

9. The user equipment of claim 1, wherein the processor is further configured to:

transmit, via the transceiver, collected data to the first network device.

10. The user equipment of claim 9, wherein the collected data is transmitted to the first network device in the event that the user equipment is within the area after handover to the third network device.

11. The user equipment of claim 9, wherein the processor is further configured to:

receive, from the second network device, a third configuration for transmitting the collected data for model training associated with artificial intelligence/machine learning (AI/ML) based positioning, channel state information compression, channel state information prediction, or beam prediction.

12. The user equipment of claim 11, wherein the third configuration comprises one of the following:

a period for transmitting the collected data;

a period for logging the measurement;

an event that trigger transmitting the collected data;

an event that trigger logging the measurement;

an indication that the user equipment is not to discard the collected data that has not been transmitted; or

trace information comprising a trace reference or a trace recording session reference.

13. The user equipment of claim 12, wherein the handover request further comprises one of the following:

an indication that the user equipment is configured not to discard the collected data that has not been transmitted; or
the trace information.

14. The user equipment of claim 11, wherein the processor is further configured to:

receive, from the third network device, a second request for the collected data that has not been transmitted after handover to the third network device.

15. A first network device comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

transmit, via the transceiver and to a user equipment, at least one measurement configuration determined by at least one network device, wherein the at least one measurement configuration is associated with data collection for model training; and

receive, via the transceiver and from the user equipment, collected data of the user equipment.

16. A second network device comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

transmit, via the transceiver and to a third network device, a handover request that includes first information associated data collection for beam prediction, wherein the second network device and the third network device are located in an area where a user equipment performs data collection; and

receive, from the third network device, a handover response comprising a radio resource control (RRC) configuration for a handover procedure.

17. The second network device of claim 16, wherein the processor is further configured to:

transmit, via the transceiver and to the third network device, a first request associated with the data collection of the user equipment.

18. The second network device of claim 17, wherein the first request comprises one of the following:

an indication requesting the third network device to provide beam measurements of the user equipment after the user equipment is handed over from the second network device to the third network device;

identities (IDs) of the beam measurements;

a duration for the user equipment to perform the beam measurements;

a duration for the user equipment to log the beam measurements;

a duration for the user equipment to transmit the beam measurements;

a period for performing the beam measurements;

a period for logging the beam measurements;

a period for transmitting the beam measurements;

second information associated with at least one beam requested by the second network device to be measured; or

a type of the beam measurements requested by the second network device.

19. The second network device of claim 16, wherein the first information comprises one of the following:

identities (IDs) of the beam measurements;

an ID of a target cell to which the user equipment is to be handed over; or

third information of a beam prediction.

20. A third network device comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

receive, via the transceiver and from a second network device, a handover request that includes first information associated data collection for beam prediction, wherein the second network device and the third network device are located in an area where a user equipment performs data collection; and

transmit, via the transceiver and to the second network device, a handover response comprising a radio resource control (RRC) configuration for a handover procedure.