

METHODS FOR HANDLING UNSUCCESSFUL COMPUTING TASK

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to a user equipment (UE), a network entity, a processor for wireless communication, methods, an apparatus for handling an unsuccessful computing task.

BACKGROUND

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

[0003] An entity (UE or gNB depending on use cases) may be requested by another entity (gNB or LMF) to perform computing tasks (for example, but not limited to, AI inference) to make prediction or compression or positioning estimation which are association with the wireless communication. However, the entity (UE/gNB) being requested may be not capable of the requested AI inference. The entity (UE/gNB) being requested for AI inference shall notify the requesting entity (gNB/LMF) about the unsuccessful AI inference. Therefore, how and which procedures should be enhanced to serve this purpose need to be further studied and investigated.

SUMMARY

[0004] The present disclosure relates to a user equipment (UE), a network entity, a processor for wireless communication, methods, a base station, an apparatus for handling an unsuccessful computing task.

[0005] In a first aspect, there is provided A user equipment (UE) comprising: a processor; and a transceiver coupled to the processor, wherein the processor is configured to: receive, via the transceiver, a first message from a network entity requesting the UE to perform a computing task associated with wireless communication; and transmit, via the transceiver, a second message indicating that the UE fails in performing the computing task to the network entity.

[0006] In a second aspect, there is provided network entity comprising: a processor; and a transceiver coupled to the processor, wherein the processor is configured to: transmit, via the transceiver, a first message to a user equipment (UE) requesting the UE to perform a computing task associated with wireless communication; and receive, via the transceiver, a second message indicating that the UE fails in performing the computing task from the UE.

[0007] In a third aspect, there is provided base station comprising: a processor; and a transceiver coupled to the processor, wherein the processor is configured to: receive, from a location management function (LMF), a first message requesting the base station to perform a computing task associated with wireless communication; and transmit, to the LMF, a second message indicating that the base station fails in performing the computing task.

[0008] In a fourth aspect, there is provided a location management function (LMF), the LMF comprising, comprising: at least one memory; and at least one processor coupled with the at least one memory and configured to: transmit, to a base station, a first message requesting the base station to perform a computing task associated with wireless communication; and receive, from the base station, a second message indicating that the base station fails in performing the computing task.

[0009] In a fifth aspect, there is provided processor for wireless communication, comprising: at least one memory; and a controller coupled with the at least one memory and configured to cause the controller to: receive, from a network entity, a first message requesting the processor to perform a computing task associated with wireless

communication; and transmit, to the network entity, a second message indicating that the processor fails in performing the computing task.

[0010] In a sixth aspect, there is provided a method performed by a first device, the method comprising: receiving, from a second device, a first message requesting the first device to perform a computing task associated with wireless communication; and transmitting, to the second device, a second message indicating that the first device fails in performing the computing task.

[0011] In a seventh aspect, there is provided performed by a second device, the method comprising: transmitting, to a first device, a first message requesting the first device to perform a computing task associated with wireless communication; and receiving, from the first device, a second message indicating that the first device fails in performing the computing task.

[0012] In an eighth aspect, there is provided a computer readable medium having instructions stored thereon, the instructions, when executed by a processor of an apparatus, causing the apparatus to perform the method according to any of the sixth and the seventh aspect of the disclosure.

[0013] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, the computing task associated with wireless communication comprise one of: a first computing task identifier; a first computing task type; a first computing task object; a first computing task time window; or a first computing task condition

[0014] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, the second message indicates one of: the computing task is not supported at the UE, or the computing task is supported at the UE while the UE is unable to perform the computing task temporarily.

[0015] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, the second message further indicates at least one of the following: the first computing task identifier; or a reason of failing of the computing task.

[0016] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, in case that the computing task is not

supported at the UE the reason of failing comprises at least one of: performing the computing task of the first computing task type is not supported; performing the computing task with the first computing task object is not supported; performing the computing task within the first computing task time window is not supported; or performing the computing task with the first computing task condition is not supported.

[0017] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, in case that the computing task is not supported at the UE, the second message further indicates one of: a second computing task type, a second computing task object, or a second computing task time window that is supported at the UE.

[0018] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, wherein in case that the computing task is supported at the UE while the UE is unable to perform the computing task temporarily, the reason of failing comprises at least one of: low battery energy; overheating; overloading; lack of configuration or input; or the first computing task condition is not fulfilled.

[0019] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, the second message further indicates at least one of the following: an estimated time that the time duration will last; or a required configuration or input which is missing currently.

[0020] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, the first message is a radio resource control (RRC) reconfiguration message, and the second message is a RRC reconfiguration complete message in response to the RRC reconfiguration message.

[0021] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, the first message requests for performing the computing task which has been pre-configured at the UE, and the second message is transmitted in response to the first message.

[0022] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, the UE may transmit the second message by

transmitting, in case that the UE is unable to report a result of the computing task at a reporting instance, a reporting message as the second message to the network entity.

[0023] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, the reporting message comprises measurements result for the same object of the computing task.

[0024] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, the computing task is for UE positioning, and the UE may receive, from the LMF, a configuration indicating a secondary positioning method; generate, based on determining a failure in performing the UE positioning, location information or assisting information using the secondary positioning method; and transmit the location information or the assisting information to the LMF.

[0025] In some implementations of the methods, the UE, the network entity, the base station, or the LMF described herein, the UE may transmit a third message to the network entity to abort the computing task based on determining that the UE cannot perform the computing task.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. 1 illustrates an example of a wireless communications system in which some embodiments of the present disclosure can be implemented.

[0027] FIG. 2 illustrates an example of a process flow in which an unsuccessful computing task is notified to a requesting entity in accordance with some example embodiments of the present disclosure.

[0028] FIGS. 3A and 3B illustrate examples of process flows in which an unsuccessful computing task is notified from UE to gNB in request/response manner in accordance with some example embodiments of the present disclosure.

[0029] FIG. 4 illustrates an example of a process flow in which an unsuccessful computing task is notified from UE to gNB in reporting manner in accordance with some example embodiments of the present disclosure.

[0030] FIG. 5 illustrates an example of a process flow in which an unsuccessful computing task is notified from UE to LMF in accordance with some example embodiments of the present disclosure.

[0031] FIG. 6 illustrates an example of a process flow in which an unsuccessful computing task is notified from gNB to LMF in accordance with some example embodiments of the present disclosure.

[0032] FIG. 7 illustrates an example of a device that is suitable for implementing some embodiments of the present disclosure.

[0033] FIG. 8 illustrates an example of a processor that is suitable for implementing some embodiments of the present disclosure.

[0034] FIG. 9 illustrates a flowchart of a method performed by a first device in accordance with aspects of the present disclosure.

[0035] FIG. 10 illustrates a flowchart of a method performed by a second device in accordance with aspects of the present disclosure.

[0036] Throughout the drawings, the same or similar reference numerals represent the same or similar elements.

DETAILED DESCRIPTION

[0037] 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 can be implemented in various manners other than the ones described below. 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.

[0038] 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.

[0039] 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. In some examples, values, procedures, or apparatuses are referred to as “best,” “lowest,” “highest,” “minimum,” “maximum,” or the like. It will be appreciated that such descriptions are intended to indicate that a selection among many used functional alternatives can be made, and such selections need not be better, smaller, higher, or otherwise preferable to other selections.

[0040] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of 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, components and/or the like, but do not preclude the presence or addition of one or more other features, elements, components and/or combinations thereof. For example, the term “includes” and its variants are to be read as open terms that mean “includes, but is not limited to.” The term “based on” is to be read as “based at least in part on.” The term “one embodiment” and “an embodiment” are to be read as “at least one embodiment.” The term “another embodiment” is to be read as “at least one other embodiment.” The use of an expression such as “A and/or B” can mean either “only A” or “only B” or “both A and B.” Other definitions, explicit and implicit, may be included below.

[0041] FIG. 1 illustrates an example of a wireless communications system 100 in which some embodiments of the present disclosure can be implemented. 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.

[0042] 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. In a 3GPP non-terrestrial network (NTN), a network entity 102 in form of a satellite can directly communicate to UE 104 using NR/LTE Uu interface. The satellite may be a transparent satellite or a regenerative satellite. For NTN with a transparent satellite, a base station on earth may communicate with a UE via the satellite. For NTN with a regenerative satellite, the base station may be on board and directly communicate with the UE.

[0043] 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] 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). In some implementations, the network entity 102 may include an entity for performing a location management function (LMF).

[0048] 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.

[0049] 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)).

[0050] 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.

[0051] 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).

[0052] 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.

[0053] 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 server 117 for performing a location management function (LMF), 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. The LMF may be defined in the core network 106 and/or the network entity 102 to provide positioning functionality by means to determine the geographic position of a UE 104 based on downlink and uplink location measuring radio signals. The packet data network 108 may include an application server 118.

[0054] 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).

[0055] 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.

[0056] 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] 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.

[0061] FIG. 2 illustrates an example of a process flow in which an unsuccessful computing task is notified to a requesting entity in accordance with some example embodiments of the present disclosure. The process flow 200 may involve a network entity 202 as the requesting entity and an UE 204 as a requested entity.

[0062] The process flow 200 may be applied to the wireless communications system 100 with reference to FIG. 1, for example, the UE 204 may be any of UEs 104. In some cases, the network entity 202 may be or deployed at any of the network entities 102; for example, the network entity 202 may be a base station (e.g., gNB). In some cases, the network entity 202 may be or deployed at the server 117 in the core network 106; for example, the network entity 202 may be an LMF. The UE 204 may be any of the UEs 104 as show in FIG. 1. It would be appreciated that the process flow 200 may be applied to other communication scenarios, which will not be described in detail.

[0063] At 210, the network entity 202 may transmit a first message 215 to the UE 204 requesting the UE 204 to perform a computing task associated with wireless communication. Accordingly, at 220, the UE 204 receives the first message 215. In some embodiments, the computing task may comprise or be associated with one or more of a first computing task identifier, a first computing task type, a first computing task object, a first computing task time window; or a first computing task condition of the computing task. The first message 215 may further indicate relevant information depending on implementations which will be described below.

[0064] At 230, the UE 204 may transmit a second message 235 indicating that the UE 204 fails in performing the computing task to the network entity 202. Accordingly, at 240, the network entity 202 receives the second message 235. Depending on UE's capability, the second message 235 may indicate that the computing task is not supported at the UE. That is, the UE 204 is not capable of performing the computing task at all. In this case, the network entity 202 may not request the UE 204 to perform the same computing task any more or at least in a near future. The second message 235 may indicate that the computing task is supported at the UE 204 but the UE 204 is unable to perform the computing task for a time duration. That is, the UE 204 is capable

of the requested computing task but cannot perform the computing task temporarily for some reason.

[0065] In some embodiments, the second message 235 may indicate a computing task identifier of the computing task. Additionally, the second message 235 may further indicate a reason of failing of the computing task. In addition to such information, the second message 235 may include relevant information depending on implementation which will be described below.

[0066] If the computing task is not supported at the UE 204, the reason may be that one or more of the requirements associated with the first message are not supported at the UE 204. In some embodiments, the reason may comprise one or more of the following: performing the computing task of the first computing task type is not supported, performing the computing task with the first computing task object is not supported, performing the computing task within the first computing task time window is not supported, performing the computing task with the first computing task condition is not supported. In this case, the second message 235 may further indicate a second computing task that is supported at the UE 204, including, for example, a second computing task type, a second computing task object, or a second computing task time window.

[0067] If the computing task is supported at the UE 204 but the UE 204 is unable to perform the computing task for a time duration, the reason of failing may comprise one or more of the following: low battery energy, overheating, overloading, lack of configuration or input, or the first computing task condition is not fulfilled. In this case, the second message further indicates at least one of the following: an estimated time that the time duration (i.e. the reason of failing) will last; or a required configuration or input which is missing currently.

[0068] In some embodiments, the network entity 202 may be a gNB requesting the UE 204 to perform a computing task associated with wireless communication, and the UE 204 informs the gNB about the unsuccessful computing task. The gNB may request the UE to perform PHY layer operation, such as channel state information (CSI) compression, time domain CSI prediction, time domain beam prediction, spatial domain beam prediction, direct positioning, AI assisted positioning. The PHY layer operation can be performed using AI/ML model at UE side. The gNB may also request the UE to

perform radio resource management (RRM) prediction, such as time domain cell/beam L3 measurement prediction, intra frequency L3 measurement prediction of other cells/beams, inter frequency L3 measurement prediction of other cells/beams. The RRM prediction can be performed using AI/ML model at UE side.

[0069] The UE may receive a first message (e.g., the first message 215) from the gNB which requests or configures the UE to perform time/spatial domain prediction or compression (which can be determined using AI/ML model) and report the result in one-time, event-triggered, or periodic manner. However, the UE may be not capable of the requested prediction/compression, or the UE may be capable but temporarily suspended due to some reasons. In such case, the UE will not transmit any result of time/spatial domain prediction or compression (which can be determined using AI/ML model) to gNB, instead the UE may transmit measurement result and may notify the gNB about the unsuccessful time/spatial domain prediction or compression (which can be determined using AI/ML model) and in addition relevant information in a second message (e.g., the second message 235) via RRC procedures.

[0070] If the UE is not capable of the requested prediction/compression at all, the relevant information in the second message may include an indication that the requested prediction/compression is not supported, and the concerned object (e.g., frequency/cell/beam to perform prediction) represented by e.g., measId or measObjId or predictionObjId or reportConfigId or eventId. The second message may further include the reason of the unsuccessful prediction/compression which can be represented by enumerated values. The reason of the unsuccessful Prediction/compression may include but not limited to: requested use case or task type (e.g., CSI prediction, beam prediction) is not supported, UE is not capable of performing the prediction/compression on the given object (e.g., frequency/cell/beam, or RRM event), UE is not capable of predicting in current condition (indoor, outdoor, large cell, small cell), UE is not capable of time domain prediction with given time window (e.g., cannot predict what happens after 10mins). In some embodiments, the UE may further indicate other task type/use case, object, condition, or time window that the UE is capable of, which can be represented by enumerated values.

[0071] If UE is capable of the requested prediction/compression but cannot perform the prediction/compression temporarily, the relevant information in the second message

may include an indication that the requested prediction/compression is temporarily not supported, and the concerned object (e.g., frequency/cell/beam to perform prediction) represented by e.g., measId or measObjId or predictionObjId or reportConfigId or eventId. The second message may further include the reason of the unsuccessful prediction/compression which can be represented by enumerated values. The reason of the unsuccessful prediction/compression may include but not limited to: low battery energy, overheating, overloading, task condition is not fulfilled, or lack of configuration or input.

[0072] For example, the gNB configures or requests UE to predict the quality of Cell #A, but the gNB has not configured the UE with enough information about Cell #A, e.g., reference signals. As another example, the UE can predict Cell #A quality, but need its neighbor cells' quality as input, however the UE does not have the measurement configuration of neighbor cells. As a further example, beam prediction may be divided into intra-cell beam measurement result prediction and Inter-cell beam measurement result prediction. Regarding Inter-cell beam, the UE may have less information e.g., no CSI-RS configuration. Therefore, the UE can predict intra-cell beam measurement result but cannot predict inter-cell beam measurement result. The above cases result in that the UE cannot perform the requested prediction temporarily, because the UE lacks configuration or input.

[0073] The prediction/compression requested by gNB may include but not limited to PHY layer AI operation and RRM prediction. The PHY layer AI operation may include but not limited to: CSI compression; time domain CSI prediction, i.e., predicting the future CSI based on measured CSI in the past; time domain beam prediction, i.e., predicting the future L1 beam quality based on measured L1 beam quality in the past; or spatial domain beam prediction, i.e., predicting Set A of beams using measurement of Set B of beams. The RRM prediction may include but not limited to: time domain cell/beam L3 measurement prediction, i.e., predicting the future L3 cell/beam quality based on measured L3 cell/beam quality in the past; intra frequency L3 measurement prediction of other cells/beams, i.e., within the same frequency, predicting L3 measurement of Set A cells/beams using L3 measurement of Set B of cells/beams; inter frequency L3 measurement prediction of other cells/beams, i.e., cross different frequencies, predicting L3 measurement of Set A cells/beams using L3 measurement of Set B of cells/beams.

[0074] In some embodiments where gNB requests UE to perform a computing task (e.g., prediction/compression using AI model), after receiving the message from the gNB requesting or configuring the UE to perform the prediction/compression and report the inference result to the gNB, the UE may determine that it is either not capable of the requested prediction/compression, or the UE is capable but temporarily suspended due to some reasons. The UE may indicate the unsuccessful prediction/compression in the response message sent to the gNB.

[0075] FIG. 3A illustrate an example of a process flow in which an unsuccessful computing task is notified from UE to gNB in request/response manner in accordance with some example embodiments of the present disclosure. The process flow in FIG. 3A is an example implementation of the process flow 200 in FIG. 2, where the UE 304 is an example of UE 204, and the gNB 302 is an example of the network entity 202.

[0076] At step 1, the gNB 302 requests the UE 304 to perform prediction/compression (e.g., predicting L1/L3 measurement in the future) via an *RRCReconfiguration* message, wherein the *RRCReconfiguration* message may contain configuration(s) related to the prediction/compression configuration, e.g., frequency/cell/beam object to predict, time window to predict. If the UE 304 cannot perform the prediction/compression as requested but can comply the rest configuration in the *RRCReconfiguration* message, the UE 304 still considers the RRC procedure successful and reply an *RRCReconfigurationComplete* message to the gNB 302 at step 2. The *RRCReconfigurationComplete* message notifies the gNB 302 about the unsuccessful prediction/compression and in addition relevant information as described above.

[0077] FIG. 3B illustrates another example of a process flow in which an unsuccessful computing task is notified from UE to gNB in request/response manner in accordance with some example embodiments of the present disclosure. The process flow in FIG. 3B is another example implementation of the process flow 200 in FIG. 2.

[0078] Assuming the configuration for prediction/compression (e.g., predicting L1/L3 measurement using AI/ML model at UE side) has been configured at the UE 304, e.g., frequency/cell/beam object to predict, time window to predict. The UE 304 does not perform prediction/compression directly after receiving the configuration. Instead, the UE 304 waits until receiving another message from the gNB 302 to trigger the

prediction/compression. In one example, at step 1, the gNB 302 may use a *UEInformationRequest* message to trigger the UE 304 to perform the prediction/compression and report the inference result in the *UEInformationResponse* message at step 2.

[0079] In the *UEInformationRequest* message, the gNB 302 may use a dedicated indicator or information element (e.g., *predictionResultRequest* IE) to request the prediction/compression result from the UE 304. In addition, the gNB 302 may use a *measId* or *measObjId* or *predictionObjId* or *reportConfigId* or *eventId* to link the prediction/compression request to a previously configured prediction/compression configuration. If the UE 304 cannot perform the prediction/compression as requested, in the *UEInformationResponse* message sent from UE to gNB, it may notify the gNB 302 about the unsuccessful prediction/compression and in addition relevant information as described above. Note that using *UEInformationRequest* and *UEInformationResponse* message is one example. It is also possible that other RRC procedures/messages are used for the same purpose, i.e., triggering and report the prediction/compression result.

[0080] In some embodiments where gNB requests UE to perform a computing task (e.g., prediction/compression using AI/ML model at UE side), after receiving the message from gNB requesting/configuring UE to perform the prediction/compression and report the inference result to gNB, UE may determine that it is capable of the requested prediction/compression at the moment and thus accept the request in the response message. However, at the time that UE needs to perform prediction/compression and generate the result, UE may confront problems and fails to perform prediction/compression. UE will indicate the unsuccessful prediction/compression in the response message sent to gNB in the subsequent message (other than the response message).

[0081] FIG. 4 illustrates an example of a process flow in which an unsuccessful computing task is notified from UE to gNB in reporting manner in accordance with some example embodiments of the present disclosure. The process flow in FIG. 4 is an example implementation of the process flow 200 in FIG. 2, where the UE 404 is an example of UE 204, and the gNB 402 is an example of the network entity 202.

[0082] At step 1, the gNB 402 configures the UE 404 to perform prediction/compression (e.g., predicting L1/L3 measurement using AI/ML model at UE

side) and report the inference result in one time, periodic, or event triggered manner via *MeasurementReport*. At step 2, the UE 404 first reply an *RRCReconfigurationComplete* message. At step 3, the UE 404 transmits the *MeasurementReport* messages including prediction result or measurement result to the gNB 402, for example, periodically.

[0083] At the moment when UE shall perform the prediction/compression and send the inference result (due to one-time, event based, periodically triggered manner), UE may confront issues like overheating or overloading etc. In such case, the UE 404 may skip the next instance of *MeasurementReport* and does not send anything to the gNB 402. Alternatively, at step 4 the UE 404 may still send a *MeasurementReport* message, wherein the UE 404 does not include any measurement result or prediction result, and notify the gNB 402 about the unsuccessful prediction/compression and in addition the relevant information as described above. Alternatively, at step 4 the UE 404 may still send a *MeasurementReport* message, wherein the UE 404 includes the measurement result for the same object and reports to the gNB 402, and notify the gNB 402 about the unsuccessful prediction/compression and in addition the relevant information as described above.

[0084] After the problem is solved and the UE 404 succeeds to make the next prediction, at step 5 the UE 404 resumes to transmit *MeasurementReport* messages including the prediction result to the gNB 402.

[0085] Next, consider embodiments where the network entity 202 is an LMF requesting the UE 204 to perform positioning estimation or provide assisting information for positioning estimation (e.g., using AI/ML model at UE side), and the UE 204 informs the LMF about unsuccessful prediction. Details will be described with reference to FIG. 5.

[0086] FIG. 5 illustrates an example of a process flow in which an unsuccessful computing task is notified from UE to LMF in accordance with some example embodiments of the present disclosure. The process flow in FIG. 5 is an example implementation of the process flow 200 in FIG. 2, where the UE 504 is an example of UE 204, and the LMF 501 is an example of the network entity 202.

[0087] The LMF 501 may request the UE 504 to perform positioning estimation or provide assisting information for positioning estimation. The positioning estimation or assisting information determination could be performed by using AI/ML model. For

example the positioning estimation can be UE-based positioning with UE-side model, UE-assisted/LMF-based positioning with UE-side model, and UE-assisted/LMF-based positioning with LMF-side model.

[0088] At step 1, the UE 504 receives a first message (e.g., LPP *RequestLocationInformation* message) from the LMF 501 which requests or configures the UE 504 to perform a computing task including positioning estimation or providing assisting information for positioning estimation (which could be location estimated by UE AI model, or assisting information determined by UE AI model such as time of arrival (ToA), path phase, reference signal time difference (RSTD), timing estimation, line of sight/non-line of sight (LOS/NLOS) indicator, reference signal receive path power (RSRPP)) in one-time/event-triggered/periodic manner.

[0089] If the UE 504 succeeds in performing the positioning estimation or providing assisting information, it transmits the *ProvideLocationInformation* message including estimated location results or assisting information to the LMF 501 at step 2. However, the UE 504 may be either not capable of the requested task, or the UE 504 is capable but temporarily suspended due to some reasons. In such case, the UE will not transmit any estimation result or assisting information to the LMF 501, instead at step 3, the UE 504 may transmit measurement result and may notify the LMF 501 about the unsuccessful task and relevant information via LPP procedures.

[0090] If UE is not capable of the requested task at all, the relevant information may include one or more of the following: an indication that the requested task is not supported; a reason of the unsuccessful task which may be represented by enumerated values; UE is not capable of the given task type of condition (e.g., UE AI based location estimation, AI based assisting information provision for LMF based location estimation); UE is not capable of the task in current condition (indoor, outdoor, large cell, small cell). In some embodiments, the relevant information may further indicate the use case, the task type, the condition that UE is capable of, which may be represented by enumerated values.

[0091] If the UE 504 is capable of the requested task but cannot perform the task temporarily, the relevant information may include one or more of the following: an indication that the requested task is temporarily not supported; a reason of the unsuccessful task, which may be represented by enumerated values (e.g., low battery

energy, low battery energy, overheating, overloaded by other tasks). In some embodiments, the relevant information may further indicate the estimated time duration that the current problem will last, which can be represented by enumerated values, e.g., 10s, 1min, and others.

[0092] The computing task requested by the LMF 501 may include UE-based positioning with UE-side model, direct AI/ML or AI/ML assisted positioning, i.e., using AI model UE estimates its current location from its spectrum environment and reports the estimation result to LMF 501. The computing task requested by the LMF 501 may include UE-assisted/LMF-based positioning with UE-side model, and AI/ML assisted positioning, i.e., using AI model UE determines assisting information (e.g., ToA, path phase, RSTD, Timing estimation, LOS/NLOS indicator, RSRPP) and reports the assisting information to LMF 501, then LMF 501 estimates the UE location taking the assisting information into account.

[0093] In the LPP *RequestLocationInformation* message at step 1, the LMF 501 may configure the UE 504 to perform AI based location estimation or AI based assisting information provision in either one-time, event-triggered, or periodic manner. Besides, the LMF 501 may also configure the UE 504 with a secondary method for UE to use as an alternative if the AI based location estimation does not work or currently unavailable due to reasons mentioned above. Then, the UE 504 starts the requested computing task following the configuration from LMF and provides the estimation result (i.e., estimated location or assisting information) to LMF via LPP *ProvideLocationInformation* message.

[0094] If UE 504 confronts issues as mentioned above and cannot perform positioning estimation or provide assisting information, it may skip the next instance of *ProvideLocationInformation* generation/transmission. Alternatively, at step 3 the UE 504 may transmit a *ProvideLocationInformation* message, wherein it does not include estimation result or the assisting information, instead it notifies the LMF 501 about the unsuccessful positioning estimation and in addition the relevant information as described above. Alternatively, if the secondary method is configured by the LMF 501, the UE 504 may generate a location estimation using the secondary method, and may include the estimated location result in the *ProvideLocationInformation* message and send to LMF. In the same *ProvideLocationInformation* message at step 3, UE may

notify the LMF 501 about the unsuccessful positioning estimation and in addition the relevant information as described above.

[0095] The secondary method may be any of the following positioning methods, including but not limited to: network-assisted GNSS methods, observed time difference of arrival (OTDOA) positioning based on LTE signals, enhanced cell ID methods based on LTE signals, WLAN positioning, Bluetooth positioning, terrestrial beacon system (TBS) positioning, sensor based methods (e.g., barometric pressure sensor, motion sensor), NR enhanced cell ID methods (NR E-CID) based on NR signals, multi-round trip time positioning (Multi-RTT based on NR signals); downlink angle-of-departure (DL-AoD) based on NR signals, downlink time difference of arrival (DL-TDOA) based on NR signals, uplink time difference of arrival (UL-TDOA) based on NR signals, and uplink angle-of-arrival (UL-AoA) including A-AoA and Z-AoA based on NR signals.

[0096] After the problem is solved and the UE 504 succeeds to make the next positioning estimation, at step 4 the UE 504 resumes to transmit *ProvideLocationInformation* messages including the estimation result or assisting information to the LMF 501.

[0097] At step 5, if the UE 504 can no longer perform and provide the estimation result or assisting information to LMF 501, the UE 504 may transmit a third message (Abort message) to LMF to abort the ongoing LPP procedure reporting the estimation result or assisting information. In the Abort message, it may notify the LMF 501 about the unsuccessful positioning estimation or provision of assisting information, and in addition the relevant information as described above.

[0098] In some embodiments, an LMF may request a network entity (e.g., gNB) to perform a computing task associated with wireless communication, for example, positioning estimation or providing assisting information for positioning estimation using AI/ML model at gNB side, and the network entity may inform the LMF about the unsuccessful computing task. Details will be described with reference to FIG. 6.

[0099] FIG. 6 illustrates an example of a process flow in which an unsuccessful computing task is notified from gNB to LMF in accordance with some example embodiments of the present disclosure. In FIG. 6, the gNB 602 may be or deployed at any of the network entities 102, and the LMF 601 may be or deployed at the server 117 in the core network 106.

[0100] The LMF 601 may request the gNB 602 to provide assisting information for positioning estimation. The assisting information determination can be performed using AI/ML model. For example, the positioning estimation can be NG-RAN node assisted positioning with gNB-side model, and NG-RAN node assisted positioning with LMF-side model.

[0101] In FIG. 6, the gNB 602 receives a Measurement request message from the LMF 601 which requests or configures the gNB to perform a computing task (e.g., positioning estimation using AI/ML model) and report the computing result (which could be estimation result or assisting information determined by gNB AI model, such as ToA, path phase, RSTD, LOS/NLOS indicator, RSRPP) in one-time/event-triggered/periodic manner. However, the gNB 602 may be either not capable of the requested computing task, or the gNB 602 is capable but temporarily suspended due to reasons. In such case, the gNB 602 does not transmit any inference result to the LMF 601, instead the gNB 602 may transmit measurement result and may notify the LMF 601 about the unsuccessful positioning estimation and relevant information via NRPPa procedures. In some embodiments, the gNB 602 may notify the LMF 601 about the unsuccessful positioning estimation and relevant information via a NRPPa MEASUREMENT RESPONSE message at step 2.

[0102] If the gNB 602 is not capable of the requested computing task at all, the relevant information may include an indication that the requested computing task is not supported, and reason of the unsuccessful computing task, which can be represented by enumerated values. The reason of the unsuccessful computing task may be that the gNB 602 does not support the requested assisting info (ToA, path phase, RSTD, Timing estimation, LOS/NLOS indicator, RSRPP). In some embodiments, the relevant information may further indicate assisting information that the gNB 602 is capable of, which may be represented by enumerated values.

[0103] If the gNB 602 is capable of the requested computing task but cannot perform the computing task temporarily, the relevant information may include an indication that the requested computing task is temporarily not supported, and reason of the unsuccessful computing task, which can be represented by enumerated values. The reason of the unsuccessful computing task may be overloading of the gNB 602. In some embodiments, the relevant information may further indicate the estimated time duration

that the current problem will last, which may be represented by enumerated values, e.g., 10s, 1min and others.

[0104] The computing task requested by the LMF 601 may include but not limited to NG-RAN node assisted positioning (e.g., ToA, path phase, RSTD, Timing estimation, LOS/NLOS indicator, RSRPP) with gNB-side model, AI/ML assisted positioning.

[0105] In FIG. 6, in the NRPPa MEASUREMENT REQUEST message, the LMF 601 may configure the gNB 602 to perform AI based assisting information provision in either one-time, event-triggered, or periodic manner. Then, the gNB 602 may start the assisting information provision following the configuration from the LMF 601 and provide the inference result (i.e., assisting information) to the LMF 601 via NRPPa MEASUREMENT REPORT message at step 4.

[0106] If the gNB 602 confronts issues as mentioned above and cannot perform the requested computing task, the gNB 602 may skip the next instance of MEASUREMENT REPORT generation/transmission. Alternatively, the gNB 602 may transmit a MEASUREMENT REPORT message, wherein the gNB 602 does not include positioning estimation or assisting information, but notify the LMF 601 about the unsuccessful task and in addition the relevant information as described above. If the gNB 602 can no longer perform and provide the positioning estimation or assisting information to LMF 601, at step 6 the gNB 602 may send a MEASUREMENT FAILURE INDICATION message to LMF 601 to abort the task. In this message, it may notify the LMF 601 about the unsuccessful computing task and in addition the relevant information as described above.

[0107] FIG. 7 illustrates an example of a device that is suitable for implementing some embodiments of the present disclosure. The device 700 may be an example of an LMF or an AMF as described herein. The device 700 may support wireless or wired communication with one or more network entities 102, UEs 104, a server 117 in a core network 106, or any combination thereof. The device 700 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 702, a memory 704, a transceiver 706, and, optionally, an I/O controller 708. 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).

[0108] The processor 702, the memory 704, the transceiver 706, 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 702, the memory 704, the transceiver 706, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0109] In some implementations, the processor 702, the memory 704, the transceiver 706, 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 702 and the memory 704 coupled with the processor 702 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 702, instructions stored in the memory 704).

[0110] For example, the processor 702 may support wireless or wired communication at the device 700 in accordance with examples as disclosed herein. The device 700 may be a first device (e.g. any of UEs 104 or any of network entities 102). The processor 702 may be configured to operable to support means for receiving, from a second device, a first message requesting the first device to perform a computing task associated with wireless communication; and means for transmitting, to the second device, a second message indicating that the first device fails in performing the computing task.

[0111] The processor 702 may support wireless or wired communication at the device 700 in accordance with examples as disclosed herein. The device 700 may be a second device (e.g. any of network entities 102, or an apparatus for performing LMF in core network). The processor 702 may be configured to operable to support means for transmitting, to a first device, a first message requesting the first device to perform a computing task associated with wireless communication; and means for receiving, from

the first device, a second message indicating that the first device fails in performing the computing task.

[0112] The processor 702 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 702 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 702. The processor 702 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 704) to cause the device 700 to perform various functions of the present disclosure.

[0113] The memory 704 may include random access memory (RAM) and read-only memory (ROM). The memory 704 may store computer-readable, computer-executable code including instructions that, when executed by the processor 702 cause the device 700 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some implementations, the code may not be directly executable by the processor 702 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 704 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.

[0114] The I/O controller 708 may manage input and output signals for the device 700. The I/O controller 708 may also manage peripherals not integrated into the device 700. In some implementations, the I/O controller 708 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 708 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 708 may be implemented as part of a processor, such as the processor 702. In some implementations, a user may interact with the device 700 via the I/O controller 708 or via hardware components controlled by the I/O controller 708.

[0115] In some implementations, the device 700 may include a single antenna 710. However, in some other implementations, the device 700 may have more than one antenna 710 (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 706 may communicate bi-directionally, via the one or more antennas 710, wired, or wireless links as described herein. For example, the transceiver 706 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 706 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 710 for transmission, and to demodulate packets received from the one or more antennas 710. The transceiver 706 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0116] 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 710 for transmitting the amplified signal into the air or wireless medium.

[0117] 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 710 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.

[0118] FIG. 8 illustrates an example of a processor 800 is suitable for implementing some embodiments of the present disclosure. The processor 800 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 800 may include a controller 802 configured to perform various operations in accordance with examples as described herein. The processor 800 may optionally include at least one memory 804. Additionally, or alternatively, the processor 800 may optionally include one or more arithmetic-logic units (ALUs) 806. 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).

[0119] The processor 800 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 800) 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).

[0120] The controller 802 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 800 to cause the processor 800 to support various operations in accordance with examples as described herein. For example, the controller 802 may operate as a control unit of the processor 800, generating control signals that manage the operation of various components of the processor 800. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0121] The controller 802 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 804 and determine subsequent instruction(s) to be executed to cause the processor 800 to support various operations in accordance with

examples as described herein. The controller 802 may be configured to track memory address of instructions associated with the memory 804. The controller 802 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 802 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 800 to cause the processor 800 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 802 may be configured to manage flow of data within the processor 800. The controller 802 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 800.

[0122] The memory 804 may include one or more caches (e.g., memory local to or included in the processor 800 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 804 may reside within or on a processor chipset (e.g., local to the processor 800). In some other implementations, the memory 804 may reside external to the processor chipset (e.g., remote to the processor 800).

[0123] The memory 804 may store computer-readable, computer-executable code including instructions that, when executed by the processor 800, cause the processor 800 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 802 and/or the processor 800 may be configured to execute computer-readable instructions stored in the memory 804 to cause the processor 800 to perform various functions (e.g., functions or tasks supporting transmit power prioritization). For example, the processor 800 and/or the controller 802 may be coupled with or to the memory 804, the processor 800, the controller 802, and the memory 804 may be configured to perform various functions described herein. In some examples, the processor 800 may include multiple processors and the memory 804 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.

[0124] The one or more ALUs 806 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or

more ALUs 806 may reside within or on a processor chipset (e.g., the processor 800). In some other implementations, the one or more ALUs 806 may reside external to the processor chipset (e.g., the processor 800). One or more ALUs 806 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 806 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 806 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 806 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 806 to handle conditional operations, comparisons, and bitwise operations.

[0125] The processor 800 may support wireless communication in accordance with examples as disclosed herein. The processor 800 may be implemented for performing a UE or a network entity as a first device. The processor 800 may be configured to or operable to support means for receiving, from a second device, a first message requesting the first device to perform a computing task associated with wireless communication; and means for transmitting, to the second device, a second message indicating that the first device fails in performing the computing task.

[0126] The processor 800 may be implemented for performing a network entity or an LMF as a second device. The processor 800 may be configured to or operable to support means transmitting, to a first device, a first message requesting the first device to perform a computing task associated with wireless communication; and means for receiving, from the first device, a second message indicating that the first device fails in performing the computing task.

[0127] FIG. 9 illustrates a flowchart of a method 900 performed by a first device in accordance with aspects of the present disclosure. The operations of the method 900 may be implemented by a device or its components as described herein. For example, the operations of the method 900 may be performed by a UE or a network entity. 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.

[0128] At 910, the method may include receiving, from a second device, a first message requesting the first device to perform a computing task associated with wireless communication. When the first device is a UE, the second device may be a network entity, such as a base station (e.g., gNB) or LMF. When the first device is a network entity, the second device may be an LMF. The operations of 910 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 910 may be performed by a UE 104 or a network entity 102 as described with reference to FIG. 1.

[0129] At 920, the method may include transmitting, to the second device, a second message indicating that the first device fails in performing the computing task. The operations of 920 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 920 may be performed by a UE 104 or a network entity 102 as described with reference to FIG. 1.

[0130] FIG. 10 illustrates a flowchart of a method performed by a second device in accordance with aspects of the present disclosure. The operations of the method 1000 may be implemented by a device or its components as described herein. For example, the operations of the method 1000 may be performed by a network entity or a server in a core network 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.

[0131] At 1010, the method may include transmitting, to a first device, a first message requesting the first device to perform a computing task associated with wireless communication. When the second device is a base station (e.g., gNB), the first device may be a UE. When the second device is an LMF, the first device may be a UE or a base station (e.g., gNB). The operations of 1010 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 810 may be performed by a network entity 102 or a server 117 implemented in the core network 106 as described with reference to FIG. 1.

[0132] At 1020, the method may include receiving, from the first device, a second message indicating that the first device fails in performing the computing task. The operations of 1020 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1020 may be performed by a network entity 102 or a server 117 implemented in the core network 106 as described with reference to FIG. 1.

[0133] 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.

[0134] 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).

[0135] 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.

[0136] 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.

[0137] 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.

[0138] 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

1. A user equipment (UE) comprising:
 - a processor; and
 - a transceiver coupled to the processor,wherein the processor is configured to:
 - receive, via the transceiver, a first message from a network entity requesting the UE to perform a computing task associated with wireless communication; and
 - transmit, via the transceiver, a second message indicating that the UE fails in performing the computing task to the network entity.
2. The UE of claim 1, wherein the computing task associated with wireless communication comprises one of:
 - a first computing task identifier;
 - a first computing task type;
 - a first computing task object;
 - a first computing task time window; or
 - a first computing task condition.
3. The UE of claim 2, wherein the second message indicates one of:
 - the computing task is not supported at the UE, or
 - the computing task is supported at the UE while the UE is unable to perform the computing task temporarily.
4. The UE of claim 3, wherein the second message further indicates at least one of the following:
 - the first computing task identifier; or
 - a reason of failing of the computing task.
5. The UE of claim 4, wherein in case that the computing task is not supported at the UE, the reason of failing comprises at least one of:
 - performing the computing task of the first computing task type is not supported;
 - performing the computing task with the first computing task object is not

supported;

performing the computing task within the first computing task time window is not supported; or

performing the computing task with the first computing task condition is not supported.

6. The UE of claim 4, wherein in case that the computing task is not supported at the UE, the second message further indicates one of:

a second computing task type, a second computing task object, or a second computing task time window that is supported at the UE.

7. The UE of claim 4, wherein in case that the computing task is supported at the UE while the UE is unable to perform the computing task temporarily, the reason of failing comprises at least one of:

low battery energy;

overheating;

overloading;

lack of configuration or input; or

the first computing task condition is not fulfilled.

8. The UE of claim 7, wherein the second message further indicates at least one of the following:

an estimated time that the time duration will last; or

a required configuration or input which is missing currently.

9. The UE of claim 1, wherein the first message is a radio resource control (RRC) reconfiguration message, and the second message is a RRC reconfiguration complete message in response to the RRC reconfiguration message.

10. The UE of claim 1, wherein the first message requests for performing the computing task which has been pre-configured at the UE, and the second message is transmitted in response to the first message.

11. The UE of claim 1, wherein the processor is configured to transmit the second message by:

transmitting, in case that the UE is unable to report a result of the computing task at a reporting instance, a reporting message as the second message to the network entity.

12. The UE of claim 11, wherein the reporting message comprises measurements result for the same object of the computing task.

13. The UE of claim 1, wherein the first message is received from a base station or a location management function (LMF).

14. The UE of claim 13, wherein the computing task is for UE positioning, and the processor is further configured to:

receive, from the LMF, a configuration indicating a secondary positioning method;

generate, based on determining a failure in performing the UE positioning, location information or assisting information using the secondary positioning method; and

transmit the location information or the assisting information to the LMF.

15. The UE of claims 13, wherein the processor is further configured to:

transmit a third message to the network entity to abort the computing task based on determining that the UE cannot perform the computing task.

16. A network entity comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

transmit, via the transceiver, a first message to a user equipment (UE) requesting the UE to perform a computing task associated with wireless communication; and

receive, via the transceiver, a second message indicating that the UE fails in

performing the computing task from the UE.

17. The network entity of claim 16, wherein the network entity is a base station or a location management function (LMF).

18. The network entity of claim 17, wherein the computing task is for UE positioning, and the processor is further configured to:

transmit, to the UE, a configuration indicating a secondary positioning method;
and

receive, from the UE, location information or assisting information generated using the secondary positioning method.

19. A base station comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

receive, from a location management function (LMF), a first message requesting the base station to perform a computing task associated with wireless communication; and

transmit, to the LMF, a second message indicating that the base station fails in performing the computing task.

20. A processor for wireless communication, comprising:

at least one memory; and

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

receive, from a network entity, a first message requesting the processor to perform a computing task associated with wireless communication; and

transmit, to the network entity, a second message indicating that the processor fails in performing the computing task.