AIoT DEVICE DISCOVERY AND UPDATE

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to apparatuses and methods for ambient internet of things (AIoT) device discovery and update.

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] AIoT has been regarded as an important internet of things (IoT) service and is being extensively studied. SA1 is considering devices being either battery-less or with limited energy storage capability (i.e., using a capacitor) and the energy is provided through the harvesting of radio waves, light, motion, heat, or any other power source that could be seen suitable. SA2 has decided to study two main types of AIoT device in Release 19, i.e., device-terminated (DT) and device-originated - device-terminated triggered (DO-DTT).

[0004] Two connectivity topologies for AIoT are to be studied. In AIoT Topology 1, an AIoT device directly and bidirectionally communicates with a network entity. In AIoT Topology 2, an AIoT device communicates bidirectionally with an intermediate node between the AIoT device and a network entity. The intermediate node transfers Ambient

IoT data and/or signalling between the network entity and the AIoT device. In AIoT Topology 2, a UE can act as the intermediate node which is under the network control.

[0005] What's more, three different kinds of services are being considered, namely, inventory, command read and command write.

SUMMARY

[0006] The present disclosure relates to UE reader, apparatuses and methods for AIoT device discovery and update. With the UE, apparatuses and methods, the first apparatus or the second apparatus may determine association between the at least one AIoT device and the UE. Therefore, when an AIoT application (APP) server sends a service request with a certain target area or a certain device identity (ID), based on the locally stored location and association information between the UE and the AIoT device, the AIoTF or the AMF will be able to find the corresponding UE and forward the service request for the AIoT device to the UE directly. Based on that, the UE can further send the service request to the target AIoT device. This can greatly help the first apparatus or the second apparatus to handle the AIoT services.

[0007] Some implementations of a UE described herein may include a processor and a transceiver coupled to the processor, wherein the processor is configured to: perform at least one of an AIoT device discovery procedure or an AIoT device discovery update procedure; and transmit, via the transceiver to a first apparatus or a second apparatus, first information about at least one AIoT device to be served by the UE.

[0008] In some implementations, the processor is further configured to: receive an AIoT device discovery request via the transceiver from the first apparatus, the second apparatus or an AIoT application server.In such implementations, the processor is configured to perform the AIoT device discovery procedure based on the AIoT device discovery request.

[0009] In some implementations, the AIoT device discovery request received from the AIoT application server comprises an inventory request.In such implementations, the processor is configured to perform the AIoT device discovery procedure based on the inventory request.

[0010] In some implementations, the first information about the at least one AIoT device comprises at least one of the following: at least one identity (ID) of the at least one

AIoT device, at least one location of the at least one AIoT device, at least one status of the at least one AIoT device, at least one type of the at least one AIoT device, capability of the at least one AIoT device, or a timestamp when the first information is obtained.

[0011] In some implementations, the processor is further configured to: transmit, via the transceiver to the first apparatus, second information about the UE associated with the first information about the at least one AIoT device.

[0012] In some implementations, the second information about the UE comprises at least one of the following: an identity (ID) of the UE, a serving area of the UE, a location of the UE, or capability of the UE.

[0013] In some implementations, the processor is further configured to: receive an AIoT device discovery update request via the transceiver from the first apparatus, the second apparatus or an AIoT application server. In such implementations, the processor is configured to perform the AIoT device discovery update procedure based on the AIoT device discovery update request.

[0014] In some implementations, the AIoT device discovery update request received from the AIoT application server comprises an inventory request. In such implementations, the processor is configured to perform the AIoT device discovery update procedure based on the inventory request.

[0015] In some implementations, the processor is further configured to: before performing the AIoT device discovery update procedure, transmit a first message via the transceiver to the first apparatus or the second apparatus, wherein the first message comprises at least one of the following: an indication indicating that the at least one AIoT device that the UE is serving is updated, a reason why the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or timestamp when the at least one AIoT device that the UE is serving is updated; and receive an AIoT device discovery update request via the transceiver from the first apparatus or the second apparatus, In some implementations, the AIoT device discovery update request comprises the ID of the UE. In such implementations, the processor is configured to perform the AIoT device discovery update procedure by: performing the AIoT device discovery update procedure based on the AIoT device discovery update request.

[0016] In some implementations, the processor is configured to transmit the first

information about the at least one AIoT device by: transmitting, via the transceiver to the first apparatus or the second apparatus, an AIoT device discovery update result which comprises the first information about the at least one AIoT device.

[0017] In some implementations, the processor is configured to perform the AIoT device discovery update procedure by: based on determining that the at least one AIoT device that the UE is serving is updated, performing the AIoT device discovery update procedure.

[0018] In some implementations, the processor is configured to transmit the first information about the at least one AIoT device by: transmitting, via the transceiver to the first apparatus or the second apparatus, an AIoT device discovery update result which comprises the first information about the at least one AIoT device.

[0019] In some implementations, the AIoT device discovery update result further comprises at least one of the following: second information about the UE associated with the first information about the at least one AIoT device, an indication indicating that the at least one AIoT device that the UE is serving is updated, a reason why the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or timestamp when the at least one AIoT device that the UE is serving is updated.

[0020] Some implementations of a first apparatus described herein may include: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the first apparatus to: determine that at least one AIoT device that a UE is serving is updated; and cause an AIoT device discovery update procedure to be performed.

[0021] In some implementations, the first apparatus causes the AIoT device discovery update procedure to be performed by transmitting a first message to a second apparatus, wherein the first message comprises at least one of the following: an indication indicating that the at least one AIoT device that the UE is serving is updated, a reason why the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or timestamp when the at least one AIoT device that the UE is serving is updated; receiving an AIoT device discovery update request from the second apparatus, wherein the AIoT device discovery update request comprises the ID of the UE; and transmitting the AIoT device discovery update request to the UE.

[0022] In some implementations, the first apparatus causes the AIoT device discovery update procedure to be performed by: based on determining that the UE is updated, transmitting an AIoT device discovery update request to the UE, wherein the AIoT device discovery update request comprises the ID of the UE.

[0023] In some implementations, the first apparatus is further caused to: receive, from the UE, an AIoT device discovery update result which comprises the first information about the at least one AIoT device; and transmit the AIoT device discovery update result to the second apparatus.

[0024] In some implementations, the AIoT device discovery update result further comprises at least one of the following: second information about the UE associated with the the first information about the at least one AIoT device, a reason why the at least one AIoT device that the UE is serving is updated, an indication indicating that the at least one AIoT device that the UE is serving is updated, timestamp when the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, or a location of the UE.

[0025] In some implementations, the first apparatus is caused to determine that the UE is updated based on determining one of the following: a tracking area update request message is received from the UE; a path switch request is received from a target network entity serving the UE, wherein the path switch request comprises a location of the UE and an identity (ID) of the UE; or a handover required request message is received from a source network entity serving the UE, wherein the handover required request message comprises the ID of the UE.

[0026] In some implementations, the first apparatus implements a source access and mobility management function (AMF) serving the UE, and the second apparatus implements an AIoT function (AIoTF). In such implementations, the first apparatus is further caused to transmit at least one of the following to a target AMF serving the UE: an identity (ID) of the second apparatus, an ID of the UE, a location of the UE, or an indication indicating that the at least one AIoT device that the UE is serving is updated.

[0027] In some implementations, the first apparatus implements a source access and mobility management function (AMF) serving the UE, and the second apparatus implements an AIoT function (AIoTF). In such implementations, the first apparatus is further caused to transmit at least one of the following to the second apparatus: an

indication indicating that the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or an ID of a target AMF serving the UE.

[0028] In some implementations, the first apparatus is implemented as an access and mobility management function (AMF) serving the UE, and the second apparatus implements a source AIoT function (AIoTF) serving the UE. In such implementations, the first apparatus is further caused to transmit at least one of the following to the second apparatus: an identity (ID) of a target AIoTF serving the UE, an ID of the UE, or a location of the UE.

[0029] In some implementations, the first apparatus is implemented as an access and mobility management function (AMF) serving the UE, and the second apparatus implements a target AIoT function (AIoTF) serving the UE. In such implementations, the first apparatus is further caused to transmit at least one of the following to the second apparatus: an identity (ID) of a source AIoTF serving the UE, an ID of the UE, or a location of the UE.

[0030] In some implementations, the first apparatus is further caused to: transmit, to the UE, an AIoT device discovery request to the UE.

[0031] Some implementations of a second apparatus described herein may include: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the second apparatus to: receive a first message from a first apparatus or a UE serving at least one AIoT device, wherein the first message comprises at least one of the following: an indication indicating that the at least one AIoT device that the UE is serving is updated, a reason why the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or timestamp when the at least one AIoT device that the UE is serving is updated; and transmit an AIoT device discovery update request to the first apparatus or the UE, wherein the AIoT device discovery update request comprises the ID of the UE; and receive, from the first apparatus or the UE, an AIoT device discovery update result which comprises first information about the at least one AIoT device.

[0032] In some implementations, the second apparatus is further caused to: determine association between the UE and the at least one AIoT device based on second information about the UE and the first information about the at least one AIoT device.

[0033] In some implementations, the AIoT device discovery update result further comprises at least one of the following: second information about the UE associated with the the first information about the at least one AIoT device, an indication indicating that the at least one AIoT device that the UE is serving is updated, a reason why the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or timestamp when the at least one AIoT device that the UE is serving is updated.

[0034] In some implementations, the second apparatus is further caused to expose at least one of the following to an AIoT application server: second information about the UE, an indication indicating that the at least one AIoT device that the UE is serving is updated, or a location of the UE.

[0035] In some implementations, the first apparatus implements a source access and mobility management function (AMF) serving the UE, and the second apparatus implements an AIoT function (AIoTF). In such implementations, the second apparatus is further caused to receive at least one of the following from the first apparatus or a target AMF serving the UE: an indication indicating that the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or an ID of the target AMF.

[0036] In some implementations, the first apparatus is implemented as an access and mobility management function (AMF) serving the UE, and the second apparatus implements a source AIoT function (AIoTF) serving the UE. In such implementations, the second apparatus is further caused to receive at least one of the following from the first apparatus: an identity (ID) of a target AIoTF serving the UE, an ID of the UE, or a location of the UE.

[0037] In some implementations, the second apparatus is further caused to transmit at least one of the following to a target AIoTF serving the UE: the ID of the UE, the location of the UE, or context information of the UE.

[0038] In some implementations, the first apparatus is implemented as an access and mobility management function (AMF) serving the UE, and the second apparatus implements a target AIoT function (AIoTF) serving the UE. In such implementations, the second apparatus is further caused to receive at least one of the following from the first apparatus: an identity (ID) of a source AIoTF serving the UE, an ID of the UE, or a

location of the UE.

[0039] In some implementations, the second apparatus is further caused to obtain, based on the ID of the UE, context information of the UE from a source AIoTF serving the UE.

[0040] In some implementations, the second apparatus is further caused to: transmit, to the UE, an AIoT device discovery request to the UE.

[0041] In some implementations, the second apparatus is further caused to: receive, from an AIoT application server an inventory request. In such implementations, the second apparatus is caused to transmit the AIoT device discovery request by transmitting the inventory request to the UE.

[0042] Some implementations of a method described herein may include: performing at least one of an AIoT device discovery procedure or an AIoT device discovery update procedure; and transmitting, to a first apparatus or a second apparatus, first information about at least one AIoT device to be served by the UE.

[0043] Some implementations of a method described herein may include: determining that at least one AIoT device that a user equipment (UE) is serving is updated; and causing an AIoT device discovery update procedure to be performed.

[0044] Some implementations of a method described herein may include: receiving a first message from a first apparatus or a UE serving at least one AIoT device, wherein the first message comprises at least one of the following: an indication indicating that the at least one AIoT device that the UE is serving is updated, a reason why the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or timestamp when the at least one AIoT device that the UE is serving is updated; and transmitting an AIoT device discovery update request to the first apparatus or the UE, wherein the AIoT device discovery update request comprises the ID of the UE; and receiving, from the first apparatus or the UE, an AIoT device discovery update result which comprises first information about the at least one AIoT device.

[0045] Some implementations of a processor described herein may include at least one memory and a controller coupled with the at least one memory and configured to cause the controller to: perform at least one of an AIoT device discovery procedure or an AIoT device discovery update procedure; and transmit, via the transceiver to a first

apparatus or a second apparatus, first information about at least one AIoT device to be served by the UE.

[0046] It is to be understood that the summary section is not intended to identify key or essential features of embodiments of the present disclosure, nor is it intended to be used to limit the scope of the present disclosure. Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0047] Figs. 1A and 1B illustrate an example of a wireless communications system that supports AIoT device discovery and update in accordance with aspects of the present disclosure, respectively;

[0048] Fig. 2 illustrates an example of a protocol stack for AIoT Topology 2 in accordance with aspects of the present disclosure;

[0049] Fig. 3 illustrates a signaling diagram illustrating an example process that supports AIoT device discovery and update in accordance with aspects of the present disclosure;

[0050] Figs. 4 to 7 illustrate a signaling diagram illustrating an example process that supports AIoT device discovery in accordance with aspects of the present disclosure, respectively;

[0051] Figs. 8 to 21 illustrate a signaling diagram illustrating an example process that supports AIoT device discovery update in accordance with aspects of the present disclosure, respectively;

[0052] Fig. 22 illustrates an example of a device that supports AIoT device discovery and update in accordance with some aspects of the present disclosure;

[0053] Fig. 23 illustrates an example of a processor that supports AIoT device discovery and update in accordance with aspects of the present disclosure; and

[0054] Figs. 24 to 26 illustrate a flowchart of a method that supports AIoT device discovery and update in accordance with aspects of the present disclosure, respectively.

DETAILED DESCRIPTION

[0055] 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.

[0056] 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] In AIoT Topology 2, a UE is working between an AIoT device and a network entity to process and transfer the message. It is necessary for the 5GC to know about the information of the UE and then handle the AIoT services. It is proposed that the UE can firstly initiate the registration procedure by itself towards the AIoT function/AMF in the 5GC so that it will have the information about the UE. Hereinafter, a UE acting as an intermediate node between an AIoT device and a network entity is also referred to as a UE reader or reader.

[0061] Since the interaction or communication between the AIoT device and the network entity is bridged on the involvement of the reader, it is necessary for the AIoT function (AIoTF), or the access and mobility management function (AMF) to know association or binding between the reader and the AIoT device within a serving area of the reader.

[0062] In view of the above, the present disclosure provides a solution that supports AIoT device discovery and update. In this solution, a UE performs at least one of an AIoT device discovery procedure or an AIoT device discovery update procedure. In turn, the UE transmits, to a first apparatus or a second apparatus, first information about at least one AIoT device to be served by the UE. With this solution, the first apparatus or the second apparatus may determine association between the at least one AIoT device and the UE. Therefore, when an AIoT application (APP) server sends a service request with a certain target area or a certain device identity (ID), based on the locally stored location and association information between the UE and the AIoT device, the AIoTF or the AMF will be able to find the corresponding UE and forward the service request for the AIoT device to the UE directly. Based on that, the UE can further send the service request to the target AIoT device. This can greatly help the first apparatus or the second apparatus to handle the AIoT services.

[0063] Aspects of the present disclosure are described in the context of a wireless communications system.

[0064] Fig. 1A illustrates an example of a wireless communications system 100A that supports AIoT device discovery and update in accordance with aspects of the present disclosure. The wireless communications system 100A may include one or more network entities 102 (also referred to as network equipment (NE)), one or more terminal devices or UEs 104, a core network 106, and a packet data network 108. The wireless

communications system 100A may support various radio access technologies. In some implementations, the wireless communications system 100A 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 100A may be a 5G network, such as an NR network. In other implementations, the wireless communications system 100A 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 100A may support radio access technologies beyond 5G. Additionally, the wireless communications system 100A may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0065] The one or more network entities 102 may be dispersed throughout a geographic region to form the wireless communications system 100A. 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.

[0066] 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.

[0067] The one or more UEs 104 may be dispersed throughout a geographic region of the wireless communications system 100A. 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 100A. In some other implementations, a UE 104 may be mobile in the wireless communications system 100A.

[0068] 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 100A.

[0069] 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.

[0070] 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).

[0071] 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.

[0072] 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)).

[0073] 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 adaption protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU may be connected to one or more DUsor 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.

[0074] 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).

[0075] 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.

[0076] 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.

[0077] 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 (APP) 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).

[0078] In the wireless communications system 100A, the network entities 102 and the UEs 104 may use resources of the wireless communications system 100A (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.

[0079] One or more numerologies may be supported in the wireless communications system 100A, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g., μ=0) may be associated with a first subcarrier spacing (e.g., 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g., μ=0) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., μ=1) may be associated with a second subcarrier

spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., μ=2) may be associated with a third subcarrier spacing (e.g., 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g., μ=3) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., μ=4) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0080] 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.

[0081] 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 100A. For instance, the first, second, third, fourth, and fifth numerologies (i.e., μ=0, μ=1, μ=2, μ=3, μ=4) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g., quantity) of symbols (e.g., OFDM symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., μ=0) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0082] In the wireless communications system 100A, 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 100A 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.

[0083] FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g., μ=0), which includes 15 kHz subcarrier spacing; a second numerology (e.g., μ=1), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., μ=3), which includes 120 kHz subcarrier spacing.

[0084] Fig. 1B illustrates an example of a wireless communications system 100B that supports AIoT device discovery and update in accordance with aspects of the present disclosure.

[0085] Generally, Fig. 1B illustrates network entities or network functions (NFs) in the core network 106 as shown in Fig. 1A.

[0086] As shown in Fig. 1B, the core network 106 may comprise an AMF 120, an AIoTF 122, an authentication server function (AUSF) 124, a unified data management (UDM) 126, a network exposure function (NEF) 128 and an application function (AF) 130.

[0087] In some implementations, the AIoTF 122 may be a dedicated NF in the 5GC that handles the AIoT related service. Alternatively, the AIoTF 122 may be co-located with the AMF 120.

[0088] In some implementations, the AIoTF 122 may implement at least one of the following functions:

- Receive and transmit AIoT related data/signalling from/to the AIoT APP server 132;
- Select appropriate UE/RAN reader for the transmission of AIoT data/signalling to the target location/area;
- Receive a registration request from the reader (such as the UE 104) and store information about the reader and information about the associated AIoT devices; or
- Establish an AIoT session with the AIoT AF/AS for transmission.
- Establish an AIoT session with the UE/RAN reader for transmission.
- Authorize and authenticate the AIoT device and reader by interacting with UDM and AUSF.

[0089] As shown in Fig. 1B, the wireless communications system 100B also comprises the network entity 102, the UE 104 and at least one AIoT device 140.

[0090] In some implementations, the at least one AIoT device 140 communicates bidirectionally with an intermediate node between the AIoT device 140 and the network entity 102. The intermediate node transfers AIoT data and/or signalling between the network entity 102 and the at least one AIoT device 140. The UE 104 may act as the intermediate node between the AIoT device 140 and the network entity 102.

[0091] In some implementations, the AF 132 may support interaction with the core network 106 to provide services, such as influencing data routing decisions, policy control functions or providing third-party services to the network.

[0092] In some implementations, the AF 132 may comprise an AIoT APP server 132.

[0093] It shall be noted that the name of each NF as described above is only exemplary. For example, the AIoTF 122 may be named differently.

[0094] It shall be also noted that although one AIoT device is shown in Fig. 1B by way of example, the wireless communications system 100B may comprise more than one AIoT devices.

[0095] Fig. 2 illustrates an example of a protocol stack for AIoT Topology 2 in accordance with aspects of the present disclosure. As shown in Fig. 2, there can be a direct connection between the UE 104 and the AIoTF 122 in the 5GC via an AIoT Layer. Based

on this, once the UE 104 has registered at the AIoTF 122 via the AMF 120, they can communicate with each other directly, i.e., the AMF 120 transparently transfers a message between the AIoTF 122 and the UE 104. The UE 104 can have an N1 NAS layer like connection with the AMF 120, and the AMF 120 can have an interface Nxx based on the service-based interface (SBI) with the AIoTF 122, just like the AMF 120 interacting with other 5GC NF.

[0096] Fig. 3 illustrates a signaling diagram illustrating an example process 300 that supports AIoT device discovery and update in accordance with aspects of the present disclosure. The process 300 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 300 will be described with reference to Fig. 1B. The process 300 may involve the at least one AIoT device 140, the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B.

[0097] As shown in Fig. 3, the UE 104 performs 310 at least one of an AIoT device discovery procedure or an AIoT device discovery update procedure with the at least one AIoT device 140.

[0098] In turn, the UE 104 transmits 320, to the AMF 120, first information about the at least one AIoT device 140 to be served by the UE 104. Hereinafter, first information about at least one AIoT device is also referred to as device information or AIoT device information for brevity.

[0099] Alternatively, the UE 104 transmits 330, to the AIoTF 122, the first information about the at least one AIoT device 140 to be served by the UE 104.

[0100] With the process 300, the AMF 120 or the AIoTF 122 may determine association between the at least one AIoT device 140 and the UE 104. Therefore, when an AIoT APP server sends a service request indicating a certain target area or a certain device ID, based on the locally stored location and association information between the UE 104 and the AIoT device 140, the AMF 120 or the AIoTF 122 will be able to find the corresponding UE 104 and forward the service request for the AIoT device 140 to the UE 104 directly. Based on that, the UE 104 can further send the service request to the target

AIoT device 140. This can greatly help the AMF 120 or the AIoTF 122 to handle the AIoT services.

[0101] Fig. 4 illustrates a signaling diagram illustrating an example process 400 that supports AIoT device discovery in accordance with aspects of the present disclosure. The process 400 may be considered as an example implementation of the process 300.

[0102] The process 400 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 400 will be described with reference to Fig. 1B. The process 400 may involve the at least one AIoT device 140, the UE 104, the AMF 120 and the AIoTF 122, the AUSF 124, the UDM 126, the NEF 128 and the AIoT APP server 132 in Fig. 1B.

[0103] Generally, Fig. 4 illustrates a registration procedure and an AIoT device discovery procedure. The registration procedure may involve actions 410, 415, 420, 425, 430 and 435. The AIoT device discovery procedure may involve actions 440A, 445 and 450.

[0104] With the registration procedure, the AIoT reader 104 (i.e., UE 104) registers itself at both the AMF 120 and the AIoTF 122.

[0105] When the registration procedure is finished, the AIoTF 122, the AMF 120 or the UE 104 can actively initiate the AIoT device discovery procedure to find the at least one AIoT device 140 within a serving area of the UE 104. By the AIoT device discovery procedure, the AMF 120, the AIoTF 122 and the UE 104 will have first information about the at least one AIoT device 140 within the serving area of the UE 104 and determine association between the UE 104 and the at least one AIoT device 140.

[0106] It should be noted that the AIoT device discovery procedure may be initiated by UE 104, the AMF 120, or the AIoTF 122 actively. An AIoT device discovery result, e.g., the first information about the at least one AIoT device 140 and second information about the associated UE 104, will be provided to the AMF 120 and/or the AIoTF 122 to find the corresponding UE 104 for at least one target AIoT device. The AIoT device

discovery result may be exposed to the AIoT APP server 132 as inventory results upon request.

[0107] As shown in Fig. 4, at 410, the UE 104 transmits an AIoT reader registration request towards the AMF 120. The AIoT reader registration request may comprise registration information of an AIoT reader (such as the UE 104).

[0108] Optionally, the registration information of the UE 104 may comprise a reader indication indicating that the UE 104 acts as an AIoT reader.

[0109] Optionally, the registration information of the UE 104 may comprise an ID of the UE 104. Hereinafter, the ID of the UE 104 is also referred to as UE ID or reader ID for brevity. For example, the ID of the UE 104 may be an internal UE ID, e.g., subscription permanent identifier (SUPI).

[0110] Alternatively or additionally, the registration information of the UE 104 may comprise at least one of the following: a location of the UE 104 (e.g., GPS coordinate), capability of the UE 104, registration type, and a serving area of the UE 104. Hereinafter, the location of the UE 104 is also referred to as UE location, and the capability of the UE 104 is also referred to as UE capability, the serving area of the UE 104 is also referred to as UE serving area.

[0111] For example, the capability of the UE 104 may comprise at least one of the following: support transmission type (CP/UP), radio capability, or group support capability.

[0112] For example, the registration type may comprise one of the following: initial registration, periodic registration, or mobility registration.

[0113] In some implementations, if the capability of the UE 104 is provided, then the reader indication may be no longer needed.

[0114] At 415, the AMF 120 receives the registration request from the UE 104, stores the registration information of the UE 104, and selects an AIoTF serving the UE 104 from a network repository function (NRF, which is not shown) based on the location of the UE 104. The NRF returns NF ID of the selected AIoTF (such as the AIoTF 122) to the AMF 120. It is assumed that the AIoTF 122 has registered itself in the NRF, together with its supporting capability.

[0115] At 420, the AMF 120 forwards the AIoT reader registration request to the selected the AIoTF 122.

[0116] The AIoT reader registration request may comprise registration information of the UE 104. For example, the registration information of the UE 104 may comprise at least one of the following: UE ID, registration type, UE capability, UE serving area or UE location.

[0117] At 425, after receiving the registration request, the AIoTF 122 interacts with the UDM 126 to check and retrieve subscription data of the UE 104. It is assumed that subscription data of the UE 104 and the at least one AIoT device 140 has been pre-configured and stored at the UDM 126. Then, the AIoTF 122 registers for the UE 104, optionally stores UE capability, UE serving area and UE location in the UDM 126.

[0118] In some implementations, the AIoTF 122 may obtain second information about the UE 104 from the registration information of the UE 104. Hereinafter, second information about the UE 104 is also referred to as reader information for brevity.

[0119] In some implementations, the AIoTF 122 may also store the second information about the UE 104 and create a context for the UE 104 locally.

[0120] In some implementations, the second information about the UE 104 may comprise at least one of the following: UE ID, UE capability, UE serving area or UE location.

[0121] The UDM 126 or unified data repository (UDR, which is not shown) stores subscription data of the at least one AIoT device 140, the subscription data of the UE 104 and (AIoT) application subscription data. The application subscription data may comprise configuration information for the AIoT application including credentials. The subscription data of the at least one AIoT device 140 may comprise individual device ID and corresponding credentials.

[0122] At 430, the AIoTF 122 transmits an AIoT reader registration response to the AMF 120 first, together with the UE ID.

[0123] Optionally, the AIoT reader registration response may comprise configuration data for the UE 104 acting as AIoT reader. For example, the configuration data for the UE 104 acting as AIoT reader may comprise at least one of the following: AIoTF UP information (e.g., IP address, tunnel endpoint identifier (TEID)) for potential UP

transmission, transmission indication (CP/UP), aggregation indication, or a discovery indication indicating the UE 104 to perform the AIoT device discovery procedure so that the AIoTF 122 can have the association between the UE and its serving AIoT devices. The AMF 120 will store and forward the information in the AIoT reader registration response to the target UE (such as the UE 104). The configuration data for the UE 104 acting as AIoT reader may also be provided to the UE 104.

[0124] Alternatively, the discovery indication may also be transmitted separately at 440A after the registration procedure is finished. Therefore, when the AIoT APP server 132 transmits a message towards some specific device(s), the AIoTF 122, based on the association or binding between the UE 104 and the at least one AIoT device 140 obtained by the AIoT device discovery procedure, will then know the corresponding UE to contact and forward the message to the UE 104 and then to the at least one AIoT device 140.

[0125] Alternatively, the discovery indication may also be transmitted by the AMF 120 separately after the registration of the UE 104 is finished, which will be described with reference to Fig. 5 later.

[0126] At 435, the AMF 120 forwards the AIoT reader registration response and the optional discovery indication to the UE 104. The AMF 120 may also include, in the AIoT reader registration response, an activation indication of the UE 104 as AIoT reader based on an indication from the AIoTF 122 (whether the AIoTF 122 has allowed or not).

[0127] Alternatively, the AIoTF 122 may directly transmit the AIoT reader registration response to the UE 104, transparently to the AMF 120.

[0128] At 440A, the AIoTF 122 transmits an AIoT device discovery request to the UE 104 to initiate the AIoT device discovery procedure. The AIoT device discovery request may comprise the discovery indication indicating the UE 104 to perform the AIoT device discovery procedure. The configuration information of the AIoT device discovery procedure may be the same as that of the inventory procedure configured by the AIoT APP server 132, or pre-configured. If the AIoT APP server 132 initiates the inventory procedure, the configuration information will be transmitted to the UE 104 within the AIoT device discovery request.

[0129] At 445, the UE 104 performs the AIoT device discovery procedure towards at least one AIoT device (such as the AIoT device 140) within its serving area, using a

process like Paging or random access channel (RACH) to obtain the first information about the at least one AIoT device 140.

[0130] In some implementations, the first information about the at least one AIoT device 140 may comprise at least one of the following: at least one ID of the at least one AIoT device 140, at least one location of the at least one AIoT device 140, at least one status of the at least one AIoT device 140, at least one type of the at least one AIoT device 140, capability of the at least one AIoT device 140, or a timestamp when the first information is obtained.

[0131] Hereinafter, at least one ID of the at least one AIoT device 140 is also referred to as device ID for brevity. For example, the device ID may comprise group-based ID or individual IDs of AIoT devices. At least one location of the at least one AIoT device 140 is also referred to as device location for brevity. At least one status of the at least one AIoT device 140 is also referred to as device status for brevity. For example, the device status may comprise one of the following: enable, disable, or permanently disable. At least one type of the at least one AIoT device 140 is also referred to as device type for brevity. Capability of the at least one AIoT device 140 is also referred to as device capability for brevity.

[0132] At 450, the UE 104 transmits an AIoT device discovery report to either the AMF 120, or the AIoTF 122 directly.

[0133] In some implementations, the AIoT device discovery report may comprise the first information about the at least one AIoT device 140. In some implementations, the AIoT device discovery report may comprise the first information about the at least one AIoT device 140 associated with second information about the UE 104. For example, the AIoT device discovery report may comprise the first information about the at least one AIoT device 140 associated with the reader ID (such as the ID of the UE 104)

[0134] For example, the AIoT device discovery report may comprise at least one of the following: device ID, device location, device status, device type, and so on.

[0135] As described above, the AIoTF 122 may obtain second information about the UE 104 from the registration information of the UE 104.

[0136] In some implementations, upon obtaining the first information about the at least one AIoT device 140 from the AIoT device discovery report, the AIoTF 122 may

determine association between the UE 104 and the at least one AIoT device 140 based on the first information about the at least one AIoT device 140 and the second information about the UE 104.

[0137] For example, the association between the UE 104 and the at least one AIoT device 140 may be in the form of UE ID # 1/device ID #1, device ID #2, ..., device ID #N.

[0138] For another example, the association between the UE 104 and the at least one AIoT device 140 may be in the form of UE ID # 1/device ID #1, device ID #2, ..., device ID #N, together with other information about the UE 104 and the at least one AIoT device, e.g., UE location and device location, UE serving area, device type, device status, UE capability, and so on.

[0139] In some implementations, the AIoTF 122 may store the association between the UE 104 and the at least one AIoT device 140 locally. When the AIoT APP server 132 transmits a service request with certain device ID or device location to the core network 106, the AIoTF 122 or the AMF 120 can refer to the locally saved association to find the corresponding UE and continue to transmit the message to it.

[0140] After the action 450, the AIoTF 122 may interact with the AUSF 124, the UDM 126 to authenticate the device ID using the credential. This credential can be provided to the at least one AIoT device 140.

[0141] Fig. 5 illustrates a signaling diagram illustrating an example process 500 that supports AIoT device discovery in accordance with aspects of the present disclosure. The process 500 may be considered as an example implementation of the process 300.

[0142] The process 500 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 500 will be described with reference to Fig. 1B. The process 500 may involve the at least one AIoT device 140, the UE 104, the AMF 120 and the AIoTF 122, the AUSF 124, the UDM 126, the NEF 128 and the AIoT APP server 132 in Fig. 1B.

[0143] The process 500 is similar to the process 400. The process 500 is different from the process 400 in an action 440B.

[0144] Specifically, at 440B, the AMF 120 transmits an AIoT device discovery request to the UE 104 to initiate the AIoT device discovery procedure. The AIoT device discovery request may comprise the discovery indication. The configuration information of the AIoT device discovery procedure may be the same as that of the inventory procedure configured by the AIoT APP server 132, or pre-configured.

[0145] Fig. 6 illustrates a signaling diagram illustrating an example process 600 that supports AIoT device discovery in accordance with aspects of the present disclosure. The process 600 may be considered as an example implementation of the process 300.

[0146] The process 600 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 600 will be described with reference to Fig. 1B. The process 600 may involve the at least one AIoT device 140, the UE 104, the AMF 120 and the AIoTF 122, the AUSF 124, the UDM 126, the NEF 128 and the AIoT APP server 132 in Fig. 1B.

[0147] The process 600 is similar to the process 400. The process 600 is different from the process 400 in an action 440C.

[0148] Specifically, at 440C, the UE 104 determines to initiate the AIoT device discovery procedure by itself. For example, the UE 104 may determine to initiate the AIoT device discovery procedure based on the per-configured configuration information of the AIoT device discovery procedure, or be the same as that of the inventory procedure configured by the AIoT APP server 132.

[0149] Alternatively, in some implementations, apart from the cases that the AIoTF 122, the AMF 120 or the UE 104 initiates the AIoT device discovery procedure, the AIoT APP server 132 may trigger an inventory request, and the inventory request can be included in an AIoT device discovery request sent to the UE 104. the UE 104 may perform the AIoT device discovery procedure based on the inventory request. Then, an inventory

result can be included in the AIoT device discovery report. Then, the AIoTF 122 can expose the inventory result to the APP server 132. This will be described with reference to Fig. 7.

[0150] Fig. 7 illustrates a signaling diagram illustrating an example process 700 that supports AIoT device discovery in accordance with aspects of the present disclosure. The process 700 may be considered as an example implementation of the process 300.

[0151] The process 700 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 700 will be described with reference to Fig. 1B. The process 700 may involve the at least one AIoT device 140, the UE 104, the AMF 120 and the AIoTF 122, the AUSF 124, the UDM 126, the NEF 128 and the AIoT APP server 132 in Fig. 1B.

[0152] Generally, Fig. 7 illustrates an AIoT device discovery procedure triggered by the AIoT APP server 132 as an inventory request procedure. Before the inventory request procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4. For brevity, Fig. 7 does not illustrate the registration procedure of the UE 104.

[0153] With the registration procedure, the AIoT reader 104 (i.e., UE 104) registers itself at both the AMF 120 and the AIoTF 122. After successful registration of the UE 104 at the AIoTF 122, the AIoTF 122 may expose 710 the second information about the UE 104 to the AIoT APP server 132 via the NEF 128, e.g., in the external UE ID format, together with the location (may be transferred into external location information) of the UE 104.

[0154] At 720, after receiving the ID of the UE 104, or just by itself, the AIoT APP server 132 may trigger an inventory request procedure to know the AIoT devices by transmitting an inventory request towards the AIoTF 122.

[0155] In some implementations, the AIoT APP server 132 may transmit the inventory request together with the reader ID, a target area, inventory filtering criteria,

inventory timer and destination report address.

[0156] The inventory filtering criteria may comprise certain filtering principles for the inventory results, of which can be performed by the UE 104 or the AIoTF 122, e.g., device type (DT, DO-DTT), device location, device status (enable/disable/permanently disable). Only those devices matching the inventory filtering criteria will be reported to the AIoT APP server 132. The inventory timer is set to limit the inventory implementation duration at UE 104 side. When the timer is expired, the UE 104 will not wait for more response from the at least one AIoT device and may aggregate the responses and transmit them to the AIoTF 122 for further actions.

[0157] When the NEF 128 receives the inventory request, it will interact with the UDM 126 and the AUSF 124 to performing at least one of the following: authorizing the inventory request based on the pre-stored subscription information of the APP; authenticating the reader ID (if any); or translating the external UE ID (e.g., Generic Public Subscription Identifier (GPSI)) into internal UE ID (SUPI); or translating the external location information into internal location information.

[0158] Moreover, the NEF 128 will interact with the NRF to select an AIoTF (such as the AIoTF 122) based on the reader ID and/or the target area. Then, the NEF 128 forwards the inventory request towards the selected AIoTF 122.

[0159] At 730, the AIoTF 122 transmits the inventory request towards the UE 104 either based on the target area, or the reader ID.

[0160] At 740, after receiving the inventory request from the AIoTF 122, the UE 104 may initiate the AIoT device discovery procedure to get the response from at least one AIoT device.

[0161] At 750, the UE 104 transmits an AIoT device discovery report to the AIoTF 122. The AIoT device discovery report may comprise an inventory response. The inventory response may comprise the first information about the at least one AIoT device 140.

[0162] For example, the inventory response may comprise at least one of the following: device ID, device location, device status, device type, device capability, or a timestamp when the first information is obtained.

[0163] At 760, the AIoTF 122 authenticates the device ID with the AUSF 124 and

the UDM 126.

[0164] As described above, the AIoTF 122 may obtain the second information about the UE 104 from the registration information of the UE 104.

[0165] At 770, upon obtaining the first information about the at least one AIoT device 140 from the AIoT device discovery report, the AIoTF 122 may determine association between the UE 104 and the at least one AIoT device 140 based on the first information about the at least one AIoT device 140 and the second information about the UE 104.

[0166] In addition, the AIoTF 122 stores the association between the UE 104 and the at least one AIoT device 140 locally and exposes the inventory result to the AIoT APP server 132 via the NEF 128.

[0167] After the registration procedure of the UE 104 and the AIoT device discovery procedure, the AMF 120 and/or the AIoTF 122 has already stored the association between the UE 104 and the at least one AIoT device 140 within its serving area. Therefore, when device ID(s) is provided by the AIoT APP server 132 for certain services, the AMF 120 and/or the AIoTF 122 can immediately determine which UE to forward the message to.

[0168] In some implementations, when the UE 104 is serving as an AIoT reader, there is a possibility that the at least one AIoT device 140 within the serving area of the UE 104 could be updated or change. The update or change of the at least one AIoT device 140 may lead to the change of the association between the UE 104 and the at least one AIoT device 140.

[0169] In some implementations, UE mobility may lead to the update or change of the at least one AIoT device 140. For example, the UE 104 may move to another place (e.g., out of certain area limit that leads to the unreachability of the at least one AIoT device 140). This kind of UE mobility will lead to the update or change of the at least one AIoT device 140 that UE is serving and then lead to the change of the association between the UE 104 and the at least one AIoT device 140.

[0170] Alternatively, in some implementations, other factors such as radio link failure between the UE 104 and the network entity 102 may lead to the update or change of the at least one AIoT device 140. After the UE 104 is reconnected, the UE 104 may need an AIoT device discovery update procedure to check the current serving AIoT devices situation.

[0171] All these kinds of changes may alter the association between the UE 104 and the at least one AIoT device 140, and at least one of the AMF 120 and the AIoTF 122 needs to be notified about the changes and use the AIoT device discovery update procedure or inventory update procedure to obtain the updated association so that it can always find the exact UE serving at least one AIoT device.

[0172] Hereinafter, some implementations of the AIoT device discovery update procedure will be described with reference to Figs. 8 to 21.

[0173] Fig. 8 illustrates a signaling diagram illustrating an example process 800 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 800 may be considered as an example implementation of the process 300.

[0174] The process 800 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 800 will be described with reference to Fig. 1B. The process 800 may involve the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B as well as at least one AIoT device 150 which is not shown in Fig. 1B.

[0175] Generally, in the process 800, the UE 104 may trigger an AIoT device discovery update procedure by transmitting a first message to the AMF 120 or the AIoTF 122 based on subscription from the AMF 120 or the AIoTF 122, or based on pre-configuration. The process 800 may be related to UE mobility or other factors such as radio link failure.

[0176] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 8 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0177] As shown in Fig. 8, before performing the AIoT device discovery update

procedure, the UE 104 determines 805 that the at least one AIoT device 140 that the UE 104 is serving is updated.

[0178] In some implementations, the AIoTF 122 or the AMF 120 may subscribe to the UE 104 for the UE location and/or the UE status after registration of the UE 104. For example, if the UE 104 moves to a certain place that has beyond certain area limit which leads to the unreachability of the at least one AIoT device 140, the UE 104 may determine, based on the subscription or configuration from the AIoTF 122 or the AMF 120, that the at least one AIoT device 140 that the UE 104 is serving is updated.

[0179] Alternatively, the UE 104 may determine, based on pre-configuration, that the at least one AIoT device 140 that the UE 104 is serving is updated.

[0180] In turn, the UE 104 transmits 810 a first message to the AMF 120.

[0181] In some implementations, the first message may comprise an indication indicating that the at least one AIoT device 140 that the UE 104 is serving is updated. Hereinafter, the indication is also referred to as a device update indication.

[0182] Alternatively or additionally, the first message may comprise a reason why the at least one AIoT device 140 that the UE 104 is serving is updated. Hereinafter, the reason is also referred to as an update reason.

[0183] Alternatively or additionally, the first message may comprise at least one of the following: an ID of the UE 104 (i.e., UE ID), a location of the UE 104 (i.e., UE location), or timestamp when the at least one AIoT device 140 that the UE 104 is serving is updated.

[0184] In some implementations, if a different UE location associated with the ID of the UE 104 is sent to the AIoTF 122, there may be no need for the update reason and the discovery update indication to be provided.

[0185] Upon receiving the first message, the AMF 120 forwards 820 the first message to the AIoTF 122.

[0186] Alternatively, the UE 104 may transmit the first message to the AIoTF 122 directly (transparent to the AMF 120) based on subscription from the AIoTF 122 or pre-configuration.

[0187] Upon receiving the first message, the AIoTF 122 transmits 830 an AIoT

device discovery update request to the AMF 120.

[0188] Upon receiving the AIoT device discovery update request, the AMF 120 forwards 840 the AIoT device discovery update request to the UE 104.

[0189] Alternatively, the AIoTF 122 may transmit the AIoT device discovery update request to the UE 104 directly.

[0190] In some implementations, the AIoT device discovery update request may comprise the ID of the UE 104. Alternatively or additionally, the AIoT device discovery update request may comprise at least one of the following: discovery criteria, discovery timer, or discovery report address.

[0191] In turn, the UE 104 performs 850, based on the AIoT device discovery update request, the AIoT device discovery update procedure towards the at least one AIoT device 150. It shall be noted that the at least one AIoT device 150 may be the same as or different from the at least one AIoT device 140.

[0192] Through the AIoT device discovery update procedure, the UE 104 may obtain first information about the at least one AIoT device 150. For example, the first information about the at least one AIoT device 150 may comprise at least one of the following: device ID, device location, or device status.

[0193] After the AIoT device discovery update procedure, the UE 104 may transmit 860 an AIoT device discovery update result to the AMF 120. The AIoT device discovery update result may comprise the first information about the at least one AIoT device 150.

[0194] Additionally, the AIoT device discovery update result may comprise timestamp when the at least one AIoT device 140 is updated.

[0195] Upon receiving the AIoT device discovery update result, the AMF 120 forwards 870 the AIoT device discovery update result to the AIoTF 122.

[0196] Alternatively, the UE 104 may transmit the AIoT device discovery update result to the AIoTF 122 directly (transparent to the AMF 120).

[0197] Upon receiving the AIoT device discovery update result, the AIoTF 122 may interact 880 with the AUSF 124 and the UDM 126 to authenticate and authorize the at least one AIoT device 150. In turn, the AIoTF 122 may update the first information about the at least one AIoT device 140 with the first information about the at least one AIoT

device 150. The AIoTF 122 may determine association between the UE 104 and the at least one AIoT device 150 based on the first information about the at least one AIoT device 150 and the second information about the UE 104. In addition, the AIoTF 122 may store the association between the UE 104 and the at least one AIoT device 150 locally, and delete the association between the UE 104 and the at least one AIoT device 140. In other words, the AIoTF 122 may update the association between the UE 104 and the at least one AIoT device 140 with the association between the UE 104 and the at least one AIoT device 150.

[0198] In some implementations, upon receiving the first message, the AIoTF 122 may report the first message to the AIoT APP server 132 via the NEF 128. For example, the first message may comprise at least one of the following: the device update indication, the update reason, an ID of the UE 104 (i.e., UE ID), a location of the UE 104 (i.e., UE location), or timestamp when the at least one AIoT device 140 that the UE 104 is serving is updated. The AIoT APP server 132 can determine whether to initiate the inventory update procedure for this situation or not.

[0199] Fig. 9 illustrates a signaling diagram illustrating an example process 900 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 900 may be considered as an example implementation of the process 300.

[0200] The process 900 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 900 will be described with reference to Fig. 1B. The process 900 may involve the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B as well as at least one AIoT device 150 which is not shown in Fig. 1B.

[0201] Generally, in the process 900, the UE 104 may trigger an AIoT device discovery update procedure by transmitting a first message to the AMF 120 or the AIoTF 122 based on subscription from the AMF 120 or the AIoTF 122, or based on pre-configuration. The process 900 may be related to UE mobility or other factors such as

radio link failure.

[0202] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 9 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0203] As shown in Fig. 9, the UE 104 determines 905 that the at least one AIoT device 140 that the UE 104 is serving is updated.

[0204] Similar to the action 805 in Fig. 8, the UE 104 may determine, based on the subscription from the AIoTF 122 or the AMF 120, that the at least one AIoT device 140 that the UE 104 is serving is updated. Alternatively, the UE 104 may determine, based on pre-configuration, that the at least one AIoT device 140 that the UE 104 is serving is updated.

[0205] In turn, the UE 104 performs 910 the AIoT device discovery update procedure towards the at least one AIoT device 150.

[0206] Through the AIoT device discovery update procedure, the UE 104 may obtain first information about the at least one AIoT device 150. For example, the first information about the at least one AIoT device 150 may comprise at least one of the following: device ID, device location, or device status.

[0207] After the AIoT device discovery update procedure, the UE 104 may transmit 920 an AIoT device discovery update result to the AMF 120. The AIoT device discovery update result may comprise the first information about the at least one AIoT device 150.

[0208] In some implementations, the AIoT device discovery update result may further comprise the second information about the UE 104 associated with the first information about the at least one AIoT device 150.

[0209] In some implementations, the AIoT device discovery update result may further comprise at least one of the following: the update indication, the update reason, the UE ID, the UE location, or timestamp when the at least one AIoT device 140 that the UE 104 is serving is updated.

[0210] Upon receiving the AIoT device discovery update result, the AMF 120

forwards 930 the AIoT device discovery update result to the AIoTF 122.

[0211] Alternatively, the UE 104 may transmit the AIoT device discovery update result to the AIoTF 122 directly (transparent to the AMF 120).

[0212] Upon receiving the AIoT device discovery update result, the AIoTF 122 may interact 940 with the AUSF 124 and the UDM 126 to authenticate and authorize the at least one AIoT device 150. In turn, the AIoTF 122 may update the first information about the at least one AIoT device 140 with the first information about the at least one AIoT device 150. The AIoTF 122 may determine association between the UE 104 and the at least one AIoT device 150 based on the first information about the at least one AIoT device 150 and the second information about the UE 104. In addition, the AIoTF 122 may store the association between the UE 104 and the at least one AIoT device 150 locally, and delete the association between the UE 104 and the at least one AIoT device 140. In other words, the AIoTF 122 may update the association between the UE 104 and the at least one AIoT device 140 with the association between the UE 104 and the at least one AIoT device 150.

[0213] In some implementations, the AMF may initiate the AIoT device discovery update procedure. This will be described with reference to Figs. 10 to 12.

[0214] Fig. 10 illustrates a signaling diagram illustrating an example process 1000 that supports AIoT device discovery update in accordance with aspects of the present disclosure.

[0215] The process 1000 may involve a first apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. For the purpose of discussion, the process 1000 will be described with reference to Fig. 1B. The process 1000 may involve the UE 104, the AMF 120 in Fig. 1B as well as at least one AIoT device 150 which is not shown in Fig. 1B.

[0216] As shown in Fig. 10, the AMF 120 determine 1010 that at least one AIoT device 140 that the UE 104 is serving is updated.

[0217] In turn, the AMF 120 causes 1020 an AIoT device discovery update procedure to be performed.

[0218] Fig. 11 illustrates a signaling diagram illustrating an example process 1100

that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 1100 may be considered as an example implementation of the process 300 or the process 1000.

[0219] The process 1100 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 1100 will be described with reference to Fig. 1B. The process 1100 may involve the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B as well as at least one AIoT device 150 which is not shown in Fig. 1B.

[0220] Generally, in the process 1100, the AMF 120 may trigger an AIoT device discovery update procedure by transmitting a first message to the AIoTF 122 based on subscription from the AIoTF 122, or based on pre-configuration. The process 1100 may be related to UE mobility or other factors such as radio link failure.

[0221] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 11 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0222] As shown in Fig. 11, before performing the AIoT device discovery update procedure, the AMF 120 determines 1105 that the at least one AIoT device 140 that the UE 104 is serving is updated.

[0223] In some implementations, the AIoTF 122 may subscribe to the AMF 120 for the UE location and/or the UE status by providing the UE ID (e.g., SUPI) after registration of the UE 104. For example, if the UE 104 moves to a certain place that has beyond certain area limit which leads to the unreachability of the at least one AIoT device 140, the AMF 120 may determine, based on the subscription from the AIoTF 122, that the at least one AIoT device 140 that the UE 104 is serving is updated.

[0224] Alternatively, the AMF 120 may determine, based on pre-configuration, that

the at least one AIoT device 140 that the UE 104 is serving is updated.

[0225] Alternatively, if a tracking area update request message is received from the UE 104, the AMF 120 may determine that the at least one AIoT device 140 that the UE 104 is serving is updated.

[0226] Alternatively, if a path switch request is received from a target network entity serving the UE 104, the AMF 120 may determine that the at least one AIoT device 140 that the UE 104 is serving is updated. The path switch request may comprise the location of the UE 104 and the ID of the UE 104.

[0227] Alternatively, if a handover required request message is received from a source network entity serving the UE 104, the AMF 120 may determine that the at least one AIoT device 140 that the UE 104 is serving is updated. The handover required request message may comprise the ID of the UE 104.

[0228] Alternatively, the AIoTF 122 may set up a timer, or the update periodicity for the UE 104, and the AMF 120 may determine that the at least one AIoT device 140 that the UE 104 is serving is updated accordingly.

[0229] In turn, the AMF 120 causes the AIoT device discovery update procedure to be performed by transmitting 910 a first message to the AIoTF 122.

[0230] In some implementations, the first message may comprise an indication indicating that the at least one AIoT device 140 that the UE 104 is serving is updated. Hereinafter, the indication is also referred to as a device update indication.

[0231] Alternatively or additionally, the first message may comprise a reason why the at least one AIoT device 140 that the UE 104 is serving is updated. Hereinafter, the reason is also referred to as an update reason.

[0232] Alternatively or additionally, the first message may comprise at least one of the following: an ID of the UE 104 (i.e., UE ID), a location of the UE 104 (i.e., UE location), or timestamp when the at least one AIoT device 140 that the UE 104 is serving is updated.

[0233] In some implementations, if a different UE location associated with the ID of the UE 104 is sent to the AIoTF 122, there may be no need for the update reason and the discovery update indication to be provided.

[0234] Upon receiving the first message, the AIoTF 122 transmits 1120 an AIoT device discovery update request to the AMF 120.

[0235] Upon receiving the AIoT device discovery update request, the AMF 120 forwards 1130 the AIoT device discovery update request to the UE 104.

[0236] Alternatively, the AIoTF 122 may transmit the AIoT device discovery update request to the UE 104 directly.

[0237] In some implementations, the AIoT device discovery update request may comprise the ID of the UE 104. Alternatively or additionally, the AIoT device discovery update request may comprise at least one of the following: discovery criteria, discovery timer, or discovery report address.

[0238] In turn, the UE 104 performs 1140, based on the AIoT device discovery update request, the AIoT device discovery update procedure towards the at least one AIoT device 150. It shall be noted that the at least one AIoT device 150 may be the same as or different from the at least one AIoT device 140.

[0239] Through the AIoT device discovery update procedure, the UE 104 may obtain first information about the at least one AIoT device 150. For example, the first information about the at least one AIoT device 150 may comprise at least one of the following: device ID, device location, or device status.

[0240] After the AIoT device discovery update procedure, the UE 104 may transmit 1150 an AIoT device discovery update result to the AMF 120. The AIoT device discovery update result may comprise the first information about the at least one AIoT device 150.

[0241] Additionally, the AIoT device discovery update result may comprise timestamp when the at least one AIoT device 140 is updated.

[0242] Upon receiving the AIoT device discovery update result, the AMF 120 forwards 1160 the AIoT device discovery update result to the AIoTF 122.

[0243] Alternatively, the UE 104 may transmit the AIoT device discovery update result to the AIoTF 122 directly (transparent to the AMF 120).

[0244] Upon receiving the AIoT device discovery update result, the AIoTF 122 may interact 1170 with the AUSF 124 and the UDM 126 to authenticate and authorize the at least one AIoT device 150. In turn, the AIoTF 122 may update the first information about

the at least one AIoT device 140 with the first information about the at least one AIoT device 150. The AIoTF 122 may determine association between the UE 104 and the at least one AIoT device 150 based on the first information about the at least one AIoT device 150 and the second information about the UE 104. In addition, the AIoTF 122 may store the association between the UE 104 and the at least one AIoT device 150 locally, and delete the association between the UE 104 and the at least one AIoT device 140. In other words, the AIoTF 122 may update the association between the UE 104 and the at least one AIoT device 140 with the association between the UE 104 and the at least one AIoT device 150.

[0245] Fig. 12 illustrates a signaling diagram illustrating an example process 1200 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 1200 may be considered as an example implementation of the process 300 or the process 1000.

[0246] The process 1200 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 1200 will be described with reference to Fig. 1B. The process 1200 may involve the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B as well as at least one AIoT device 150 which is not shown in Fig. 1B.

[0247] Generally, in the process 1200, the AMF 120 may initiate an AIoT device discovery update procedure by transmitting an AIoT device discovery update request to the UE 104 based on subscription from the AIoTF 122 or pre-configuration. The process 1200 may be related to UE mobility or other factors such as radio link failure.

[0248] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 12 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0249] As shown in Fig. 12, the AMF 120 determines 1205 that the at least one AIoT

device 140 that the UE 104 is serving is updated.

[0250] Similar to the action 1105 in Fig. 11, the AMF 120 may determine, based on the subscription from the AIoTF 122, that the at least one AIoT device 140 that the UE 104 is serving is updated. Alternatively, the AMF 120 may determine, based on pre-configuration, that the at least one AIoT device 140 that the UE 104 is serving is updated.

[0251] Alternatively, if a tracking area update request message is received from the UE 104, the AMF 120 may determine that the at least one AIoT device 140 that the UE 104 is serving is updated.

[0252] Alternatively, if a path switch request is received from a target network entity serving the UE 104, the AMF 120 may determine that the at least one AIoT device 140 that the UE 104 is serving is updated. The path switch request may comprise the location of the UE 104 and the ID of the UE 104.

[0253] Alternatively, if a handover required request message is received from a source network entity serving the UE 104, the AMF 120 may determine that the at least one AIoT device 140 that the UE 104 is serving is updated. The handover required request message may comprise the ID of the UE 104.

[0254] Alternatively, the AIoTF 122 may set up a timer, or the update periodicity for the UE 104, and the AMF 120 may determine that the at least one AIoT device 140 that the UE 104 is serving is updated accordingly.

[0255] The AMF 120 transmits 1210 the AIoT device discovery update request to the UE 104.

[0256] In some implementations, the AIoT device discovery update request may comprise the ID of the UE 104. Alternatively or additionally, the AIoT device discovery update request may comprise at least one of the following: discovery criteria, discovery timer, or discovery report address.

[0257] In turn, the UE 104 performs 1220 the AIoT device discovery update procedure towards the at least one AIoT device 150 based on the AIoT device discovery update request.

[0258] Through the AIoT device discovery update procedure, the UE 104 may obtain first information about the at least one AIoT device 150. For example, the first

information about the at least one AIoT device 150 may comprise at least one of the following: device ID, device location, or device status.

[0259] After the AIoT device discovery update procedure, the UE 104 may transmit 1230 an AIoT device discovery update result to the AMF 120. The AIoT device discovery update result may comprise the first information about the at least one AIoT device 150.

[0260] In some implementations, the AIoT device discovery update result may further comprise the second information about the UE 104 associated with the first information about the at least one AIoT device 150.

[0261] In some implementations, the AIoT device discovery update result may further comprise at least one of the following: the update indication, the update reason, the UE ID, the UE location, or timestamp when the at least one AIoT device 140 that the UE 104 is serving is updated.

[0262] Upon receiving the AIoT device discovery update result, the AMF 120 forwards 1240 the AIoT device discovery update result to the AIoTF 122.

[0263] Alternatively, the UE 104 may transmit the AIoT device discovery update result to the AIoTF 122 directly (transparent to the AMF 120).

[0264] Upon receiving the AIoT device discovery update result, the AIoTF 122 may interact 1250 with the AUSF 124 and the UDM 126 to authenticate and authorize the at least one AIoT device 150. In turn, the AIoTF 122 may update the first information about the at least one AIoT device 140 with the first information about the at least one AIoT device 150. The AIoTF 122 may determine association between the UE 104 and the at least one AIoT device 150 based on the first information about the at least one AIoT device 150 and the second information about the UE 104. In addition, the AIoTF 122 may store the association between the UE 104 and the at least one AIoT device 150 locally, and delete the association between the UE 104 and the at least one AIoT device 140. In other words, the AIoTF 122 may update the association between the UE 104 and the at least one AIoT device 140 with the association between the UE 104 and the at least one AIoT device 150.

[0265] It should be noted that, when sending the AIoT device discovery update request from the second apparatus to the first apparatus or the UE, the update configuration could also be sent, together with the ID of the UE, such as the reporting

address, update filtering criteria, target location, etc.

[0266] In some implementations, for UE mobility, there could be a case that the UE 104 has moved to a serving area of a different AMF from the AMF 120, but still within the same serving area of the AIoTF 122. In such implementations, the AMF 120 may implement a source AMF serving the UE 104. This will be described with reference to Figs. 13 to 15.

[0267] Fig. 13 illustrates a signaling diagram illustrating an example process 1300 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 1300 may be considered as an example implementation of the process 300 or the process 1000.

[0268] The process 1300 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 1300 will be described with reference to Fig. 1B. The process 1300 may involve the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B as well as an AMF 160 which is not shown in Fig. 1B.

[0269] Generally, in the process 1300, the UE 104 has moved to a serving area of a different AMF from the AMF 120, but still within the same serving area of the AIoTF 122. In such implementations, the AMF 120 may implement a source AMF (S-AMF) 120 serving the UE 104 and the AMF 160 may implement a target AMF (T-AMF) 160 serving the UE 104.

[0270] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 13 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0271] In the process 1300, for N2 handover with the AMF 120 change, the source AMF 120 receives a handover required request message from the source network entity. The handover required request message may comprise the ID of the UE 104. The target

AMF 160 receives the location of the UE 104 from the target network entity via handover notify message.

[0272] As shown in Fig. 13, the source AMF 120 may transmit 1310 at least one of the following to the target AMF 160: an ID of the AIoTF 122 (i.e., AIoTF ID), the UE ID, the UE location, or the device update indication.

[0273] In turn, the target AMF 160 may transmit 1320, based on the AIoTF ID, at least one of the following to the AIoTF 122: the UE ID, the UE location, the device update indication, the update reason.

[0274] In some implementations, if the UE location is provided to the AIoTF 122, there is no need to provide the update reason and device update indication.

[0275] Then, the AIoTF 122 transmits 1330 an AIoT device discovery update request to the UE 104.

[0276] Upon receiving the AIoT device discovery update request, the UE 104 may perform the AIoT device discovery update procedure as described with reference to Figs. 8, 10, 11 and 12.

[0277] Fig. 14 illustrates a signaling diagram illustrating an example process 1400 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 1400 may be considered as an example implementation of the process 300 or the process 1000. For the purpose of discussion, the process 1400 will be described with reference to Fig. 1B. The process 1400 may involve the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B as well as an AMF 160 which is not shown in Fig. 1B.

[0278] Similar to the process 1300, in the process 1400, the UE 104 has moved to a serving area of a different AMF from the AMF 120, but still within the same serving area of the AIoTF 122. In such implementations, the AMF 120 may implement a source AMF (S-AMF) 120 serving the UE 104 and the AMF 160 may implement a target AMF (T-AMF) 160 serving the UE 104.

[0279] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 14 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0280] In the process 1400, for N2 handover with the AMF 120 change, the source AMF 120 receives a handover required request message from the source network entity. The handover required request message may comprise the ID of the UE 104. The target AMF 160 receives the location of the UE 104 from the target network entity via handover notify message.

[0281] As shown in Fig. 14, the source AMF 120 may transmit 1410 at least one of the following to the AIoTF 122: the device update indication, the UE ID, the UE location, or an ID of the target AMF 160 (i.e., target AMF ID).

[0282] If the UE location is provided, the device update indication and the update reason may be optional. The AIoTF 122 can use the target AMF ID to send a message to the UE 104.

[0283] Then, the AIoTF 122 transmits 1420 an AIoT device discovery update request to the UE 104.

[0284] Upon receiving the AIoT device discovery update request, the UE 104 may perform the AIoT device discovery update procedure as described with reference to Figs. 8, 10, 11 and 12.

[0285] Fig. 15 illustrates a signaling diagram illustrating an example process 1500 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 1500 may be considered as an example implementation of the process 300 or the process 1000. For the purpose of discussion, the process 1500 will be described with reference to Fig. 1B. The process 1500 may involve the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B as well as an AMF 160 which is not shown in Fig. 1B.

[0286] Similar to the process 1300, in the process 1500, the UE 104 has moved to a serving area of a different AMF from the AMF 120, but still within the same serving area of the AIoTF 122. In such implementations, the AMF 120 may implement a source AMF (S-AMF) 120 serving the UE 104 and the AMF 160 may implement a target AMF (T-AMF) 160 serving the UE 104.

[0287] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 15 does not illustrate the registration procedure of the UE 104

and the AIoT device discovery procedure.

[0288] In the process 1500, for N2 handover with the AMF 120 change, the source AMF 120 receives a handover required request message from the source network entity. The handover required request message may comprise the ID of the UE 104. The target AMF 160 receives the location of the UE 104 from the target network entity via handover notify message.

[0289] As shown in Fig. 15, the UE 104 may transmit 1510 at least one of the following to the AIoTF 122: the device update indication, the update reason, or the UE location (such as the updated location of the UE 104).

[0290] Then, the AIoTF 122 transmits 1520 an AIoT device discovery update request to the UE 104.

[0291] Upon receiving the AIoT device discovery update request, the UE 104 may perform the AIoT device discovery update procedure as described with reference to Figs. 8, 10, 11 and 12.

[0292] Alternatively, in some implementations, if the UE 104 initiates the AIoT device discovery update procedure, the UE 104 may transmit the first information about the at least one AIoT device 150 at the action 1510. For example, the UE 104 initiates the AIoT device discovery update procedure by performing the process 900. In such implementations, the action 1520 may not be performed.

[0293] In some implementations, for UE mobility, there could be a case that the UE 104 has moved to a serving area of a different AIoTF from the AIoTF 122, but still within the same serving area of the AMF 120. In such implementations, the AIoTF 122 may implement a source AIoTF serving the UE 104. This will be described with reference to Figs. 16 to 18.

[0294] Fig. 16 illustrates a signaling diagram illustrating an example process 1600 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 1600 may be considered as an example implementation of the process 300 or the process 1000.

[0295] The process 1600 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120

in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 1600 will be described with reference to Fig. 1B. The process 1600 may involve the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B as well as an AIoTF 170 which is not shown in Fig. 1B.

[0296] Generally, in the process 1600, the UE 104 has moved to a serving area of a different AIoTF from the AIoTF 122, but still within the same serving area of the AMF 120. In such implementations, the AIoTF 122 may implement a source AIoTF (S-AIoTF) 122 serving the UE 104 and the AIoTF 170 may implement a target AIoTF (T-AIoTF) 170 serving the UE 104.

[0297] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 16 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0298] As shown in Fig. 16, the AMF 120 may transmit 1610 at least one of the following to the source AIoTF 122: an ID of the target AIoTF 170 (i.e., target AIoTF ID), the UE ID or the UE location (such as the updated location of the UE 104).

[0299] Optionally, the AMF 120 may indicate the source AIoTF 122 to transmit context information of the UE 104 to the target AIoTF 170.

[0300] In turn, the source AIoTF 122 transmits 1620, based on the target AIoTF ID, at least one of the following to the target AIoTF 170: the UE ID, the UE location (such as the updated location of the UE 104) or the context information of the UE 104.

[0301] In some implementations, if the UE location is provided, there is no need to provide the update reason and the device update indication to the target AIoTF 170.

[0302] In turn, the target AIoTF 170 initiates 1630 the AIoT device discovery update procedure towards the UE 104 by transmitting an AIoT device discovery update request to the UE 104.

[0303] Fig. 17 illustrates a signaling diagram illustrating an example process 1700 that supports AIoT device discovery update in accordance with aspects of the present

disclosure. The process 1700 may be considered as an example implementation of the process 300 or the process 1000.

[0304] The process 1700 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 1700 will be described with reference to Fig. 1B. The process 1700 may involve the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B as well as an AIoTF 170 which is not shown in Fig. 1B.

[0305] Generally, in the process 1700, the UE 104 has moved to a serving area of a different AIoTF from the AIoTF 122, but still within the same serving area of the AMF 120. In such implementations, the AIoTF 122 may implement a source AIoTF (S-AIoTF) 122 serving the UE 104 and the AIoTF 170 may implement a target AIoTF (T-AIoTF) 170 serving the UE 104.

[0306] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 17 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0307] As shown in Fig. 17, the AMF 120 may transmit 1710 at least one of the following to the target AIoTF 170: an ID of the source AIoTF 122 (i.e., source AIoTF ID), the UE ID or the UE location (such as the updated location of the UE 104).

[0308] In some implementations, the target AIoTF 170 may be selected from the NRF based on the updated location of the UE 104.

[0309] In turn, the target AIoTF 170 uses the UE ID to obtain 1720 context information of the UE 104 from the source AIoTF 122 based on the source AIoTF ID received from the AMF 120.

[0310] In turn, the target AIoTF 170 initiates 1730 the AIoT device discovery update procedure towards the UE 104 by transmitting an AIoT device discovery update request

to the UE 104.

[0311] Fig. 18 illustrates a signaling diagram illustrating an example process 1800 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 1800 may be considered as an example implementation of the process 300 or the process 1000.

[0312] The process 1800 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 1800 will be described with reference to Fig. 1B. The process 1800 may involve the UE 104, the AMF 120 and the AIoTF 122 in Fig. 1B as well as an AIoTF 170 which is not shown in Fig. 1B.

[0313] Generally, in the process 1800, the UE 104 has moved to a serving area of a different AIoTF from the AIoTF 122, but still within the same serving area of the AMF 120. In such implementations, the AIoTF 122 may implement a source AIoTF (S-AIoTF) 122 serving the UE 104 and the AIoTF 170 may implement a target AIoTF (T-AIoTF) 170 serving the UE 104.

[0314] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 18 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0315] As shown in Fig. 18, the UE 104 may transmit 1810 at least one of the following to the target AIoTF 170: the device update indication, the update reason, or the UE location (such as the updated location of the UE 104).

[0316] Then, the target AIoTF 170 transmits 1820 an AIoT device discovery update request to the UE 104.

[0317] Upon receiving the AIoT device discovery update request, the UE 104 may perform the AIoT device discovery update procedure as described with reference to Figs.

8, 10, 11 and 12.

[0318] Alternatively, in some implementations, if the UE 104 initiates the AIoT device discovery update procedure, the UE 104 may transmit the first information about the at least one AIoT device 150 at the action 1810. For example, the UE 104 initiates the AIoT device discovery update procedure by performing the process 900. In such implementations, the action 1820 may not be performed.

[0319] It shall be noted that in the processes 1600, 1700 and 1800, since the AIoTF 122 has changed, the AMF 120 can help the UE 104 to register to the target AIoTF 170.

[0320] In some implementations, for UE mobility, there could be a case that the UE 104 has moved to a serving area of a different AMF and a different AIoTF. Under this circumstance, the UE 104 can send a registration request to the target AIoTF 170 via the AMF 120 as illustrated in Fig. 4. The AIoT device discovery procedure will be triggered accordingly. This will be described with reference to Figs. 19 to 21.

[0321] Fig. 19 illustrates a signaling diagram illustrating an example process 1900 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 1900 may be considered as an example implementation of the process 300 or the process 1000.

[0322] The process 1900 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 1900 will be described with reference to Fig. 1B. The process 1900 may involve the UE 104, the AMF 120, the AIoTF 122 in Fig. 1B as well as an AMF 160 and an AIoTF 170 which is not shown in Fig. 1B.

[0323] Generally, in the process 1900, the UE 104 has moved to a serving area of a different AIoTF from the AIoTF 122 and to a serving area of a different AMF from the AMF 120. In such implementations, the AIoTF 122 may implement a source AIoTF (S-AIoTF) 122 serving the UE 104 and the AIoTF 170 may implement a target AIoTF (T-AIoTF) 170 serving the UE 104. The AMF 120 may implement a source AMF (S-AMF)

120 serving the UE 104 and the AMF 160 may implement a target AMF (T-AMF) 160 serving the UE 104.

[0324] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 19 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0325] As shown in Fig. 19, the source AMF 120 transmits 1910 at least one of the following to the target AMF 160: the UE ID, the UE location, the source AIoTF ID, or the target AIoTF ID.

[0326] The target AMF 160 transmits 1920 at least one of the following to the source AIoTF 122: the UE ID, the UE location, the target AIoTF ID, or the update indication to the source AIoTF 122. Optionally, the target AMF 160 may ask the source AIoTF 122 to transfer the UE context of the UE 104 to the target AIoTF 170.

[0327] The source AIoTF 122 transmits 1930 at least one of the following to the target AIoTF 170: the UE ID, the UE location or UE context of the UE 104.

[0328] The target AIoTF 170 initiates 1940 the AIoT device discovery update procedure towards the UE 104 by transmitting an AIoT device discovery update request to the UE 104 via the target AMF 160.

[0329] Upon receiving the AIoT device discovery update request, the UE 104 may perform the AIoT device discovery update procedure as described with reference to Figs. 8, 10, 11 and 12.

[0330] In some implementations, there is another possibility that the source AMF 120 directly sends the UE ID, the UE location, the source AIoTF ID and the target AMF ID to the target AIoTF 170. The target AIoTF 170 can retrieve the UE context from the source AIoTF 122.

[0331] Alternatively, the source AMF 120 can send the UE ID, the UE location, the target AMF ID and the target AIoTF ID to the source AIoTF 122. The source AIoTF 122 can forward the UE ID, the UE location, the target AMF ID and the UE context to the target AIoTF 170.

[0332] Fig. 20 illustrates a signaling diagram illustrating an example process 2000 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 2000 may be considered as an example implementation of the process 300 or the process 1000.

[0333] The process 2000 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 2000 will be described with reference to Fig. 1B. The process 2000 may involve the UE 104, the AMF 120, the AIoTF 122 in Fig. 1B as well as an AMF 160 and an AIoTF 170 which is not shown in Fig. 1B.

[0334] Generally, in the process 2000, the UE 104 has moved to a serving area of a different AIoTF from the AIoTF 122 and to a serving area of a different AMF from the AMF 120. In such implementations, the AIoTF 122 may implement a source AIoTF (S-AIoTF) 122 serving the UE 104 and the AIoTF 170 may implement a target AIoTF (T-AIoTF) 170 serving the UE 104. The AMF 120 may implement a source AMF (S-AMF) 120 serving the UE 104 and the AMF 160 may implement a target AMF (T-AMF) 160 serving the UE 104.

[0335] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs. 4 to 7. For brevity, Fig. 20 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0336] As shown in Fig. 20, the source AMF 120 transmits 2010 at least one of the following to the target AMF 160: the UE ID, the UE location, the source AIoTF ID, or the target AIoTF ID.

[0337] The target AMF 160 transmits 2020 at least one of the following to the target AIoTF 170: the UE ID, the UE location, the source AIoTF ID.

[0338] The target AIoTF 170 uses the UE ID to obtain 2030 the UE context of the

UE 104 from the source AIoTF 122 based on the received source AIoTF ID from the target AMF 160.

[0339] The target AIoTF 170 initiates 2040 the AIoT device discovery update procedure towards the UE 104 by transmitting an AIoT device discovery update request to the UE 104 via the target AMF 160.

[0340] Upon receiving the AIoT device discovery update request, the UE 104 may perform the AIoT device discovery update procedure as described with reference to Figs. 8, 10, 11 and 12.

[0341] Fig. 21 illustrates a signaling diagram illustrating an example process 2100 that supports AIoT device discovery update in accordance with aspects of the present disclosure. The process 2100 may be considered as an example implementation of the process 300 or the process 1000.

[0342] The process 2100 may involve a first apparatus and a second apparatus. In some implementations, the first apparatus may perform the AMF 120 in Fig. 1B. Alternatively, the first apparatus may perform other network function than the AMF 120 in Fig. 1B. In some implementations, the second apparatus may perform the AIoTF 122 in Fig. 1B. Alternatively, the second apparatus may perform other network function than the AIoTF 122 in Fig. 1B. For the purpose of discussion, the process 2100 will be described with reference to Fig. 1B. The process 2100 may involve the UE 104, the AMF 120, the AIoTF 122 in Fig. 1B as well as an AMF 160 and an AIoTF 170 which is not shown in Fig. 1B.

[0343] Generally, in the process 2100, the UE 104 has moved to a serving area of a different AIoTF from the AIoTF 122 and to a serving area of a different AMF from the AMF 120. In such implementations, the AIoTF 122 may implement a source AIoTF (S-AIoTF) 122 serving the UE 104 and the AIoTF 170 may implement a target AIoTF (T-AIoTF) 170 serving the UE 104. The AMF 120 may implement a source AMF (S-AMF) 120 serving the UE 104 and the AMF 160 may implement a target AMF (T-AMF) 160 serving the UE 104.

[0344] Before the AIoT device discovery update procedure, the registration procedure of the UE 104 may be performed as described with reference to Fig. 4 and an AIoT device discovery procedure may be performed as described with reference to Figs.

4 to 7. For brevity, Fig. 21 does not illustrate the registration procedure of the UE 104 and the AIoT device discovery procedure.

[0345] As shown in Fig. 21, the UE 104 may transmit 2110 at least one of the following to the target AIoTF 170: the device update indication, the update reason, or the UE location (such as the updated location of the UE 104).

[0346] Then, the target AIoTF 170 transmits 2120 an AIoT device discovery update request to the UE 104.

[0347] Upon receiving the AIoT device discovery update request, the UE 104 may perform the AIoT device discovery update procedure as described with reference to Figs. 8, 10, 11 and 12.

[0348] Alternatively, in some implementations, if the UE 104 initiates the AIoT device discovery update procedure, the UE 104 may transmit the first information about the at least one AIoT device 150 at the action 2110. For example, the UE 104 initiates the AIoT device discovery update procedure by performing the process 900. In such implementations, the action 2120 may not be performed.

[0349] Fig. 22 illustrates an example of a device 2200 that supports AIoT device discovery and update in accordance with aspects of the present disclosure. The device 2200 may be an example of a network entity 102 or a UE 104 as described herein. The device 2200 may support wireless communication with one or more network entities 102, UEs 104, or any combination thereof. The device 2200 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 2202, a memory 2204, a transceiver 2206, and, optionally, an I/O controller 22014. 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).

[0350] The processor 2202, the memory 2204, the transceiver 2206, 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 2202, the memory 2204, the transceiver 2206, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0351] In some implementations, the processor 2202, the memory 2204, the transceiver 2206, 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 2202 and the memory 2204 coupled with the processor 2202 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 2202, instructions stored in the memory 2204).

[0352] For example, the processor 2202 may support wireless communication at the device 2200 in accordance with examples as disclosed herein. The processor 2202 may be configured to operable to support a means for performing the following: performing at least one of an AIoT device discovery procedure or an AIoT device discovery update procedure; and transmitting, to a first apparatus or a second apparatus, first information about at least one AIoT device to be served by the UE.

[0353] Alternatively, in some implementations, the processor 2202 may be configured to operable to support a means for performing the following: determining that at least one AIoT device that a user equipment (UE) is serving is updated; and causing an AIoT device discovery update procedure to be performed.

[0354] Alternatively, in some implementations, the processor 2202 may be configured to operable to support a means for performing the following: receiving a first message from a first apparatus or a UE serving at least one AIoT device, wherein the first message comprises at least one of the following: an indication indicating that the at least one AIoT device that the UE is serving is updated, a reason why the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or timestamp when the at least one AIoT device that the UE is serving is updated; and transmitting an AIoT device discovery update request to the first apparatus or the UE, wherein the AIoT device discovery update request comprises the ID of the UE; and receiving, from the first apparatus or the UE, an AIoT device discovery update result which comprises first information about the at least one AIoT device.

[0355] The processor 2202 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 2202 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 2202. The processor 2202 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 2204) to cause the device 2200 to perform various functions of the present disclosure.

[0356] The memory 2204 may include random access memory (RAM) and read-only memory (ROM). The memory 2204 may store computer-readable, computer-executable code including instructions that, when executed by the processor 2202 cause the device 2200 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 2202 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 2204 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.

[0357] The I/O controller 22014 may manage input and output signals for the device 2200. The I/O controller 22014 may also manage peripherals not integrated into the device M02. In some implementations, the I/O controller 22014 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 22014 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 22014 may be implemented as part of a processor, such as the processor 2202. In some implementations, a user may interact with the device 2200 via the I/O controller 22014 or via hardware components controlled by the I/O controller 22014.

[0358] In some implementations, the device 2200 may include a single antenna 2210. However, in some other implementations, the device 2200 may have more than one antenna 2210 (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 2206 may communicate bi-directionally, via the one or more antennas 2210, wired, or wireless links as described herein. For example, the transceiver 2206 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 2206 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 2210 for transmission, and to demodulate packets received from the one or more antennas 2210. The transceiver 2206 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0359] 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 2210 for transmitting the amplified signal into the air or wireless medium.

[0360] 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 2210 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.

[0361] Fig. 23 illustrates an example of a processor 2300 that supports AIoT device discovery and update in accordance with aspects of the present disclosure. The processor 2300 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 2300 may include a

controller 2302 configured to perform various operations in accordance with examples as described herein. The processor 2300 may optionally include at least one memory 2304, such as L1/L2/L3 cache. Additionally, or alternatively, the processor 2300 may optionally include one or more arithmetic-logic units (ALUs) 2306. 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).

[0362] The processor 2300 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 2300) 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).

[0363] The controller 2302 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 2300 to cause the processor 2300 to support various operations in accordance with examples as described herein. For example, the controller 2302 may operate as a control unit of the processor 2300, generating control signals that manage the operation of various components of the processor 2300. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0364] The controller 2302 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 2304 and determine subsequent instruction(s) to be executed to cause the processor 2300 to support various operations in accordance with examples as described herein. The controller 2302 may be configured to track memory address of instructions associated with the memory 2304. The controller 2302 may be configured to decode instructions to determine the operation to be performed and the

operands involved. For example, the controller 2302 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 2300 to cause the processor 2300 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 2302 may be configured to manage flow of data within the processor 2300. The controller 2302 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 2300.

[0365] The memory 2304 may include one or more caches (e.g., memory local to or included in the processor 2300 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 2304 may reside within or on a processor chipset (e.g., local to the processor 2300). In some other implementations, the memory 2304 may reside external to the processor chipset (e.g., remote to the processor 2300).

[0366] The memory 2304 may store computer-readable, computer-executable code including instructions that, when executed by the processor 2300, cause the processor 2300 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 2302 and/or the processor 2300 may be configured to execute computer-readable instructions stored in the memory 2304 to cause the processor 2300 to perform various functions. For example, the processor 2300 and/or the controller 2302 may be coupled with or to the memory 2304, the processor 2300, the controller 2302, and the memory 2304 may be configured to perform various functions described herein. In some examples, the processor 2300 may include multiple processors and the memory 2304 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.

[0367] The one or more ALUs 2306 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 2306 may reside within or on a processor chipset (e.g., the processor 2300). In some other implementations, the one or more ALUs 2306 may reside external to the processor chipset (e.g., the processor 2300). One or more ALUs 2306 may perform one or more computations such as addition, subtraction, multiplication, and division on data.

For example, one or more ALUs 2306 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 2306 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 2306 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 2306 to handle conditional operations, comparisons, and bitwise operations.

[0368] For example, the processor 2300 may support wireless communication at the device 2200 in accordance with examples as disclosed herein. The processor 2300 may be configured to operable to support a means for performing the following: performing at least one of an AIoT device discovery procedure or an AIoT device discovery update procedure; and transmitting, to a first apparatus or a second apparatus, first information about at least one AIoT device to be served by the UE.

[0369] Alternatively, in some implementations, the processor 2300 may be configured to operable to support a means for performing the following: determining that at least one AIoT device that a user equipment (UE) is serving is updated; and causing an AIoT device discovery update procedure to be performed.

[0370] Alternatively, in some implementations, the processor 2300 may be configured to operable to support a means for performing the following: receiving a first message from a first apparatus or a UE serving at least one AIoT device, wherein the first message comprises at least one of the following: an indication indicating that the at least one AIoT device that the UE is serving is updated, a reason why the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or timestamp when the at least one AIoT device that the UE is serving is updated; and transmitting an AIoT device discovery update request to the first apparatus or the UE, wherein the AIoT device discovery update request comprises the ID of the UE; and receiving, from the first apparatus or the UE, an AIoT device discovery update result which comprises first information about the at least one AIoT device.

[0371] Fig. 24 illustrates a flowchart of a method 2400 that supports AIoT device discovery and update in accordance with aspects of the present disclosure. The operations of the method 2400 may be implemented by a device or its components as described

herein. For example, the operations of the method 2400 may be performed by the 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.

[0372] At 2410, the method may include performing at least one of an AIoT device discovery procedure or an AIoT device discovery update procedure. The operations of 2410 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 2410 may be performed by a device as described with reference to Fig. 1A or 1B.

[0373] At 2420, the method may include transmitting, to a first apparatus or a second apparatus, first information about at least one AIoT device to be served by the UE. The operations of 2420 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 2420 may be performed by a device as described with reference to Fig. 1A or 1B.

[0374] Fig. 25 illustrates a flowchart of a method 2500 that supports AIoT device discovery and update in accordance with aspects of the present disclosure. The operations of the method 2500 may be implemented by a device or its components as described herein. For example, the operations of the method 2500 may be performed by a first apparatus 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.

[0375] At 2510, the method may include determining that at least one AIoT device that a user equipment (UE) is serving is updated. The operations of 2510 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 2510 may be performed by a device as described with reference to Fig. 1A or 1B.

[0376] At 2520, the method may include causing an AIoT device discovery update procedure to be performed. The operations of 2520 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 2520 may be performed by a device as described with reference to Fig. 1A or 1B.

[0377] Fig. 26 illustrates a flowchart of a method 2600 that supports AIoT device discovery and update in accordance with aspects of the present disclosure. The operations of the method 2600 may be implemented by a device or its components as described herein. For example, the operations of the method 2600 may be performed by a second apparatus 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.

[0378] At 2610, the method may include receiving a first message from a first apparatus or a UE serving at least one AIoT device. The first message comprises at least one of the following: an indication indicating that the at least one AIoT device that the UE is serving is updated, a reason why the at least one AIoT device that the UE is serving is updated, an identity (ID) of the UE, a location of the UE, or timestamp when the at least one AIoT device that the UE is serving is updated. The operations of 2610 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 2610 may be performed by a device as described with reference to Fig. 1A or 1B.

[0379] At 2620, the method may include transmitting an AIoT device discovery update request to the first apparatus or the UE, wherein the AIoT device discovery update request comprises the ID of the UE. The operations of 2620 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 2620 may be performed by a device as described with reference to Fig. 1A or 1B.

[0380] At 2630, the method may include receiving, from the first apparatus or the UE, an AIoT device discovery update result which comprises first information about the at least one AIoT device. The operations of 2630 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 2630 may be performed by a device as described with reference to Fig. 1A or 1B.

[0381] It shall be noted that implementations of the present disclosure which have been described with reference to Figs. 1 to 21 are also applicable to the device 2200, the processor 2300 and the methods 2400, 2500 and 2600.

[0382] 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.

[0383] 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.

[0384] 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.

[0385] 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.

[0386] 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.

[0387] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

WHAT IS CLAIMED IS:

1. A user equipment (UE), comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

perform at least one of an ambient internet-of-things (AIoT) device discovery procedure or an AIoT device discovery update procedure; and

transmit, via the transceiver to a first apparatus or a second apparatus, first information about at least one AIoT device to be served by the UE.

2. The UE of claim 1, wherein the processor is further configured to:

receive an AIoT device discovery request via the transceiver from the first apparatus, the second apparatus or an AIoT application server; and

wherein the processor is configured to perform the AIoT device discovery procedure based on the AIoT device discovery request.

3. The UE of claim 2, wherein the AIoT device discovery request received from the AIoT application server comprises an inventory request; and

wherein the processor is configured to perform the AIoT device discovery procedure based on the inventory request.

4. The UE of claim 1, wherein the first information about the at least one AIoT device comprises at least one of the following:

at least one identity (ID) of the at least one AIoT device,

at least one location of the at least one AIoT device,

at least one status of the at least one AIoT device,

at least one type of the at least one AIoT device,

capability of the at least one AIoT device, or

a timestamp when the first information is obtained.

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

transmit, via the transceiver to the first apparatus, second information about the UE associated with the first information about the at least one AIoT device.

6. The UE of claim 5, wherein the second information about the UE comprises at least one of the following:

an identity (ID) of the UE,

a serving area of the UE,

a location of the UE, or

capability of the UE.

7. The UE of claim 1, wherein the processor is further configured to:

before performing the AIoT device discovery update procedure, transmit a first message via the transceiver to the first apparatus or the second apparatus, wherein the first message comprises at least one of the following:

an indication indicating that the at least one AIoT device that the UE is serving is updated,

a reason why the at least one AIoT device that the UE is serving is updated,

an identity (ID) of the UE,

a location of the UE, or

timestamp when the at least one AIoT device that the UE is serving is updated; and

receive an AIoT device discovery update request via the transceiver from the first apparatus or the second apparatus, wherein the AIoT device discovery update request comprises the ID of the UE; and

wherein the processor is configured to perform the AIoT device discovery update procedure by:

performing the AIoT device discovery update procedure based on the AIoT device discovery update request.

8. The UE of claim 7, wherein the processor is configured to transmit the first information about the at least one AIoT device by:

transmitting, via the transceiver to the first apparatus or the second apparatus, an AIoT device discovery update result which comprises the first information about the at least one AIoT device.

9. A first apparatus, comprising:

at least one memory; and

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

determine that at least one ambient internet-of-things (AIoT) device that a user equipment (UE) is serving is updated ; and

cause an AIoT device discovery update procedure to be performed.

10. The first apparatus of claim 9, wherein the first apparatus causes the AIoT device discovery update procedure to be performed by:

transmitting a first message to a second apparatus, wherein the first message comprises at least one of the following:

an indication indicating that the at least one AIoT device that the UE is serving is updated,

a reason why the at least one AIoT device that the UE is serving is updated,

an identity (ID) of the UE,

a location of the UE, or

timestamp when the at least one AIoT device that the UE is serving is updated;

receiving an AIoT device discovery update request from the second apparatus, wherein the AIoT device discovery update request comprises the ID of the UE; and

transmitting the AIoT device discovery update request to the UE.

11. The first apparatus of claim 9, wherein the first apparatus causes the AIoT device discovery update procedure to be performed by:

based on determining that the UE is updated, transmitting an AIoT device discovery update request to the UE, wherein the AIoT device discovery update request comprises the ID of the UE.

12. The first apparatus of claim 9, wherein the first apparatus is caused to determine that the UE is updated based on determining one of the following:

a tracking area update request message is received from the UE;

a path switch request is received from a target network entity serving the UE, wherein the path switch request comprises a location of the UE and an identity (ID) of the UE; or

a handover required request message is received from a source network entity serving the UE, wherein the handover required request message comprises the ID of the UE.

13. The first apparatus of claim 9, wherein the first apparatus implements a source access and mobility management function (AMF) serving the UE, and the second apparatus implements an AIoT function (AIoTF); and

wherein the first apparatus is further caused to transmit at least one of the following to a target AMF serving the UE:

an identity (ID) of the second apparatus,

an ID of the UE,

a location of the UE, or

an indication indicating that the at least one AIoT device that the UE is serving is updated.

14. The first apparatus of claim 9, wherein the first apparatus implements a source access and mobility management function (AMF) serving the UE, and the second apparatus implements an AIoT function (AIoTF); and

wherein the first apparatus is further caused to transmit at least one of the following to the second apparatus:

an indication indicating that the at least one AIoT device that the UE is serving is updated,

an identity (ID) of the UE,

a location of the UE, or

an ID of a target AMF serving the UE.

15. The first apparatus of claim 9, wherein the first apparatus is further caused to:

transmit, to the UE, an AIoT device discovery request to the UE.

16. A second apparatus, comprising:

at least one memory; and

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

receive a first message from a first apparatus or a user equipment (UE) serving at least one ambient internet-of-things (AIoT) device, wherein the first message comprises at least one of the following:

an indication indicating that the at least one AIoT device that the UE is serving is updated,

a reason why the at least one AIoT device that the UE is serving is updated,

an identity (ID) of the UE,

a location of the UE, or

timestamp when the at least one AIoT device that the UE is serving is updated; and

transmit an AIoT device discovery update request to the first apparatus or the UE, wherein the AIoT device discovery update request comprises the ID of the UE; and

receive, from the first apparatus or the UE, an AIoT device discovery update result which comprises first information about the at least one AIoT device.

17. The second apparatus of claim 16, wherein the second apparatus is further caused to:

determine association between the UE and the at least one AIoT device based on second information about the UE and the first information about the at least one AIoT device.

18. The second apparatus of claim 16, wherein the AIoT device discovery update result further comprises at least one of the following:

second information about the UE associated with the first information about the at least one AIoT device,

an indication indicating that the at least one AIoT device that the UE is serving is updated,

a reason why the at least one AIoT device that the UE is serving is updated,

an identity (ID) of the UE,

a location of the UE, or

timestamp when the at least one AIoT device that the UE is serving is updated.

19. The second apparatus of claim 16, wherein the second apparatus is further caused to:

transmit, to the UE, an AIoT device discovery request to the UE.

20. The second apparatus of claim 19, wherein the second apparatus is further caused to:

receive, from an AIoT application server an inventory request; and

wherein the second apparatus is caused to transmit the AIoT device discovery request by transmitting the inventory request to the UE.