

## DEVICES AND METHODS OF COMMUNICATION

### TECHNICAL FIELD

**[0001]** The present disclosure relates to wireless communications, and more specifically to devices and methods of communication for ambient Internet of things (A-IoT).

### 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]** A-IoT is an Internet of things (IoT) technology of supporting battery-less devices with no energy storage capability or devices with energy storage that do not need to be replaced or recharged manually. Recently, it is proposed to design a compact protocol stack and corresponding procedures for A-IoT, e.g., paging, random access, data transmission, etc.

### SUMMARY

**[0004]** The present disclosure relates to methods, devices, and systems that support a paging for an A-IoT device. By considering reception and/or identification of a paging for an A-IoT device, a paging for an A-IoT device may be enhanced.

**[0005]** In one aspect, some implementations of the method and devices described herein may comprise: determining first time or resource information of a first message for paging the first device based on one of the following: second time or resource information associated with wake up or synchronization of the first device, or a set of resources for a control signaling for the first message; and receiving, from a second device via a transceiver, the first message based on the first time or resource information.

**[0006]** In some implementations of the method and devices described herein, the second time or resource information may comprise at least one of the following: a time point after the wake up of the first device; a time point or time-frequency resource associated with a physical layer signal after the wake up of the first device; a time point or time-frequency resource associated with a carrier wave or physical layer signal for waking up the first device; a time-frequency resource indicated in system information of the second device after the wake up of the first device; or time information carried via the carrier wave.

**[0007]** In some implementations of the method and devices described herein, the time information carried in the carrier wave may comprise at least one of the following: a slot offset to the wake up of the first device; a slot offset to reception of the carrier wave; or a slot offset to reception of the physical layer signal.

**[0008]** In some implementations of the method and devices described herein, determining the first time or resource information may comprise: determining the second time or resource information as the first time or resource information.

**[0009]** In some implementations of the method and devices described herein, determining the first time or resource information may comprise: receiving, from the second device via the transceiver, the control signaling based on the second time or resource information or the set of resources; and determining the first time or resource information in the control signaling.

**[0010]** Some implementations of the method and devices described herein may further comprise at least one of the following: in accordance with a determination that the first message is received, receiving no second message for paging the first device from a third device in a period of time; or in accordance with a determination that a

plurality of messages for paging the first device are received, determining, as the first message, one of the plurality of messages that has a strongest carrier wave or physical layer signal.

**[0011]** In another aspect, some implementations of the method and devices described herein may comprise: receiving a message from a second device via a transceiver; and determining that the message is for paging the first device based on at least one of the following: time or resource information of reception of the message, a type of the message, or information of a carrier wave for waking up the first device.

**[0012]** In some implementations of the method and devices described herein, the information of the carrier wave may comprise at least one of the following: a time duration of the carrier wave; an attribute of the carrier wave; or a time-frequency resource of the carrier wave.

**[0013]** In some implementations of the method and devices described herein, determining that the message is for paging the first device may comprise at least one of the following: in accordance with a determination that the message is a message firstly received after a time point, determining that the message is for paging the first device; in accordance with a determination that the message is received at a time-frequency resource, determining that the message is for paging the first device; in accordance with a determination that the type of the message indicates the message is for paging the first device, determining that the message is for paging the first device; or in accordance with a determination that the information of the carrier wave indicates the message is for paging the first device, determining that the message is for paging the first device.

**[0014]** In some implementations of the method and devices described herein, the time point may comprise at least one of the following: a time point after the wake up of the first device; a time point of receiving the carrier wave; a time point of receiving a physical layer signal after the wake up of the first device; or a time point of receiving system information of the second device after the wake up of the first device.

**[0015]** Some implementations of the method and devices described herein may further comprise: determining the type of the message in a further message from the second device; or determining the type of the message in the message.

**[0016]** In some implementations of the method and devices described herein, the first device may be an A-IoT device, and the second device may be a base station or a communication node between the base station and the A-IoT device.

**[0017]** In another aspect, some implementations of the method and devices described herein may comprise: transmitting, to a first device via a transceiver, a first message for paging the first device based on time or resource information associated with wake up or synchronization of the first device, or transmitting, to the first device via the transceiver, a control signaling for the first message based on the time or resource information associated with wake up or synchronization of the first device or a set of resources for the control signaling.

**[0018]** In some implementations of the method and devices described herein, the time or resource information may comprise at least one of the following: a time point after the wake up of the first device; a time point or time-frequency resource associated with a physical layer signal after the wake up of the first device; a time point or time-frequency resource associated with a carrier wave or physical layer signal for waking up the first device; a time-frequency resource indicated in system information of the second device after the wake up of the first device; or time information carried in the carrier wave.

**[0019]** In some implementations of the method and devices described herein, the time information carried in the carrier wave may comprise at least one of the following: a slot offset to the wake up of the first device; a slot offset to reception of the carrier wave; or a slot offset to reception of the physical layer signal.

**[0020]** In another aspect, some implementations of the method and devices described herein may comprise: in accordance with a determination that a message for paging a first device is to be transmitted, performing an operation comprising at least one of the following: transmitting the message based on time or resource information indicating the message; transmitting the message or a further message comprising a type of the message; or transmitting a carrier wave, the information of the carrier wave indicating the message.

**[0021]** In some implementations of the method and devices described herein, the information of the carrier wave may comprise at least one of the following: a time

duration of the carrier wave; an attribute of the carrier wave; or a time-frequency resource of the carrier wave.

**[0022]** In some implementations of the method and devices described herein, transmitting the message based on the time or resource information indicating the message may comprise at least one of the following: transmitting the message as a message firstly transmitted after a time point; transmitting the message at a time-frequency resource; transmitting the message after transmitting the carrier wave based on the information of the carrier wave; or transmitting the message after transmitting the further message.

**[0023]** In some implementations of the method and devices described herein, the time point may comprise at least one of the following: a time point after the wake up of the first device; a time point of transmitting the carrier wave; a time point of transmitting a physical layer signal after the wake up of the first device; or a time point of transmitting system information of the second device after the wake up of the first device.

**[0024]** In some implementations of the method and devices described herein, the first device may be an A-IoT device, and the second device may be a base station or a communication node between the base station and the A-IoT device.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0025]** FIG. 1 illustrates an example of a wireless communications system that supports a paging for an A-IoT device in accordance with aspects of the present disclosure.

**[0026]** FIG. 2 illustrates a signaling chart of an example process that supports a paging for an A-IoT device in accordance with aspects of the present disclosure.

**[0027]** FIG. 3A illustrates a diagram illustrating an example paging for an A-IoT device in accordance with aspects of the present disclosure.

**[0028]** FIG. 3B illustrates a diagram illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure.

**[0029]** FIG. 3C illustrates a diagram illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure.

[0030] FIG. 3D illustrates a diagram illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure.

[0031] FIG. 3E illustrates a diagram illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure.

[0032] FIG. 3F illustrates a diagram illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure.

[0033] FIG. 4 illustrates a signaling chart of another example process that supports a paging for an A-IoT device in accordance with aspects of the present disclosure.

[0034] FIG. 5A illustrates a diagram illustrating an example paging for an A-IoT device in accordance with aspects of the present disclosure.

[0035] FIG. 5B illustrates a diagram illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure.

[0036] FIG. 5C illustrates a diagram illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure.

[0037] FIG. 6 illustrates an example of a device that supports a paging for an A-IoT device in accordance with aspects of the present disclosure.

[0038] FIG. 7 illustrates an example of a processor that supports a paging for an A-IoT device in accordance with aspects of the present disclosure.

[0039] FIG. 8 illustrates a flowchart of a method that supports a paging for an A-IoT device in accordance with aspects of the present disclosure.

[0040] FIG. 9 illustrates a flowchart of another method that supports a paging for an A-IoT device in accordance with aspects of the present disclosure.

[0041] FIG. 10 illustrates a flowchart of another method that supports a paging for an A-IoT device in accordance with aspects of the present disclosure.

[0042] FIG. 11 illustrates a flowchart of another method that supports a paging for an A-IoT device in accordance with aspects of the present disclosure.

#### DETAILED DESCRIPTION

**[0043]** 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.

**[0044]** 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.

**[0045]** 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. The term 'embodiment' may be interchangeably used with 'implementation'.

**[0046]** 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 implementations. As used herein, the term 'and/or' includes any and all combinations of one or more of the listed terms.

**[0047]** The terminology used herein is for the purpose of describing particular implementations only and is not intended to be limiting of example implementations. 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.

**[0048]** In the context of the present disclosure, the term ‘first device’ refers to a battery-less device with no energy storage capability or a device with energy storage that do not need to be replaced or recharged manually. The term ‘first device’ may be interchangeably used with ‘A-IoT device’ or ‘A-IoT UE’.

**[0049]** In the context of the present disclosure, the term ‘second device’ refers to a node communicating with an A-IoT device. For example, the node may be a base station or a communication node between the base station and the A-IoT device. For example, the communication node may be a relay, integrated access and backhaul (IAB) node, UE, repeater, etc. which is capable of A-IoT associated functionalities. In some embodiments, the second device may be a node providing excitation signal or energy to the A-IoT device. In some embodiments, the second device may be a node transmitting a command to the A-IoT device to implement a selection, inventory or access (e.g., read and write) to the A-IoT device.

**[0050]** In the context of the present disclosure, the term ‘paging message’ refers to a message for paging an A-IoT device. The term ‘A-IoT’ may be interchangeably used with ‘passive IoT’.

**[0051]** An A-IoT device may only backscatter a signal and have no ability to generate uplink transmission internally. This means that an A-IoT device cannot monitor a paging with an idle mode discontinuous reception (DRX) like that in a wireless communication system such as LTE, NR, etc.. Thus, reception of a paging from network needs to be designed for A-IoT devices, especially for those A-IoT devices which can only backscatter a carrier wave for uplink transmission.

**[0052]** In view of this, embodiments of the present disclosure provide solutions of a paging for an A-IoT device. In one aspect, a first device (i.e., an A-IoT device) may determine first time or resource information of a first message for paging the first device based on one of the following: second time or resource information associated with wake up or synchronization of the first device, or a set of resources for a control signaling for the first message. Based on the first time or resource information, the first

device may receive the first message from a second device. In this way, a paging for an A-IoT device may be received.

**[0053]** In another aspect, upon reception of a message from a second device, a first device may determine that the message is for paging the first device based on at least one of the following: time or resource information of reception of the message, a type of the message, or information of a carrier wave for waking up the first device. In this way, a paging for an A-IoT device may be identified.

**[0054]** In another aspect, a second device may transmit, to a first device, a first message for paging the first device based on time or resource information associated with wake up or synchronization of the first device. Alternatively, the second device may transmit, to the first device, a control signaling for the first message based on the time or resource information associated with wake up or synchronization of the first device or a set of resources for the control signaling. In this way, reception of a paging for an A-IoT device may be ensured.

**[0055]** In another aspect, if a message for paging a first device is to be transmitted, a second device may perform an operation comprising at least one of the following: transmitting the message based on time or resource information indicating the message; transmitting the message or a further message comprising a type of the message; or transmitting a carrier wave, the information of the carrier wave indicating the message. In this way, an identification of a paging for an A-IoT device may be facilitated.

**[0056]** Aspects of the present disclosure are described in the context of a wireless communications system.

**[0057]** FIG. 1 illustrates an example of a wireless communications system 100 that supports a paging for an A-IoT device in accordance with aspects of the present disclosure. The wireless communications system 100 may include one or more network entities (also referred to as network equipment (NE)). For convenience, network entities 102-1, 102-2 and 102-3 are shown and are collectively referred to as one or more network entities 102 hereinafter. The wireless communications system 100 may further include one or more A-IoT devices 101, one or more UEs 104, a core network (CN) 106, and a packet data network 108. The wireless communications system 100 may support various radio access technologies. In some implementations, the wireless

communications system 100 may be a 4G network, such as an LTE network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communications system 100 may be a 5G network, such as an NR network. In other implementations, the wireless communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

**[0058]** The one or more A-IoT devices 101 may be dispersed throughout a geographic region of the wireless communications system 100. An A-IoT device 101 may be a battery-less device with no energy storage capability or a device with energy storage that do not need to be replaced or recharged manually. The A-IoT device 101 may comprise an energy harvesting module and a backscattering module. The A-IoT device 101 may receive an energy supply signal or command via the energy harvesting module and backscatter a signal via the backscattering module.

**[0059]** The one or more network entities 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the network entities 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a radio access network (RAN), a base transceiver station, an access point, a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. A network entity 102 and a UE 104 may communicate via a communication link 110, which may be a wireless or wired connection. For example, a network entity 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

**[0060]** 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.

**[0061]** The one or more UEs 104 may be dispersed throughout a geographic region of the wireless communications system 100. A UE 104 may include or may be referred to as a mobile device, a wireless device, a remote device, a remote unit, a handheld device, or a subscriber device, or some other suitable terminology. In some implementations, the UE 104 may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE 104 may be referred to as an Internet-of-Things (IoT) device, an Internet-of-Everything (IoE) device, or machine-type communication (MTC) device, among other examples. In some implementations, a UE 104 may be stationary in the wireless communications system 100. In some other implementations, a UE 104 may be mobile in the wireless communications system 100.

**[0062]** 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 IAB node, or another network equipment), as shown in FIG. 1. Additionally, or alternatively, a UE 104 may support communication with other network entities 102 or UEs 104, which may act as relays in the wireless communications system 100.

**[0063]** 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.

**[0064]** 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).

**[0065]** 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 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.

**[0066]** 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)).

**[0067]** Split of functionality between a CU, a DU, and an RU may be flexible and may support different functionalities depending upon which functions (e.g., network layer functions, protocol layer functions, baseband functions, radio frequency functions, and any combinations thereof) are performed at a CU, a DU, or an RU. For example, a functional split of a protocol stack may be employed between a CU and a DU such that the CU may support one or more layers of the protocol stack and the DU may support one or more different layers of the protocol stack. In some implementations, the CU may host upper protocol layer (e.g., a layer 3 (L3), a layer 2 (L2)) functionality and signaling (e.g., Radio Resource Control (RRC), service data adaptation protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU may be connected to one or more DUs or RUs, and the one or more DUs or RUs may host lower protocol layers, such as a layer 1 (L1) (e.g., physical (PHY) layer) or an L2 (e.g., radio link control (RLC) layer, medium access control (MAC) layer) functionality and signaling, and may each be at least partially controlled by the CU 160.

**[0068]** 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).

**[0069]** 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.

**[0070]** 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 one or more core network elements 103. A core network element 103 may be a control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management functions (AMF)) or 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.

**[0071]** 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, N3, or another network interface). The packet data network 108 may include an application server 118. In some implementations, one or more UEs 104 may communicate with the application server 118. A UE 104 may establish a session (e.g., a protocol data unit (PDU) session, or the like) with the core network 106 via a network entity 102. The core network 106 may route traffic (e.g., control information, data, and the like) between the UE 104 and the application server 118 using the established session (e.g., the established PDU session). The PDU session may be an example of a logical connection between the UE 104 and the core network 106 (e.g., one or more network functions of the core network 106).

**[0072]** In the wireless communications system 100, the network entities 102 and the UEs 104 may use resources of the wireless communications system 100 (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers)) to perform various operations (e.g., wireless communications). In some implementations, the network entities 102 and the UEs 104 may support different resource structures. For example, the network entities 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the network entities 102 and the UEs 104 may support a single frame structure. In

some other implementations, such as in 5G and among other suitable radio access technologies, the network entities 102 and the UEs 104 may support various frame structures (i.e., multiple frame structures). The network entities 102 and the UEs 104 may support various frame structures based on one or more numerologies.

**[0073]** One or more numerologies may be supported in the wireless communications system 100, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g.,  $\mu=0$ ) may be associated with a first subcarrier spacing (e.g., 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g.,  $\mu=0$ ) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g.,  $\mu=1$ ) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g.,  $\mu=2$ ) may be associated with a third subcarrier spacing (e.g., 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g.,  $\mu=3$ ) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g.,  $\mu=4$ ) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

**[0074]** 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.

**[0075]** Additionally or alternatively, a time interval of a resource (e.g., a communication resource) may be organized according to slots. For example, a subframe may include a number (e.g., quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communications system 100. For instance, the first, second, third, fourth, and fifth numerologies (i.e.,  $\mu=0$ ,  $\mu=1$ ,  $\mu=2$ ,  $\mu=3$ ,  $\mu=4$ ) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g., quantity) of

symbols (e.g., OFDM symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g.,  $\mu=0$ ) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

**[0076]** In the wireless communications system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communications system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5 (114.25 GHz – 300 GHz). In some implementations, the network entities 102 and the UEs 104 may perform wireless communications over one or more of the operating frequency bands. In some implementations, FR1 may be used by the network entities 102 and the UEs 104, among other equipment or devices for cellular communications traffic (e.g., control information, data). In some implementations, FR2 may be used by the network entities 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

**[0077]** FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g.,  $\mu=0$ ), which includes 15 kHz subcarrier spacing; a second numerology (e.g.,  $\mu=1$ ), which includes 30 kHz subcarrier spacing; and a third numerology (e.g.,  $\mu=2$ ), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g.,  $\mu=2$ ), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g.,  $\mu=3$ ), which includes 120 kHz subcarrier spacing.

**[0078]** In some scenarios, the A-IoT device 101 may directly and bidirectionally communicate with the network entity 102. The communication between the A-IoT

device 101 and the network entity 102 includes A-IoT data and/or signaling. These scenarios may be called as Topology 1.

**[0079]** In some scenarios, the A-IoT device 101 may communicate bidirectionally with an intermediate node between the A-IoT device 101 and the network entity 102. The intermediate node may be the UE 104, a relay, a IAB node, a repeater, etc. which is capable of A-IoT. The intermediate node may transfer A-IoT data and/or signaling between the A-IoT device 101 and the network entity 102. These scenarios may be called as Topology 2.

**[0080]** In some scenarios, the A-IoT device 101 may transmit data/signaling to the network entity 102, and receive data/signaling from an assisting node; or the A-IoT device 101 may receive data/signaling from the network entity 102, and transmit data/signaling to the assisting node. The assisting node may be the UE 104, a relay, an IAB node, a repeater, etc. which is capable of A-IoT. These scenarios may be called as Topology 3.

**[0081]** In some scenarios, the A-IoT device 101 may communicate bidirectionally with the UE 104. The communication between the A-IoT device 101 and the UE 104 includes A-IoT data and/or signaling. These scenarios may be called as Topology 4.

**[0082]** Embodiments of the present disclosure provide solutions of a paging for an A-IoT device. The solutions will be described in connection with FIGs. 2 to 5C below.

**[0083]** FIG. 2 illustrates an example of a process 200 that supports a paging for an A-IoT device in accordance with aspects of the present disclosure. For purpose of discussion, the process 200 will be described in connection with FIG. 1. The process 200 may involve a first device and a second device. The first device may be an A-IoT device, and the second device may be a base station or a communication node between the base station and the A-IoT device. For illustration, the following description will be given by assuming that the first device is the A-IoT device 101, and the second device is the network entity 102-1. It is to be understood that the steps and the order of the steps in FIG. 2 are merely for illustration, and not for limitation.

**[0084]** It is assumed that the A-IoT device 101 wakes up autonomously or by carrier wave trigger or physical layer signal trigger. The carrier wave may be an energy carrier or carrier wave with signaling.

[0085] As shown in FIG. 2, the A-IoT device 101 may determine 210 time or resource information (for convenience, also referred to as first time or resource information herein) of a message (for convenience, also referred to as a first message herein) for paging the A-IoT device 101.

[0086] With reference to FIG. 2, in some embodiments, the A-IoT device 101 may determine 211 the first time or resource information based on time or resource information (for convenience, also referred to as second time or resource information herein) associated with wake up or synchronization of the A-IoT device 101.

[0087] In some embodiments, the network entity 102-1 may directly transmit the first message without a separate control signaling for paging reception based on the second time or resource information associated with wake up or synchronization of the A-IoT device 101. In this case, the A-IoT device 101 may determine the second time or resource information as the first time or resource information.

[0088] In some embodiments, the second time or resource information may comprise a time point after the wake up of the A-IoT device 101. FIG. 3A illustrates a diagram 300A illustrating an example paging for an A-IoT device in accordance with aspects of the present disclosure. As shown in FIG. 3A, the A-IoT device 101 wakes up at a timing T1. After X slots since the timing T1, a paging for the A-IoT device 101 may be received at a timing T2. It is to be understood that a value of X may be configured or predefined. It is also to be understood that 'slot' is merely an example, and any other suitable time units (e.g., sub-slot, frame, sub-frame,  $\mu$ s, ms, etc.) may also be feasible.

[0089] In some embodiments, the second time or resource information may comprise a time point or time-frequency resource associated with a physical layer signal or carrier wave. In some embodiments, the second time or resource information may comprise a time point or time-frequency resource associated with a physical layer signal after the wake up of the A-IoT device 101. In some embodiments, the physical layer signal may be a synchronization signal or any other suitable signals.

[0090] In some embodiments, the second time or resource information may comprise a time point or time-frequency resource associated with a carrier wave or physical layer signal for waking up the A-IoT device 101. In some embodiments, the

physical layer signal may be a wake up signal, a synchronization signal, or any other suitable signals.

**[0091]** FIG. 3B illustrates a diagram 300B illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure. As shown in FIG. 3B, at a timing T3, a synchronization signal is detected or a carrier wave for waking up the A-IoT device 101 is received. After Y slots since the timing T3, a paging for the A-IoT device 101 may be received at a timing T4. It is to be understood that a value of Y may be configured or predefined. It is also to be understood that 'slot' is merely an example, and any other suitable time units (e.g., sub-slot, frame, sub-frame,  $\mu$ s, ms, etc.) may also be feasible.

**[0092]** FIG. 3C illustrates a diagram 300C illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure. As shown in FIG. 3C, a time-frequency resource 310 is used for a synchronization signal or a carrier wave, and a time-frequency resource 320 is used for a paging for the A-IoT device 101. There is a mapping between the time-frequency resource 310 and the time-frequency resource 320. The mapping between the time-frequency resource 310 and the time-frequency resource 320 may be predefined or configured for the A-IoT device 101.

**[0093]** In some embodiments, the second time or resource information may comprise a time-frequency resource indicated in system information of the network entity 102-1 after the wake up of the A-IoT device 101. FIG. 3D illustrates a diagram 300D illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure. As shown in FIG. 3D, after wake up, the A-IoT device 101 may receive system information at a timing T5. In the system information, a time and/or frequency location 330 may be configured for the A-IoT device 101. The A-IoT device 101 may receive the paging according to the received system information. For example, 2 bits with four code points may be used to indicate 1/2/3/4 slots. This means that the paging is to be received after 1/2/3/4 slots since reception of the system information.

**[0094]** In some embodiments, the second time or resource information may comprise time information carried in the carrier wave. In some embodiments, the time information carried in the carrier wave may comprise a slot offset to the wake up of the A-IoT device 101. In some embodiments, the time information carried in the carrier

wave may comprise a slot offset to reception of the carrier wave. In some embodiments, the time information carried in the carrier wave may comprise a slot offset to reception of the physical layer signal. For example, 2 bits with four code points may be used to indicate 1/2/3/4 slots. This means that the paging is to be received after 1/2/3/4 slots since wake up or reception of the carrier wave or reception of a specific physical layer signal (e.g., synchronization signal).

**[0095]** In some embodiments, the network entity 102-1 may transmit a control signaling for the first message. In other words, the A-IoT device 101 may receive the first message with a separate control signaling for paging reception. In some embodiments, the first time or resource information of the first message may be indicated by the control signaling.

**[0096]** In some embodiments, the network entity 102-1 may transmit the control signaling based on the second time or resource information associated with wake up or synchronization of the A-IoT device 101. Correspondingly, the A-IoT device 101 may receive the control signaling based on the second time or resource information or the set of resources, and determine the first time or resource information from the control signaling. The reception of the control signaling based on the second time or resource information is the same as the reception of the first message based on the second time or resource information described above, and thus is not repeated here for conciseness.

**[0097]** With reference to FIG. 2, in some embodiments, the A-IoT device 101 may determine 212 the first time or resource information based on a set of resources for the control signaling. In some embodiments, the set of resources may be predefined or configured for the A-IoT device 101.

**[0098]** In some embodiments, the network entity 102-1 may transmit the control signaling based on the set of resources for the control signaling. In this case, the A-IoT device 101 may receive the control signaling based on the set of resources, and determine the first time or resource information from the control signaling.

**[0099]** Continuing to refer to FIG. 2, the A-IoT device 101 may receive 220 the first message based on the first time or resource information. In this way, reception of the paging for the A-IoT device 101 may be ensured.

**[0100]** In some scenarios, when a paging for an A-IoT device is triggered from core network, multiple entities may send the same paging message to find the A-IoT device. Multiple paging messages from different entities may be coordinated by a central controller to avoid interference. Thus, paging reception of an A-IoT device in these scenarios also needs to be defined.

**[0101]** With reference to FIG. 2, in some embodiments, if the first message is received, the A-IoT device 101 may not receive 230 another message (also referred to as a second message herein) for paging the A-IoT device 101 from a third device in a period of time.

**[0102]** FIG. 3E illustrates a diagram 300E illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure. As shown in FIG. 3E, multiple paging messages from different entities BS1, BS2 and BS3 may be sent consecutively in time domain. Because of different distances between the A-IoT device 101 and different entities, paging from different entities may or may not wake up the A-IoT device 101. In this example, a carrier or signal from the entity BS1 wakes up the A-IoT device 101. In this case, the A-IoT device 101 may receive the paging from BS1, and may not receive the paging from entities BS2 and BS3 in a period of time.

**[0103]** With reference to FIG. 2, in some embodiments, if a plurality of messages for paging the A-IoT device 101 are received, the A-IoT device 101 may determine 240, as the first message, one of the plurality of messages that has a strongest carrier wave or physical layer signal.

**[0104]** FIG. 3F illustrates a diagram 300F illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure. As shown in FIG. 3F, multiple paging messages from different entities BS1, BS2 and BS3 may be sent in different frequency resources in the same slot. Because of different distances between the A-IoT device 101 and different entities, paging from different entities may or may not wake up the A-IoT device 101. Paging from different entities may have different signal strength when arrived at the A-IoT device 101. In this example, the A-IoT device 101 may receive a paging associated with the strongest carrier wave or physical layer signal (e.g., from BS2) that wakes up the A-IoT device 101.

**[0105]** In some embodiments, multiple paging messages from different entities may be sent in different frequency resources and sent in different slots. In this case, the A-IoT device 101 may receive a paging that associated with the strongest carrier wave that wakes up the A-IoT device 101 in a specific slot. Alternatively, the A-IoT device 101 may receive a paging associated with the strongest physical layer signal, e.g., synchronization signal.

**[0106]** So far, a solution of paging reception for an A-IoT device is described. With the process 200, a paging for an A-IoT device may be surely received.

**[0107]** FIG. 4 illustrates a signaling chart of another example process 400 that supports a paging for an A-IoT device in accordance with aspects of the present disclosure. For purpose of discussion, the process 400 will be described in connection with FIG. 1. The process 400 may involve a first device and a second device. The first device may be an A-IoT device, and the second device may be a base station or a communication node between the base station and the A-IoT device. For illustration, the following description will be given by assuming that the first device is the A-IoT device 101, and the second device is the network entity 102-1. It is to be understood that the steps and the order of the steps in FIG. 4 are merely for illustration, and not for limitation.

**[0108]** As shown in FIG. 4, the A-IoT device 101 may receive 410 a message from the network entity 102-1.

**[0109]** With reference to FIG. 4, in some embodiments, if a message (for convenience, also referred to as a paging message hereinafter) for paging the A-IoT device 101 is to be transmitted, the network entity 102-1 may transmit 411 the paging message based on time or resource information indicating the paging message.

**[0110]** In some embodiments, the network entity 102-1 may transmit the paging message as a message firstly transmitted after a time point. In some embodiments, the time point may be a time point after the wake up of the A-IoT device 101. In some embodiments, the time point may be a time point of transmitting a carrier wave. In some embodiments, the time point may be a time point of transmitting a physical layer signal (e.g., synchronization signal) after the wake up of the A-IoT device 101. In some

embodiments, the time point may be a time point of transmitting system information of the network entity 102-1 after the wake up of the A-IoT device 101.

**[0111]** FIG. 5A illustrates a diagram 500A illustrating an example paging for an A-IoT device in accordance with aspects of the present disclosure. As shown in FIG. 5A, a synchronization signal is transmitted at a timing T6. Message 1 and Message 2 are transmitted after the synchronization signal. Message 1 firstly transmitted after the synchronization signal is determined as a paging message.

**[0112]** With reference to FIG. 4, in some embodiments, if a message for paging the A-IoT device 101 is to be transmitted, the network entity 102-1 may transmit 412 the message comprising a type of the message. The type of the message may indicate a paging message.

**[0113]** With reference to FIG. 4, in some embodiments, if a message for paging the A-IoT device 101 is to be transmitted, the network entity 102-1 may transmit 413 a further message comprising the type of the message. In some embodiments, the further message may be a physical layer control signaling. In some embodiments, the further message may be system information. It is to be understood that any other suitable messages may also be feasible.

**[0114]** In some embodiments, one or several bits may be used to explicitly indicate the message type. For example, the one or several bits may indicate whether the message is a paging message. In another example, the one or several bits may indicate the message is other type of message, e.g. system information, random access response (RAR), etc.

**[0115]** With reference to FIG. 4, in some embodiments, if a message for paging the A-IoT device 101 is to be transmitted, the network entity 102-1 may transmit 414 a carrier wave indicating the message. In other words, the information of the carrier wave may indicate whether the following message is a paging message.

**[0116]** In some embodiments, a time duration of the carrier wave may implicitly indicate whether the following message is a paging message. That is, different time duration may indicate different message types.

[0117] FIG. 5B illustrates a diagram 500B illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure. As shown in FIG. 5B, a time duration 510 for energy activation of an A-IoT device indicates the following message is a paging message. A time duration 520 for energy activation of an A-IoT device indicates the following message is other message.

[0118] In some embodiments, an attribute of the carrier wave may indicate whether the following message is a paging message. For example, an envelop of the carrier wave may implicitly indicate whether the following message is a paging message. It is to be understood that any other suitable attributes may also be feasible.

[0119] In some embodiments, a time-frequency resource of the carrier wave may indicate the following message is a paging message. For example, the network entity 102-1 may transmit the paging message after transmitting a carrier wave at a specific time-frequency resource. In this case, the specific time-frequency resource sending energy from the carrier wave may indicate that the followed message is a paging message.

[0120] In some embodiments, a time-frequency resource of a physical layer signal may indicate the following message is a paging message. For example, the network entity 102-1 may transmit the paging message after transmitting the physical layer signal at a specific time-frequency resource. In this case, the specific time-frequency resource sending the physical layer signal may indicate that the followed message is a paging message.

[0121] FIG. 5C illustrates a diagram 500C illustrating another example paging for an A-IoT device in accordance with aspects of the present disclosure. As shown in FIG. 5C, if a physical layer signal or a carrier wave that wakes up an A-IoT device is transmitted in a time-frequency location 530, then the followed message at a time-frequency location 540 is a paging message. Otherwise, the followed message is other message.

[0122] In some embodiments, the network entity 102-1 may transmit the paging message at a specific time-frequency resource. In this case, the specific time-frequency resource may indicate that the current message is the paging message.

**[0123]** Continuing to refer to FIG. 4, upon reception of the message from the network entity 102-1, the A-IoT device 101 may determine 420 whether the message is a paging message.

**[0124]** In some embodiments, the A-IoT device 101 may determine whether the message is a paging message based on at least one of the following: time or resource information of reception of the message, the type of the message, or the information of the carrier wave for waking up the A-IoT device 101.

**[0125]** With reference to FIG. 4, in some embodiments, if the message is a message firstly received after a time point, the A-IoT device 101 may determine 421 that the message is for paging the A-IoT device 101. In some embodiments, the time point may be a time point after the wake up of the A-IoT device 101. In some embodiments, the time point may be a time point of receiving the carrier wave. In some embodiments, the time point may be a time point of receiving a physical layer signal after the wake up of the A-IoT device 101. In some embodiments, the time point may be a time point of receiving system information of the network entity 102-1 after the wake up of the A-IoT device 101.

**[0126]** With reference to FIG. 4, in some embodiments, if the message is received at a specific time-frequency resource, the A-IoT device 101 may determine 422 that the message is for paging the A-IoT device 101.

**[0127]** With reference to FIG. 4, in some embodiments, if the type of the message indicates the message is for paging the A-IoT device 101, the A-IoT device 101 may determine 423 that the message is for paging the A-IoT device 101. In some embodiments, the A-IoT device 101 may determine the type of the message in a further message from the network entity 102-1. In some embodiments, the further message may be a physical layer control signaling. In some embodiments, the further message may be system information. In some embodiments, the A-IoT device 101 may determine the type of the message in the message.

**[0128]** With reference to FIG. 4, in some embodiments, if the information of the carrier wave indicates the message is for paging the A-IoT device 101, the A-IoT device 101 may determine 424 that the message is for paging the A-IoT device 101. In some embodiments, the information of the carrier wave may comprise at least one of the

following: the time duration of the carrier wave; the attribute of the carrier wave; or the time-frequency resource of the carrier wave.

**[0129]** It is to be understood that operations in steps 411 to 414 correspond to operations in steps 421 to 424, and thus other details of the steps 411 to 414 are not repeated here for conciseness.

**[0130]** With the process 400, an A-IoT device may determine or identify a paging message before or after reception of the paging message. Thus, paging reception for an A-IoT device may be enhanced.

**[0131]** FIG. 6 illustrates an example of a device 600 that supports a paging for an A-IoT device in accordance with aspects of the present disclosure. The device 600 may be an example of a first device or a second device as described herein. The device 600 may support wireless communication with one or more network entities 102, UEs 104, the core network element 103, or any combination thereof. The device 600 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 602, a memory 604, a transceiver 606, and, optionally, an I/O controller 608. 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).

**[0132]** The processor 602, the memory 604, the transceiver 606, 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 602, the memory 604, the transceiver 606, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

**[0133]** In some implementations, the processor 602, the memory 604, the transceiver 606, 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 602 and the memory 604 coupled with the processor 602 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 602, instructions stored in the memory 604).

**[0134]** For example, the processor 602 may support wireless communication at the device 600 in accordance with examples as disclosed herein. In some embodiments where the device 600 is implemented as a first device, in one aspect, the processor 602 may be configured to operable to support a means for: determining first time or resource information of a first message for paging the first device based on one of the following: second time or resource information associated with wake up or synchronization of the first device, or a set of resources for a control signaling for the first message; and receiving, from a second device via a transceiver, the first message based on the first time or resource information. In another aspect, the processor 602 may be configured to operable to support a means for: receiving a message from a second device via a transceiver; and determining that the message is for paging the first device based on at least one of the following: time or resource information of reception of the message, a type of the message, or information of a carrier wave for waking up the first device.

**[0135]** In some embodiments where the device 600 is implemented as a second device, in one aspect, the processor 602 may be configured to operable to support a means for: transmitting, to a first device via a transceiver, a first message for paging the first device based on time or resource information associated with wake up or synchronization of the first device, or transmitting, to the first device via the transceiver, a control signaling for the first message based on the time or resource information associated with wake up or synchronization of the first device or a set of resources for the control signaling. In another aspect, the processor 602 may be configured to operable to support a means for: in accordance with a determination that a message for paging a first device is to be transmitted, performing an operation comprising at least one of the following: transmitting the message based on time or resource information indicating the message; transmitting the message or a further message comprising a type of the message; or transmitting a carrier wave, the information of the carrier wave indicating the message.

**[0136]** The processor 602 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 602 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 602. The processor 602 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 604) to cause the device 600 to perform various functions of the present disclosure.

**[0137]** The memory 604 may include random access memory (RAM) and read-only memory (ROM). The memory 604 may store computer-readable, computer-executable code including instructions that, when executed by the processor 602 cause the device 600 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 602 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 604 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.

**[0138]** The I/O controller 608 may manage input and output signals for the device 600. The I/O controller 608 may also manage peripherals not integrated into the device 600. In some implementations, the I/O controller 608 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 608 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 608 may be implemented as part of a processor, such as the processor 606. In some implementations, a user may interact with the device 600 via the I/O controller 608 or via hardware components controlled by the I/O controller 608.

**[0139]** In some implementations, the device 600 may include a single antenna 610. However, in some other implementations, the device 600 may have more than one antenna 610 (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 606 may communicate bi-directionally, via the one or more antennas 610, wired, or wireless links as described herein. For example, the transceiver 606 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 606 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 610 for transmission, and to demodulate packets received from the one or more antennas 610. The transceiver 606 may include one or more transmit chains, one or more receive chains, or a combination thereof.

**[0140]** 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 610 for transmitting the amplified signal into the air or wireless medium.

**[0141]** 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 610 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.

**[0142]** FIG. 7 illustrates an example of a processor 700 that supports a paging for an A-IoT device in accordance with aspects of the present disclosure. The processor 700 may be an example of a processor configured to perform various operations in

accordance with examples as described herein. The processor 700 may include a controller 702 configured to perform various operations in accordance with examples as described herein. The processor 700 may optionally include at least one memory 704, such as L1/L2/L3 cache. Additionally, or alternatively, the processor 700 may optionally include one or more arithmetic-logic units (ALUs) 706. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

**[0143]** The processor 700 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g., receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 700) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

**[0144]** The controller 702 may be configured to manage and coordinate various operations (e.g., signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 700 to cause the processor 700 to support various operations in accordance with examples as described herein. For example, the controller 702 may operate as a control unit of the processor 700, generating control signals that manage the operation of various components of the processor 700. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

**[0145]** The controller 702 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 704 and determine subsequent instruction(s) to be executed to cause the processor 700 to support various operations in accordance with examples as described herein. The controller 702 may be configured to track memory address of instructions associated with the memory 704. The controller 702 may be

configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 702 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 700 to cause the processor 700 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 702 may be configured to manage flow of data within the processor 700. The controller 702 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 700.

**[0146]** The memory 704 may include one or more caches (e.g., memory local to or included in the processor 700 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 704 may reside within or on a processor chipset (e.g., local to the processor 700). In some other implementations, the memory 704 may reside external to the processor chipset (e.g., remote to the processor 700).

**[0147]** The memory 704 may store computer-readable, computer-executable code including instructions that, when executed by the processor 700, cause the processor 700 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 702 and/or the processor 700 may be configured to execute computer-readable instructions stored in the memory 704 to cause the processor 700 to perform various functions. For example, the processor 700 and/or the controller 702 may be coupled with or to the memory 704, and the processor 700, the controller 702, and the memory 704 may be configured to perform various functions described herein. In some examples, the processor 700 may include multiple processors and the memory 704 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

**[0148]** The one or more ALUs 706 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 706 may reside within or on a processor chipset (e.g., the processor 700). In some other implementations, the one or more ALUs 706 may reside external to the processor chipset (e.g., the processor 700). One or more ALUs 706 may perform one or

more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 706 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 706 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 706 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 706 to handle conditional operations, comparisons, and bitwise operations.

**[0149]** The processor 700 may support wireless communication in accordance with examples as disclosed herein. In some embodiments where the processor 700 is implemented at a first device, in one aspect, the processor 700 may be configured to or operable to support a means for: determining first time or resource information of a first message for paging the first device based on one of the following: second time or resource information associated with wake up or synchronization of the first device, or a set of resources for a control signaling for the first message; and receiving, from a second device via a transceiver, the first message based on the first time or resource information. In another aspect, the processor 700 may be configured to operable to support a means for: receiving a message from a second device via a transceiver; and determining that the message is for paging the first device based on at least one of the following: time or resource information of reception of the message, a type of the message, or information of a carrier wave for waking up the first device.

**[0150]** In some embodiments where the processor 700 is implemented at a second device, in one aspect, the processor 700 may be configured to or operable to support a means for: transmitting, to a first device via a transceiver, a first message for paging the first device based on time or resource information associated with wake up or synchronization of the first device, or transmitting, to the first device via the transceiver, a control signaling for the first message based on the time or resource information associated with wake up or synchronization of the first device or a set of resources for the control signaling. In another aspect, the processor 700 may be configured to operable to support a means for: in accordance with a determination that a message for paging a first device is to be transmitted, performing an operation comprising at least

one of the following: transmitting the message based on time or resource information indicating the message; transmitting the message or a further message comprising a type of the message; or transmitting a carrier wave, the information of the carrier wave indicating the message.

**[0151]** FIG. 8 illustrates a flowchart of a method 800 that supports a paging for an A-IoT device in accordance with aspects of the present disclosure. The operations of the method 800 may be implemented by a device or its components as described herein. For example, the operations of the method 800 may be performed by a first device 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.

**[0152]** At block 810, the method 800 may comprise determining first time or resource information of a first message for paging the first device based on one of the following: second time or resource information associated with wake up or synchronization of the first device, or a set of resources for a control signaling for the first message. The operations of 810 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 810 may be performed by a device as described with reference to FIG. 1.

**[0153]** In some embodiments, the second time or resource information may comprise at least one of the following: a time point after the wake up of the first device; a time point or time-frequency resource associated with a physical layer signal after the wake up of the first device; a time point or time-frequency resource associated with a carrier wave or physical layer signal for waking up the first device; a time-frequency resource indicated in system information of the second device after the wake up of the first device; or time information carried via the carrier wave.

**[0154]** In some embodiments, the time information carried in the carrier wave may comprise at least one of the following: a slot offset to the wake up of the first device; a slot offset to reception of the carrier wave; or a slot offset to reception of the physical layer signal.

**[0155]** In some embodiments, determining the first time or resource information may comprise: determining the second time or resource information as the first time or resource information.

**[0156]** In some embodiments, determining the first time or resource information may comprise: receiving, from the second device, the control signaling based on the second time or resource information or the set of resources; and determining the first time or resource information in the control signaling.

**[0157]** At block 820, the method 800 may comprise receiving the first message from a second device based on the first time or resource information. The operations of 820 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 820 may be performed by a device as described with reference to FIG. 1.

**[0158]** In some embodiments, the method 800 may further comprise at least one of the following: in accordance with a determination that the first message is received, receiving no second message for paging the first device from a third device in a period of time; or in accordance with a determination that a plurality of messages for paging the first device are received, determining, as the first message, one of the plurality of messages that has a strongest carrier wave or physical layer signal.

**[0159]** In some embodiments, the first device is an A-IoT device, and the second device is a base station or a communication node between the base station and the A-IoT device.

**[0160]** FIG. 9 illustrates a flowchart of another method 900 that supports a paging for an A-IoT device in accordance with aspects of the present disclosure. The operations of the method 900 may be implemented by a device or its components as described herein. For example, the operations of the method 900 may be performed by a first device 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.

**[0161]** At block 910, the method 900 may comprise receiving a message from a second device. The operations of 910 may be performed in accordance with examples

as described herein. In some implementations, aspects of the operations of 910 may be performed by a device as described with reference to FIG. 1.

**[0162]** At block 920, the method 900 may comprise determining that the message is for paging the first device based on at least one of the following: time or resource information of reception of the message, a type of the message, or information of a carrier wave for waking up the first device. The operations of 920 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 920 may be performed by a device as described with reference to FIG. 1.

**[0163]** In some embodiments, the information of the carrier wave may comprise at least one of the following: a time duration of the carrier wave; an attribute of the carrier wave; or a time-frequency resource of the carrier wave.

**[0164]** In some embodiments, determining that the message is for paging the first device may comprise at least one of the following: in accordance with a determination that the message is a message firstly received after a time point, determining that the message is for paging the first device; in accordance with a determination that the message is received at a time-frequency resource, determining that the message is for paging the first device; in accordance with a determination that the type of the message indicates the message is for paging the first device, determining that the message is for paging the first device; or in accordance with a determination that the information of the carrier wave indicates the message is for paging the first device, determining that the message is for paging the first device.

**[0165]** In some embodiments, the time point may comprise at least one of the following: a time point after the wake up of the first device; a time point of receiving the carrier wave; a time point of receiving a physical layer signal after the wake up of the first device; or a time point of receiving system information of the second device after the wake up of the first device.

**[0166]** In some embodiments, the method 900 may further comprise: determining the type of the message in a further message from the second device; or determining the type of the message in the message.

**[0167]** In some embodiments, the first device is an A-IoT device, and the second device is a base station or a communication node between the base station and the A-IoT device.

**[0168]** FIG. 10 illustrates a flowchart of another method 1000 that supports a paging for an A-IoT device in accordance with aspects of the present disclosure. The operations of the method 1000 may be implemented by a device or its components as described herein. For example, the operations of the method 1000 may be performed by a second device 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.

**[0169]** At block 1010, the method 1000 may comprise transmitting, to a first device, a first message for paging the first device based on time or resource information associated with wake up or synchronization of the first device, or transmitting, to the first device, a control signaling for the first message based on the time or resource information associated with wake up or synchronization of the first device or a set of resources for the control signaling. The operations of 1010 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1010 may be performed by a device as described with reference to FIG. 1.

**[0170]** In some embodiments, the time or resource information may comprise at least one of the following: a time point after the wake up of the first device; a time point or time-frequency resource associated with a physical layer signal after the wake up of the first device; a time point or time-frequency resource associated with a carrier wave or physical layer signal for waking up the first device; a time-frequency resource indicated in system information of the second device after the wake up of the first device; or time information carried in the carrier wave.

**[0171]** In some embodiments, the time information carried in the carrier wave may comprise at least one of the following: a slot offset to the wake up of the first device; a slot offset to reception of the carrier wave; or a slot offset to reception of the physical layer signal.

[0172] In some embodiments, the first device is an A-IoT device, and the second device is a base station or a communication node between the base station and the A-IoT device.

[0173] FIG. 11 illustrates a flowchart of another method 1100 that supports a paging for an A-IoT device in accordance with aspects of the present disclosure. The operations of the method 1100 may be implemented by a device or its components as described herein. For example, the operations of the method 1100 may be performed by a second device 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.

[0174] At block 1110, the method 1100 may comprise determining that a message for paging a first device is to be transmitted. The operations of 1110 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1110 may be performed by a device as described with reference to FIG. 1.

[0175] At block 1120, the method 1100 may comprise performing an operation comprising at least one of the following: transmitting the message based on time or resource information indicating the message; transmitting the message or a further message comprising a type of the message; or transmitting a carrier wave, the information of the carrier wave indicating the message. The operations of 1120 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1120 may be performed by a device as described with reference to FIG. 1.

[0176] In some embodiments, the information of the carrier wave may comprise at least one of the following: a time duration of the carrier wave; an attribute of the carrier wave; or a time-frequency resource of the carrier wave.

[0177] In some embodiments, transmitting the message based on the time or resource information indicating the message may comprise at least one of the following: transmitting the message as a message firstly transmitted after a time point; transmitting the message at a time-frequency resource; transmitting the message after transmitting

the carrier wave based on the information of the carrier wave; or transmitting the message after transmitting the further message.

**[0178]** In some embodiments, the time point may comprise at least one of the following: a time point after the wake up of the first device; a time point of transmitting the carrier wave; a time point of transmitting a physical layer signal after the wake up of the first device; or a time point of transmitting system information of the second device after the wake up of the first device.

**[0179]** In some embodiments, the first device is an A-IoT device, and the second device is a base station or a communication node between the base station and the A-IoT device.

**[0180]** It is to be understood that the operations of the methods 800 to 1100 correspond to that described in connection with FIGs. 2 to 5C, and thus other details are not repeated here for conciseness.

**[0181]** 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.

**[0182]** 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).

**[0183]** 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.

**[0184]** 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.

**[0185]** 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.

**[0186]** 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 first device, comprising:  
a processor; and  
a transceiver coupled to the processor,  
wherein the processor is configured to:  
determine first time or resource information of a first message for paging the first device based on one of the following:  
second time or resource information associated with wake up or synchronization of the first device, or  
a set of resources for a control signaling for the first message; and  
receive, from a second device via the transceiver, the first message based on the first time or resource information.
2. The first device of claim 1, wherein the second time or resource information comprises at least one of the following:  
a time point after the wake up of the first device;  
a time point or time-frequency resource associated with a physical layer signal after the wake up of the first device;  
a time point or time-frequency resource associated with a carrier wave or physical layer signal for waking up the first device;  
a time-frequency resource indicated in system information of the second device after the wake up of the first device; or  
time information carried via the carrier wave.
3. The first device of claim 2, wherein the time information carried in the carrier wave comprises at least one of the following:  
a slot offset to the wake up of the first device;  
a slot offset to reception of the carrier wave; or  
a slot offset to reception of the physical layer signal.

4. The first device of claim 1, wherein the processor is configured to determine the first time or resource information by:

determining the second time or resource information as the first time or resource information.

5. The first device of claim 1, wherein the processor is configured to determine the first time or resource information by:

receiving, from the second device via the transceiver, the control signaling based on the second time or resource information or the set of resources; and  
determining the first time or resource information in the control signaling.

6. The first device of claim 1, wherein the processor is further configured to at least one of the following:

in accordance with a determination that the first message is received, receive no second message for paging the first device from a third device in a period of time; or

in accordance with a determination that a plurality of messages for paging the first device are received, determine, as the first message, one of the plurality of messages that has a strongest carrier wave or physical layer signal.

7. A first device, comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

receive a message from a second device via the transceiver; and

determine that the message is for paging the first device based on at least one of the following:

time or resource information of reception of the message,

a type of the message, or

information of a carrier wave for waking up the first device.

8. The first device of claim 7, wherein the information of the carrier wave comprises at least one of the following:

a time duration of the carrier wave;

an attribute of the carrier wave; or  
a time-frequency resource of the carrier wave.

9. The first device of claim 7, wherein the processor is configured to determine that the message is for paging the first device by at least one of the following:

in accordance with a determination that the message is a message firstly received after a time point, determining that the message is for paging the first device;

in accordance with a determination that the message is received at a time-frequency resource, determining that the message is for paging the first device;

in accordance with a determination that the type of the message indicates the message is for paging the first device, determining that the message is for paging the first device; or

in accordance with a determination that the information of the carrier wave indicates the message is for paging the first device, determining that the message is for paging the first device.

10. The first device of claim 9, wherein the time point comprises at least one of the following:

a time point after the wake up of the first device;

a time point of receiving the carrier wave;

a time point of receiving a physical layer signal after the wake up of the first device; or

a time point of receiving system information of the second device after the wake up of the first device.

11. The first device of claim 9, wherein the processor is further configured to:

determine the type of the message in a further message from the second device;

or

determine the type of the message in the message.

12. The first device of claim 1 or 7, wherein the first device is an ambient Internet of things (A-IoT) device, and the second device is a base station or a communication node between the base station and the A-IoT device.

13. A second device, comprising:  
a processor; and  
a transceiver coupled to the processor,  
wherein the processor is configured to:

transmit, to a first device via the transceiver, a first message for paging the first device based on time or resource information associated with wake up or synchronization of the first device, or

transmit, to the first device via the transceiver, a control signaling for the first message based on the time or resource information associated with wake up or synchronization of the first device or a set of resources for the control signaling.

14. The second device of claim 13, wherein the time or resource information comprises at least one of the following:

a time point after the wake up of the first device;

a time point or time-frequency resource associated with a physical layer signal after the wake up of the first device;

a time point or time-frequency resource associated with a carrier wave or physical layer signal for waking up the first device;

a time-frequency resource indicated in system information of the second device after the wake up of the first device; or

time information carried in the carrier wave.

15. The second device of claim 14, wherein the time information carried in the carrier wave comprises at least one of the following:

a slot offset to the wake up of the first device;

a slot offset to reception of the carrier wave; or

a slot offset to reception of the physical layer signal.

16. A second device, comprising:  
a processor; and  
a transceiver coupled to the processor,  
wherein the processor is configured to:

in accordance with a determination that a message for paging a first device is to be transmitted, perform an operation comprising at least one of the following:

transmitting the message based on time or resource information indicating the message;

transmitting the message or a further message comprising a type of the message; or

transmitting a carrier wave, the information of the carrier wave indicating the message.

17. The second device of claim 16, wherein the information of the carrier wave comprises at least one of the following:

a time duration of the carrier wave;

an attribute of the carrier wave; or

a time-frequency resource of the carrier wave.

18. The second device of claim 16, wherein the processor is configured to transmit the message based on the time or resource information indicating the message by at least one of the following:

transmitting the message as a message firstly transmitted after a time point;

transmitting the message at a time-frequency resource;

transmitting the message after transmitting the carrier wave based on the information of the carrier wave; or

transmitting the message after transmitting the further message.

19. The second device of claim 18, wherein the time point comprises at least one of the following:

a time point after the wake up of the first device;

a time point of transmitting the carrier wave;

a time point of transmitting a physical layer signal after the wake up of the first device; or

a time point of transmitting system information of the second device after the wake up of the first device.

20. The second device of claim 13 or 16, wherein the first device is an ambient Internet of things (A-IoT) device, and the second device is a base station or a communication node between the base station and the A-IoT device.