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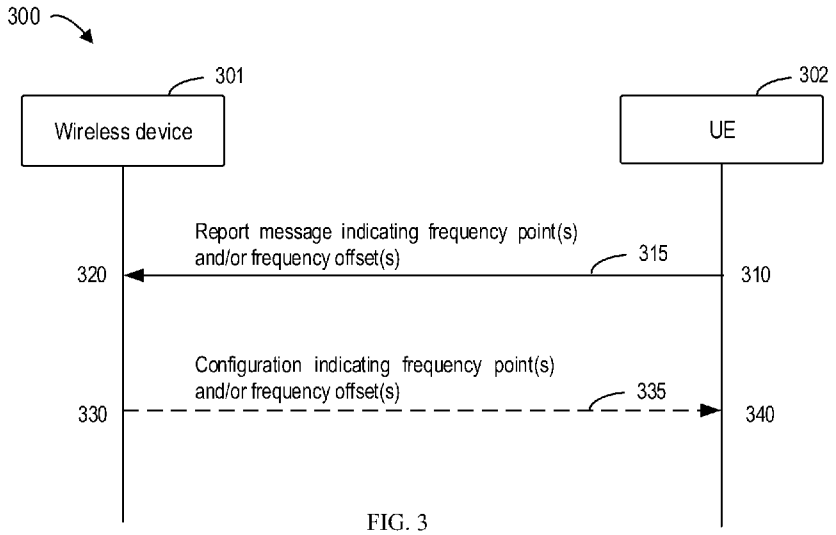


FIG. 3

(57) Abstract: Various aspects of the present disclosure relate to devices, a processor for wireless communication, a network entity, methods, and a computer readable medium for frequency reporting for carrier wave reception and backscattering transmission. A UE transmits, to a wireless device, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE. In this way, UEs are enabled to report frequency carrier wave transmission frequency point (s) and/or frequency offset value (s) to BS side.

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FREQUENCY REPORTING FOR CARRIER WAVE RECEPTION AND BACKSCATTERING TRANSMISSION

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to a user equipment (UE) for wireless communication, a wireless device, a processor for wireless communication, methods, and a computer readable medium for frequency reporting for carrier wave reception and backscattering transmission.

BACKGROUND

[0002] A wireless communications system may include one or multiple network wireless 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 wireless devices, such as a base station may support wireless communications for one or multiple user wireless 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 wireless 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] In recent years, Internet of Things (IoT) has attracted much attention in the wireless communication world. More "things" are expected to be interconnected for improving productivity efficiency and increasing comforts of life. Further reduction of size, complexity, and power consumption of IoT devices can enable the deployment of tens or even hundreds of billions of IoT devices for various applications and provide added value across the entire value chain. It is impossible to power all the IoT devices by battery that needs to be replaced or recharged manually, which leads to high maintenance cost, serious environmental issues, and even safety hazards for some use cases, for example, wireless sensors in electrical power, and petroleum industries.

[0004] Most of the existing wireless devices are powered by battery that needs to be replaced or recharged manually. The automation and digitalization of various industries open numbers of new markets requiring new IoT technologies of supporting batteryless devices with no energy storage capability or devices with energy storage that do not need to be replaced or recharged manually. It is proposed that uplink (UL) transmission of such devices is backscattered on a carrier wave provided externally. Study on the frequencies for carrier wave reception and corresponding backscattering transmission is needed to enhance the IoT technologies.

SUMMARY

[0005] The present disclosure relates to a UE for wireless communication, a wireless device, a processor for wireless communication, methods, and a computer readable medium for frequency reporting for carrier wave reception and backscattering transmission.

[0006] In a first aspect, there is provided a user equipment (UE) for wireless communication, comprising: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the UE to: transmit, to a wireless device, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

[0007] In a second aspect, there is provided a wireless device, comprising: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the wireless device to: receive, from a user equipment (UE), a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

[0008] In a third aspect, there is provided a processor for wireless communication, comprising: at least one memory; and a controller coupled with the at least one memory and configured to cause the controller to: transmit, to a wireless device, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

[0009] In a fourth aspect, there is provided a method performed by a user equipment (UE), the method comprising: transmitting, to a wireless device, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

[0010] In a fifth aspect, there is provided a method performed by a wireless device, the method comprising: receiving, from a user equipment (UE), a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

[0011] In a sixth aspect, there is provided a computer readable medium having instructions stored thereon, the instructions, when executed by a processor of an apparatus, causing the apparatus to perform the method according to the fourth or the fifth aspect of the disclosure.

[0012] In some implementations of the methods, the UE and the wireless device described herein, the UE may transmit the report message via the backscattering transmission and at the transmission frequency point.

[0013] In some implementations of the methods, the UE and the wireless device described herein, the configuration may comprise one or more of: a set of one or more frequency point indexes; a default frequency point of the UE; a frequency point associated with the configuration; or a set of one or more offset value indexes to the frequency point associated with the configuration, and wherein the set of one or more frequency points is based at least in part on one or more of the set of one or more frequency point indexes, the default frequency point of the UE, the frequency point associated with the configuration, or the set of one or more offset value indexes to the frequency point associated with the configuration.

[0014] In some implementations of the methods, the UE and the wireless device described herein, the set of one or more frequency offsets may be based on one or more of at least one frequency point of the set of one or more frequency points or a reference frequency index.

[0015] In some implementations of the methods, the UE and the wireless device described herein, the UE may determine at least one frequency point of the set of one or more frequency points for the carrier wave reception; and determined a frequency offset

value based on one or more of the set of one or more frequency offsets or a capability of the UE.

[0016] In some implementations of the methods, the UE and the wireless device described herein, the configuration may further comprise at least one of: a first indication on whether the carrier wave reception is allocated in a downlink (DL) spectrum or an uplink (UL) spectrum; or a second indication on whether the backscattering transmission is allocated in the DL spectrum or the UL spectrum.

[0017] In some implementations of the methods, the UE and the wireless device described herein, the UE may receive an index of the configuration.

[0018] In some implementations of the methods, the UE and the wireless device described herein, the report message may comprise one frequency offset value that indicates a threshold frequency offset value of the UE.

[0019] In some implementations of the methods, the UE and the wireless device described herein, the UE may receive an indication on a frequency offset value, wherein the frequency offset value is based at least in part on the threshold frequency offset value; and perform the backscattering transmission of the UE based at least in part on the frequency offset value.

[0020] In some implementations of the methods, the UE and the wireless device described herein, the report message may indicate one or more of a type of the UE or a capability of the UE.

[0021] In some implementations of the methods, the UE and the wireless device described herein, the report message may comprise identity information of the UE.

[0022] In some implementations of the methods, the UE and the wireless device described herein, the UE may perform an uplink transmission or a sidelink transmission comprising the report message.

[0023] In some implementations of the methods, the UE and the wireless device described herein, one or more of the carrier wave reception or the backscattering transmission may satisfy at least one of the following: the carrier wave reception is allocated in a DL spectrum and the corresponding backscattering transmission is allocated in a UL spectrum; the carrier wave reception is allocated in the DL spectrum and the corresponding backscattering transmission is allocated in the DL spectrum; the

carrier wave reception is allocated in the UL spectrum and the corresponding backscattering transmission is allocated in the UL spectrum; or the carrier wave reception is allocated in the UL spectrum and the corresponding backscattering transmission is allocated in the DL spectrum.

[0024] In some implementations of the methods, the UE and the wireless device described herein, the UE may comprise an ambient Internet of things (IoT) device.

[0025] In some implementations of the methods, the UE and the wireless device described herein, the wireless device may transmit, to the UE, a configuration that indicates one or more of a set of one or more frequency points or a set of one or more frequency offsets for one or more of the carrier wave reception or the backscattering transmission of the UE.

[0026] In some implementations of the methods, the UE and the wireless device described herein, the wireless device may transmit an index of the configuration.

[0027] In some implementations of the methods, the UE and the wireless device described herein, the wireless device may transmit an indication on a frequency offset value, wherein the frequency offset value is based at least in part on the threshold frequency offset value.

[0028] In some implementations of the methods, the UE and the wireless device described herein, the wireless device may perform an uplink reception or a sidelink reception comprising the report message.

[0029] In some implementations of the methods, the UE and the wireless device described herein, the wireless device may perform one or more carrier wave transmissions at one or more corresponding carrier wave frequencies, wherein each of the carrier wave transmissions is separately performed within a corresponding time duration.

[0030] In some implementations of the methods, the UE and the wireless device described herein, the wireless device may comprise one of a base station, an assisting node, an intermediate node, a relay node, or a repeater, or a UE.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] FIG. 1 illustrates an example of a wireless communications system in which some embodiments of the present disclosure can be implemented.

[0032] FIGS. 2A-2E illustrate examples of connectivity topologies for ambient IoT networks and devices.

[0033] FIG. 3 illustrates a process flow of a frequency reporting procedure in accordance with some example embodiments of the present disclosure.

[0034] FIGS. 4A-4H illustrate examples of frequency points(s) and frequency offset(s) for carrier wave reception and backscattering transmission in accordance with some example embodiments of the present disclosure.

[0035] FIG. 5 illustrates a schematic diagram of carrier wave transmissions at multiple frequency points in accordance with some example embodiments of the present disclosure.

[0036] FIG. 6 illustrates an example of a device that is suitable for implementing some embodiments of the present disclosure.

[0037] FIG. 7 illustrates an example of a processor that is suitable for implementing some embodiments of the present disclosure.

[0038] FIG. 8 illustrates a flowchart of a method performed by a UE in accordance with aspects of the present disclosure.

[0039] FIG. 9 illustrates a flowchart of a method performed by a wireless device in accordance with aspects of the present disclosure.

[0040] Throughout the drawings, the same or similar reference numerals represent the same or similar elements.

DETAILED DESCRIPTION

[0041] Principles of the present disclosure will now be described with reference to some embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein can be implemented in various manners other than the ones described below. In the following description and claims, unless

defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0042] 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.

[0043] It shall be understood that although the terms "first" and "second" or the like may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another element. For example, a first element could also be termed as a second element, and similarly, a second element could also be termed as a first element, without departing from the scope of embodiments. As used herein, the term "and/or" includes any and all combinations of one or more of the listed terms. In some examples, values, procedures, or apparatuses are referred to as "best," "lowest," "highest," "minimum," "maximum," or the like. It will be appreciated that such descriptions are intended to indicate that a selection among many used functional alternatives can be made, and such selections need not be better, smaller, higher, or otherwise preferable to other selections.

[0044] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of embodiments. As used herein, the singular forms "a," "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises," "comprising," "has," "having," "includes" and/or "including," when used herein, specify the presence of stated features, elements, components and/or the like, but do not preclude the presence or addition of one or more other features, elements, components and/or combinations thereof. For example, the term "includes" and its variants are to be read as open terms that mean "includes, but is not limited to."

The term "based on" is to be read as "based at least in part on." The term "one embodiment" and "an embodiment" are to be read as "at least one embodiment." The term "another embodiment" is to be read as "at least one other embodiment." The use of an expression such as "A and/or B" can mean either "only A" or "only B" or "both A and B." Other definitions, explicit and implicit, may be included below.

[0045] As mentioned above, most of the existing wireless devices are powered by batteries that need to be replaced or recharged manually. The automation and digitization of various industries opens numerous new markets requiring new IoT technologies of supporting batteryless devices with no energy storage capability or devices with energy storage that do not need to be replaced or recharged manually. The form factor of such devices must be reasonably small to convey the validity of target use cases.

[0046] It is proposed by 3GPP that uplink (UL) transmission of IoT devices may be backscattered on a carrier wave provided externally. For devices with power consumption less than 1 μW peak, the UL transmission is backscattered on a carrier wave provided externally, and for devices with peak power consumption less than a few hundred μW, UL transmission may be generated internally by the device, or be backscattered on a carrier wave provided externally.

[0047] For a batteryless device (e.g., an ambient IoT device), the UL transmission is backscattered on a carrier wave provided externally. The device may be set with a default frequency point (e.g., f0) or configurable frequency point (e.g., f0, f1, f2, f3) for carrier wave reception. In addition, the device may be set with one or more frequency offset value(s) (e.g., fs1, fs2, fs3, fs4) or a maximum value of configurable frequency offset corresponding to the carrier wave transmission frequency point. This capability information is unknown at BS side (e.g., a base station, an assisting node, an intermediate node, a relay node, or a repeater, or a UE).

[0048] In view of this, procedures and relevant signals are proposed to support reporting frequency carrier wave transmission frequency point(s) and/or frequency offset value(s) to BS side (e.g., a base station, an assisting node, an intermediate node, a relay node, or a repeater, or a UE) to enhance carrier wave reception and backscattering transmission at low power consumption devices, such as ambient IoT devices.

[0049] Aspects of the present disclosure are described in the context of a wireless communications system. FIG. 1 illustrates an example of a wireless communications system 100 in which some embodiments of the present disclosure can be implemented. The wireless communications system 100 may include one or more network entities 102 (also referred to as network equipment (NE)), one or more UEs 104, a core network 106, and a packet data network 108. The wireless communications system 100 may support various radio access technologies. In some implementations, the wireless communications system 100 may be a 4G network, such as an LTE network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communications system 100 may be a 5G network, such as an NR network. In other implementations, the wireless communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0050] The one or more network entities 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the network entities 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a radio access network (RAN), a base transceiver station, an access point, a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. A network entity 102 and a UE 104 may communicate via a communication link 110, which may be a wireless or wired connection. For example, a network entity 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface. In a 3GPP non-terrestrial network (NTN), a network entity 102 in form of a satellite can directly communicate to UE 104 using NR/LTE Uu interface. The satellite may be a transparent satellite or a regenerative satellite. For NTN with a transparent satellite, a base station on earth may communicate with a UE via the satellite. For NTN with a regenerative satellite, the base station may be on board and directly communicate with the UE.

[0051] 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.

[0052] 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, an ambient IoT 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.

[0053] The one or more UEs 104 may be devices in different forms or having different capabilities. Some examples of UEs 104 are illustrated in FIG. 1. A UE 104 may be capable of communicating with various types of devices, such as the network entities 102, other UEs 104, or network equipment (e.g., the core network 106, the packet data network 108, a relay device, an integrated access and backhaul (IAB) node, or another network equipment), as shown in FIG. 1. Additionally, or alternatively, a UE

104 may support communication with other network entities 102 or UEs 104, which may act as relays in the wireless communications system 100.

[0054] 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.

[0055] 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).

[0056] In some implementations, a network entity 102 may be configured in a disaggregated architecture, which may be configured to utilize a protocol stack physically or logically distributed among two or more network entities 102, such as an integrated access backhaul (IAB) network, an open RAN (O-RAN) (e.g., a network configuration sponsored by the O-RAN Alliance), or a virtualized RAN (vRAN) (e.g., a cloud RAN (C-RAN)). For example, a network entity 102 may include one or more of a central unit (CU), a distributed unit (DU), a radio unit (RU), a RAN Intelligent Controller (RIC) (e.g., a Near-Real Time RIC (Near-RT RIC), a Non-Real Time RIC

(Non-RT RIC)), a Service Management and Orchestration (SMO) system, or any combination thereof.

[0057] 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)).

[0058] Split of functionality between a CU, a DU, and an RU may be flexible and may support different functionalities depending upon which functions (e.g., network layer functions, protocol layer functions, baseband functions, radio frequency functions, and any combinations thereof) are performed at a CU, a DU, or an RU. For example, a functional split of a protocol stack may be employed between a CU and a DU such that the CU may support one or more layers of the protocol stack and the DU may support one or more different layers of the protocol stack. In some implementations, the CU may host upper protocol layer (e.g., a layer 3 (L3), a layer 2 (L2)) functionality and signaling (e.g., Radio Resource Control (RRC), service data adaption protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU may be connected to one or more 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.

[0059] 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).

[0060] 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.

[0061] The core network 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The core network 106 may be an evolved packet core (EPC), or a 5G core (5GC), which may include a control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management functions (AMF)) and a user plane entity that routes packets or interconnects to external networks (e.g., a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). In some implementations, the control plane entity may manage non-access stratum (NAS) functions, such as mobility, authentication, and bearer management (e.g., data bearers, signal bearers, etc.) for the one or more UEs 104 served by the one or more network entities 102 associated with the core network 106.

[0062] The core network 106 may communicate with the packet data network 108 over one or more backhaul links 116 (e.g., via an S1, N2, N2, or another network interface). The packet data network 108 may include an application server 118. In some implementations, one or more UEs 104 may communicate with the application server 118. A UE 104 may establish a session (e.g., a protocol data unit (PDU) session, or the like) with the core network 106 via a network entity 102. The core network 106 may route traffic (e.g., control information, data, and the like) between the UE 104 and the application server 118 using the established session (e.g., the established PDU session). The PDU session may be an example of a logical connection between the UE 104 and the core network 106 (e.g., one or more network functions of the core network 106).

[0063] 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.

[0064] 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.

[0065] 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.

[0066] 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., μ=0, μ=1, μ=2, μ=3, μ=4) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g., quantity) of symbols (e.g., OFDM symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., μ=0) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0067] 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.

[0068] FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g., μ=0), which includes 15 kHz subcarrier spacing; a second numerology (e.g., μ=1), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third

numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., μ=3), which includes 120 kHz subcarrier spacing.

[0069] FIGS. 2A-2E illustrate examples of connectivity topologies for ambient IoT networks and devices. In all these topologies, an ambient IoT device may be provided with a carrier wave from other node(s) either inside or outside the topology. The links in each topology may be bidirectional or unidirectional. In FIGS. 2A-2E, base station (BS), UE, assisting node, or intermediate node could be multiple BSs or UEs, respectively. The mixture of indoor and outdoor placement of such nodes may be regarded as a network implementation choice. Account would need to be taken of potential impact on device or node complexity. In the connectivity topologies, this does not imply the existence of multi-hop assisting or intermediate nodes.

[0070] FIG. 2A illustrates Topology 1 in which the ambient IoT device directly and bidirectionally communicates with a base station. The communication between the base station and the ambient IoT device includes ambient IoT data and/or signalling. This topology includes the possibility that a BS transmitting to the ambient IoT device is a different from a BS receiving from the ambient IoT device.

[0071] FIG. 2B illustrates Topology 2 in which the ambient IoT device communicates bidirectionally with an intermediate node between the device and a base station. In this topology, the intermediate node can be a relay, integrated access and backhaul (IAB) node, UE, a repeater, etc. which is capable of ambient IoT. The intermediate node may transfer ambient IoT data and/or signalling between the BS and the ambient IoT device.

[0072] FIGS. 2C and 2D illustrate Topology 3 in which the ambient IoT device transmits data/signalling to a base station, and receives data/signalling from the assisting node (FIG. 2C); or the ambient IoT device receives data/signalling from a base station and transmits data/signalling to the assisting node (FIG. 2D). In this topology, the assisting node can be a relay, an IAB node, UE, a repeater, etc. which is capable of ambient IoT.

[0073] FIG. 2E illustrates Topology 4 in which the ambient IoT device communicates bidirectionally with a UE. The communication between UE and the ambient IoT device includes ambient IoT data and/or signalling.

[0074] FIG. 3 illustrates a process flow 300 of a frequency reporting procedure in accordance with some example embodiments of the present disclosure. The process flow 300 may involve a wireless device 301 and a UE 302. The wireless device 301 may be a network entity 102 or a UE 104 which is capable of providing carrier waves, and the UE 302 may be a UE 104 which is capable of harvesting energy via the carrier waves from the wireless device 301 and perform corresponding backscattering transmission using the harvested energy. It would be appreciated that the process flow 300 may be applied to other communication scenarios.

[0075] With reference to FIGS. 2A-2E, the wireless device 301 may comprise a base station. Alternatively or additionally, the wireless device 301 may comprise an intermediate node such as an access point, an IAB node, a relay, a repeater. Alternatively or additionally, the wireless device 301 may comprise a UE. The UE 302 may comprise an IoT device, for example, an ambient IoT device or a tag.

[0076] At 310, the UE 302 may transmit, to a wireless device 301, a report message 315 that indicates at least one frequency point and/or at least one frequency offset for carrier wave reception and/or backscattering transmission of the UE 302. Accordingly, at 320, the wireless device 301 receives the report message 315 from the UE 302.

[0077] The report message 315 may be a physical layer control information or transmitted via a higher layer signalling, e.g., e.g., medium access control (MAC) control element (MAC CE) or radio resource control (RRC) signalling. In some embodiments, the transmission of the report message 315 may be an uplink or sidelink transmission for reporting. The report message 315 may be transmitted via the backscattering transmission of the UE 302.

[0078] The report message 315 may indicate the frequency point(s) and/or the frequency offset(s) implicitly. In some embodiments, the report message 315 may comprise information on a device type and/or device capability of the UE 302. In this way, the wireless device 301 may derive the frequency point(s) and/or the frequency offset(s) based on the device type and/or the device capability. In addition, the report message 315 may carry identity (ID) information of the UE 302.

[0079] Upon reception of the report message 315, the wireless device 301 obtains the capability information of the UE 302 about frequencies for carrier wave reception and backscattering transmission. Therefore, the wireless device 301 may perform carrier

wave transmission at the frequency point(s) in the report message 315, and expect to receive backscattering transmissions (e.g., data transmission) at a frequency point according to the report message 315.

[0080] In some embodiments, the report message 315 may indicate one frequency point f0 and one frequency offset fs. In this case, the wireless device 301 may determine the frequency point of carrier wave transmission based on a reported frequency point f0. Then the wireless device 301 may perform carrier wave transmission in frequency point f0 and expect to receive a further transmission at frequency point f0+fs. If the frequency point and the frequency offset are implicitly indicated, the wireless device 301 may determine the frequency point of carrier wave transmission based on reported device type or device capability.

[0081] In some embodiments, the report message 315 may indicate one or more frequency points (e.g., {f1, f2, f3, f4}) and/or one or more frequency offset value (e.g., {fs1, fs2, fs3, fs4}). It is to be understood that different numbers of the frequency points or the frequency offset value are possible. In this case, the wireless device 301 receives the report message 315 and determines the frequency point of carrier wave transmission based on the reported one or more frequency point(s) {f1, f2, f3, f4}, and/or one or more frequency offset value {fs1, fs2, fs3, fs4}. Alternatively, the wireless device 301 may determine the frequency point of carrier wave transmission based on reported device type or device capability.

[0082] In some embodiments, the report message 315 may comprise one frequency offset value that indicates a threshold frequency offset value of the UE. The threshold frequency offset value may be, for example, the maximum frequency offset value supported by the UE 302, e.g., fs4. In this case, the wireless device 301 may determine a frequency offset value no larger than the threshold, e.g., fs1, fs2, or fs3, and indicate it to the UE 302. The wireless device may expect to receive a further backscattering transmission at frequency point f0+fs1, f0+fs2, or f0+f3.

[0083] At 330, the wireless device 301 may transmit, to the UE 302, a configuration 335 that indicates one or more frequency points and/or one or more frequency offsets for carrier wave reception and/or backscattering transmission of the UE 302. Accordingly, at 340, the UE 302 may receive the configuration 335 from the wireless device 301. The configuration 335 may be a physical layer control information or

transmitted via a higher layer signalling, e.g., MAC CE or RRC signalling. Note that the transmission of configuration 335 is optional and may be omitted in some embodiments.

[0084] The configuration 335 indicates frequency point(s) of carrier wave transmission and/or frequency offset(s). Here, 'or' means that the indication of the frequency point(s) of carrier wave transmission or the frequency offset value(s) may be not present. That is, the indicated frequency point of carrier wave transmission is default to the UE, e.g., a default frequency point or same as the frequency point of transmission of the configuration 335. The indicated frequency point of carrier wave transmission may be same as or different from the frequency point of transmission of the configuration 335. In some embodiments, the configuration 335 may be based at least in part on the report message 315. That is, the indicated frequency point(s) and frequency offset value(s) are supported by the UE 302.

[0085] To indicate the one or more frequency points for carrier wave reception, the configuration 335 may comprise one or more frequency point index. Additionally or alternatively, the configuration 335 may comprise a default frequency point of the UE for carrier wave reception. Additionally or alternatively, the configuration 335 may comprise a same frequency point of transmission of the configuration 335 for carrier wave reception. Additionally or alternatively, the configuration 335 may comprise one or more offset value index to the frequency point of transmission of the configuration. In this case, the UE 302 may derive the frequency point(s) for carrier wave reception by applying the offset value(s) to index to the same frequency point for configuration transmission.

[0086] The frequency offset(s) indicated in the configuration 335 may be associated with a base frequency, i.e., a frequency from which the offset(s) is calculated or derived. The base frequency may be one of the indicated one or more frequency points in the configuration 335. Alternatively, the base frequency may be associated with a reference frequency index. For example, the base frequency may be a band frequency, e.g., 900Mhz.

[0087] With the configuration 335, the UE 302 may perform carrier wave reception at the indicated frequency point(s) and perform corresponding backscattering transmission for data transmission and frequency reporting. To perform the backscattering transmission, the UE 302 may determine a transmission frequency point

for the backscattering transmission based on the indicated frequency point(s) and/or the frequency offset(s).

[0088] Note that the indication of the frequency offset(s) may be optional in the configuration 335. If the indication of the frequency offset(s) is present, the UE 302 may determine the transmission frequency point by applying the frequency offset(s) to the base frequency, e.g., one of the indicated frequency points. For example, if the configuration 335 indicates a frequency point f0 and a frequency offset fs 1, then the UE 302 may perform the carrier wave reception at the frequency point f0, and perform the corresponding backscattering transmission at transmission frequency point f0+fs1. If the frequency offset(s) is not present, the UE 302 may determine the transmission frequency for backscattering transmission based on UE's capability, for example, applying one of supported frequency offset(s) of the UE 302 or a default frequency offset value to the indicated frequency point(s) of carrier wave(s).

[0089] In some embodiments, the configuration 335 may comprise indications on spectrum allocation of the carrier wave reception and corresponding backscattering transmission. The wireless device 301 may include in the configuration 335 a first indication on whether the carrier wave reception is allocated in a downlink (DL) spectrum or an uplink (UL) spectrum, and/or a second indication on whether the backscattering transmission is allocated in the downlink (DL) spectrum or the uplink (UL) spectrum.

[0090] FIG. 4A illustrate an example of frequency points(s) and frequency offset(s) for carrier wave reception and backscattering transmission in accordance with some example embodiments of the present disclosure. In FIG. 4A. the carrier wave reception is allocated in a DL spectrum and the corresponding backscattering transmission is allocated in a UL spectrum.

[0091] With reference to FIG. 4A, the wireless device 301 transmits a configuration to indicate one frequency point of carrier wave transmission in DL spectrum and/or to indicate one or more frequency offset value(s). Here, 'or' means that the indication of the frequency point of carrier wave transmission or the frequency offset value(s) may be not present. That is, the indicated frequency point of carrier wave transmission is default to the UE, e.g., a default frequency point, or same as the frequency point of the configuration transmission. The indicated frequency point of carrier wave transmission

may be same as or different from the frequency point of transmission of the configuration. In addition, the configuration may carry a first indication indicating the carrier wave reception is allocated in a DL and/or a second indication indicating the backscattering transmission is allocated in the UL spectrum.

[0092] The frequency point f0 may be indicated explicitly by a frequency point index or may be indicated by an offset value corresponding to frequency point of the configuration transmission. The indicated one or more frequency offset values (e.g., fs1, fs2, fs3, and fs4) may be indicated based on indicated f0, or based on frequency point of the first transmission, or based on a reference frequency index in the UL spectrum. In addition, the UE 301 may determine the frequency offset value based on device capability (i.e., indication of frequency offset may be not needed.)

[0093] Upon reception of the configuration 335, the UE 302 determines a frequency point f0 for carrier wave reception. The UE 302 also determines frequency offset value based on indicated frequency offset value and/or the device capability, i.e., one or more of fs1, fs2, fs3, and fs4. The UE 302 then reports the frequency point f0, and one or more of fs1, fs2, fs3, and fs4 to the wireless device 301. Accordingly, after receiving the report message, the wireless device 301 may perform carrier wave transmission in the determined frequency point, e.g., f0 in the DL spectrum and expect to receive the backscattering transmission at frequency point f0+fs1, f0+fs2, f0+fs3, and f0+fs4 in the UL spectrum, as shown in FIG. 4A.

[0094] As one example, the wireless device 301 transmits the configuration to indicate one frequency point of carrier wave transmission in DL spectrum (e.g., f0) and to indicate available frequency offset value(s), e.g., fs1, fs2 and fs3, and the UE 302 has capability to support frequency offset value fs1 and fs2. The UE 302 may determine the fs1 as frequency offset value. The UE 302 receives carrier waves at the frequency point f0, and performs the corresponding backscattering transmission(s) at the frequency point f0+fs1.

[0095] As another example, the wireless device 301 transmits a configuration to indicate one frequency point of carrier wave transmission in DL spectrum (e.g., f0) and does not indicate available frequency offset value(s). The UE 302 has capability to support frequency offset value fs1, fs2, and fs3. The UE 302 may determine the offset fs2 as frequency offset value. The UE 302 receives carrier waves at the frequency point

f0, and performs the corresponding backscattering transmission(s) at the frequency point f0+fs2.

[0096] FIG. 4B illustrate an example of frequency points(s) and frequency offset(s) for carrier wave reception and backscattering transmission in accordance with some example embodiments of the present disclosure. In FIG. 4B. the carrier wave reception is allocated in a DL spectrum and the corresponding backscattering transmission is allocated in a UL spectrum.

[0097] The wireless device 301 transmits a configuration (e.g., configuration 335) to indicate one or more frequency points of carrier wave transmission in DL spectrum and/or to indicate one frequency offset value. Here, 'or' means that the indication of the frequency offset value may be not present. That is, the frequency offset value is default to the UE 302, e.g., fs. The indicated frequency point of carrier wave transmission may be same as or different from the frequency point of the configuration transmission. In addition, the configuration may carry a first indication indicating the carrier wave reception is allocated in a DL and/or a second indication indicating the backscattering transmission is allocated in the UL spectrum.

[0098] The frequency points f0, f1, f2, and f3 may be indicated explicitly by one or more frequency point indexes or may be indicated by one or more offset values corresponding to frequency point of the configuration transmission. The indicated one frequency offset value fs may be indicated by a frequency offset value index or based on device capability (i.e., indication can be not needed.)

[0099] Upon reception of the configuration 335, the UE 302 determines a frequency point one or more of the frequency points f0, f1, f2, and f3 for carrier wave reception. The UE 302 also determines frequency offset value based on indicated frequency offset value and/or the device capability, i.e., fs. The UE 302 then reports the one or more of f0, f1, f2, and f3, and the frequency offset fs to the wireless device 301. Accordingly, after receiving the report message, the wireless device 301 may perform carrier wave transmission in the frequency point(s) according to the report, and expect to receive the backscattering transmission at frequency points f0+fs1, f0+fs2, f0+fs3, or f0+fs4 in the UL spectrum, as shown in FIG. 4B.

[0100] As one example, the wireless device 301 transmits a configuration to indicate frequency points of carrier wave transmission in DL spectrum (e.g., f0, f1, f2

and f3) and to indicate one available frequency offset value, e.g., fs. The UE 302 may determine f1 as frequency point(s) of carrier wave transmission. The UE 302 receives carrier waves at the frequency point f1, and performs the corresponding backscattering transmission(s) at the frequency point f1+fs.

[0101] As another example, the wireless device 301 transmits a configuration to indicate only frequency points of carrier wave transmission in DL spectrum (e.g., f0, f1, f2 and f3). The UE 302 device may determine f1 as frequency point(s) of carrier wave transmission and determines fs based on default value. The UE 302 receives carrier waves at the frequency point f1, and performs the corresponding backscattering transmission(s) at the frequency point f1+fs.

[0102] In the embodiments described with reference to FIGS. 4A and 4B, the carrier wave reception is allocated in a DL spectrum and the corresponding backscattering transmission is allocated in a UL spectrum. It is to be understood that different DL or UL spectrum allocations are also applicable. Indications on the spectrum allocations could be configured or indicated to the UE 302, for example, via the configuration 335. In some embodiments, a first indication may be included in the configuration to indicate whether the carrier wave reception is allocated in the DL spectrum or the UL spectrum, and/or a second indication may be included to indicate whether the backscattering transmission is allocated in the DL spectrum or the UL spectrum.

[0103] FIG. 4C illustrate an example of frequency points(s) and frequency offset(s) for carrier wave reception and backscattering where both of the carrier wave reception and the corresponding backscattering transmission are allocated in the UL spectrum. In FIG. 4C, there are one frequency point for carrier wave reception and multiple frequency offsets for backscattering transmission. The corresponding process flow is similar with that described with reference to FIG. 4A except for indications of spectrum allocation.

[0104] FIG. 4D illustrate an example of frequency points(s) and frequency offset(s) for carrier wave reception and backscattering where both of the carrier wave reception and the corresponding backscattering transmission are allocated in the UL spectrum. In FIG. 4D, there are multiple frequency points for carrier wave reception and one frequency offset for backscattering transmission. The corresponding process flow is

similar with that described with reference to FIG. 4B except for indications of spectrum allocation.

[0105] FIG. 4E illustrate an example of frequency points(s) and frequency offset(s) for carrier wave reception and backscattering where both of the carrier wave reception and the corresponding backscattering transmission are allocated in the DL spectrum. In FIG. 4E, there are one frequency point for carrier wave reception and multiple frequency offsets for backscattering transmission. The corresponding process flow is similar with that described with reference to FIG. 4A except for indications of spectrum allocation.

[0106] FIG. 4F illustrate an example of frequency points(s) and frequency offset(s) for carrier wave reception and backscattering where both of the carrier wave reception and the corresponding backscattering transmission are allocated in the DL spectrum. In FIG. 4F, there are multiple frequency points for carrier wave reception and one frequency offset for backscattering transmission. The corresponding process flow is similar with that described with reference to FIG. 4B except for indications of spectrum allocation.

[0107] FIG. 4G illustrate an example of frequency points(s) and frequency offset(s) for carrier wave reception and backscattering where the carrier wave reception is allocated in the UL spectrum and the corresponding backscattering transmission is allocated in the DL spectrum. In FIG. 4G, there are one frequency point for carrier wave reception and multiple frequency offsets for backscattering transmission. The corresponding process flow is similar with that described with reference to FIG. 4A except for indications of spectrum allocation.

[0108] FIG. 4H illustrate an example of frequency points(s) and frequency offset(s) for carrier wave reception and backscattering where the carrier wave reception is allocated in the UL spectrum and the corresponding backscattering transmission is allocated in the DL spectrum. In FIG. 4H, there are one frequency point for carrier wave reception and multiple frequency offsets for backscattering transmission. The corresponding process flow is similar with that described with reference to FIG. 4B except for indications of spectrum allocation.

[0109] In some embodiments, the UE 302 may report a threshold for the frequency offset value(s), for example, the maximum frequency offset value (e.g., fs4) to the

wireless device 301. The wireless device 301 may determine a frequency offset value equal to or less than the maximum frequency offset value, e.g., fs2, and indicate to the UE 302. The wireless device 301 may perform carrier wave transmission at frequency point f0 and expect to receive the backscattering transmission at the frequency point f0+fs2.

[0110] To simply signaling of the configuration, the indicating information may be a (pre)configuration information for both the wireless device 301 and the UE 302. and a configuration index may be used for the indication or configuration procedure. In some embodiments, a set of configurations may be (pre)configured to the wireless device 301 and the UE 302, as shown in Table 1 below. Each configuration is associated with one or more frequency points and one or more frequency offsets. The wireless device 301 may indicate a configuration index to the UE 302, e.g., Configuration #1. The UE 302 may determines DL f0 for carrier wave reception and determines DL f0 + UL fs 2 for backscattering transmission. In addition, the pre-configured Table 1 may be associated with a frequency value configuration which specifies frequency values for the parameters in the table. For example, DL f0= x Mhz, UL f0 = y Mhz, DL f1= a Mhz, DL f2= bMhz, and the others.

Table 1: pre-configurations of frequency points and frequency offsets

Configuration	Carrier wave frequency point fx and frequency offset value fsx				
1	DL f0	UL fs1	UL fs2	UL fs3	UL fs4
2	DL f0	DL f1	DL f2	DL f3	UL fs
3	UL f0	UL fs1	UL fs2	UL fs3	UL fs4
4	UL f0	UL f1	UL f2	UL f3	UL fs
5	DL f1	DL fs1	DL fs2	DL fs3	DL fs4
6	DL f2	DL f1	DL f2	DL f3	DL fs
7	UL f0	DL fs1	DL fs2	DL fs3	DL fs4
8	UL f0	UL f1	UL f2	UL f3	DL fs

[0111] In an environment with a large number of deployed UEs, the wireless device 301 may perform carrier wave scanning to collect the capability information of the UEs via the proposed reporting scheme. The wireless device 301 may perform one or more carrier wave transmissions at one or more corresponding frequency points (e.g., f0, fi, f2, f3) to trigger the UEs to transmit the report messages. The carrier wave transmissions at multiple frequency points may be performed within corresponding time durations.

[0112] While performing the carrier wave transmissions, the wireless device 301 may indicate the UE 302 to report its carrier wave frequency point (e.g., f0) and/or frequency offset (e.g., fs). Here, the frequency offset fs may be one or more of the indicated frequency offset values (fs1, fs2 fs3, fs4), or may be the maximum value of frequency offset, e.g., fs4. In some embodiments, the wireless device 301 may include ID information of UE(s) in the indication.

[0113] The UE 302 receives the carrier wave transmission in the frequency point e.g., f0 and performs the backscattering transmission at the frequency point f0+fs. Here, fs may be one or more of frequency offset (fs1, fs2 fs3, fs4), or fs may be the maximum value of frequency offset, e.g., fs4. The UE 302 may perform backscattering transmission based on indicated ID information. In some embodiment, the UE 302 may perform backscattering transmission by including its ID information.

[0114] FIG. 5 illustrates a schematic diagram of carrier wave transmissions at multiple frequency points in accordance with some example embodiments of the present disclosure. For example, as shown in FIG. 5, at time duration t1, the wireless device performs carrier wave transmission at frequency point f0 and an ambient IoT device performs backscattering transmission at frequency point (f0+fs1, f0+fs2, f0+fs3), the backscattering transmission may include an ambient IoT device ID information. It means the ambient IoT device with the ID information has the reception capability in frequency point f0 with frequency offset (fs1, fs2, fs3).

[0115] At time duration t2, if by default or being indicated to report the maximum value of frequency offset, an ambient IoT device may perform backscattering transmission at frequency point (f1+fs3). It means the ambient IoT device has the reception capability at frequency point f1 with frequency offset (fs1, fs2 and fs3).

[0116] At time duration t3, if by default or being indicated to report frequency offset value for ID 1 and ID 2, an ambient IoT device with ID 1 may perform backscattering transmission in frequency point (f2+fs2) and an ambient IoT device with ID 2 may perform backscattering transmission in frequency point (f2+fs3).

[0117] At time duration t4, if by default or being indicated to report the maximum value of frequency offset, an ambient IoT device with ID 3 may perform backscattering transmission in frequency point (f3+fs2) with ID 3 information. It means the ambient

IoT device including ID information 3 has the reception capability in frequency point f3 with frequency offset (fs1and fs2).

[0118] FIG. 6 illustrates an example of a device that is suitable for implementing some embodiments of the present disclosure. The device 600 may be an example of a UE 104 or network entity 102 as described herein. The device 600 may support wireless communication with one or more network entities 102, UEs 104, 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).

[0119] 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.

[0120] 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).

[0121] For example, the processor 602 may support wireless communication at the device 600 in accordance with examples as disclosed herein. The device 600 may be an example of a UE 104, e.g. an ambient IoT device. In this case, the processor 602 may be

configured to operable to support means for transmitting, to a wireless device, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

[0122] The device 600 may be an example of a network entity or a UE 104. In this case, the processor 602 may be configured to operable to support means for receiving, from a UE, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

[0123] 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.

[0124] 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.

[0125] 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 602. In some implementations, a user may interact with the device 600 via the I/O controller 808 or via hardware components controlled by the I/O controller 608.

[0126] 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 706 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0127] 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.

[0128] 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.

[0129] FIG. 7 illustrates an example of a processor 700 is suitable for implementing some embodiments 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. 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).

[0130] 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).

[0131] 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.

[0132] 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.

[0133] 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).

[0134] 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 (e.g., functions or tasks supporting transmit power prioritization). For example, the processor 700 and/or the controller 702 may be coupled with or to the memory 704, the processor 700, the controller 702, and the memory 704 may be configured to perform various functions described herein. In some examples, the

processor 700 may include multiple processors and the memory 704 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[0135] 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.

[0136] The processor 700 may implemented at a UE 104 (e.g. an ambient IoT device). In this case, the processor 900 may be configured to operable to support means for transmitting, to a wireless device, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

[0137] The processor 700 may support wireless communication in accordance with examples as disclosed herein. The processor 700 may implemented at a network entity 102 or a UE 104. In this case, the processor 700 may be configured to operable to support means for receiving, from a user equipment (UE), a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

[0138] FIG. 8 illustrates a flowchart of a method 800 performed by a UE 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 UE 104 as described herein. In some implementations, the UE may execute a set of instructions to control the function elements of the UE to perform the described functions. Additionally, or alternatively, the UE may perform aspects of the described functions using special-purpose hardware.

[0139] At 810, the method may include transmitting, to a wireless device, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE. 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 UE 104 as described with reference to FIG. 1.

[0140] FIG. 9 illustrates a flowchart of a method 900 performed by a wireless 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 network entity 102 or a UE 104 as described herein. In some implementations, the wwireireless device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the wireless device may perform aspects of the described functions using special-purpose hardware.

[0141] At 910, the method may include receiving, from a user equipment (UE), a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE. 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 network entity 102 or a UE 104 as described with reference to FIG. 1.

[0142] 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.

[0143] 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.

[0144] 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.

[0145] 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.

[0146] 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.

[0147] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

1. A user equipment (UE) for wireless communication, comprising:

at least one memory; and

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

transmit, to a wireless device, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

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

receive, from the wireless device, a configuration that indicates one or more of a set of one or more frequency points or a set of one or more frequency offsets for one or more of the carrier wave reception or the backscattering transmission of the UE, and

determine, based on one or more of the set of one or more frequency points or the set of one or more frequency offsets, a transmission frequency point for the backscattering transmission of the UE.

3. The UE of claim 2, wherein to transmit, to the wireless device, the report message, the at least one processer is configured to cause the UE to transmit the report message via the backscattering transmission and at the transmission frequency point.

4. The UE of claim 2, wherein the configuration comprises one or more of: a set of one or more frequency point indexes; a default frequency point of the UE; a frequency point associated with the configuration; or a set of one or more offset value indexes to the frequency point associated with the configuration, and

wherein the set of one or more frequency points is based at least in part on one or more of the set of one or more frequency point indexes, the default frequency point of the UE, the frequency point associated with the configuration, or the set of one or more offset value indexes to the frequency point associated with the configuration.

5. The UE of claim 2, wherein the set of one or more frequency offsets is based on one or more of at least one frequency point of the set of one or more frequency

points or a reference frequency index.

6. The UE of claim 2, wherein, to determine, the transmission frequency point for the backscattering transmission of the UE, the at least one processor is configured to cause the UE to:

determine at least one frequency point of the set of one or more frequency points for the carrier wave reception; and

determine a frequency offset value based on one or more of the set of one or more frequency offsets or a capability of the UE.

7. The UE of claim 2, wherein the configuration further comprises at least one of:

a first indication on whether the carrier wave reception is allocated in a downlink (DL) spectrum or an uplink (UL) spectrum; or

a second indication on whether the backscattering transmission is allocated in the DL spectrum or the UL spectrum.

8. The UE of claim 2, wherein to receive, from the wireless device, the configuration, the at least one processor is configured to cause the UE to receive an index of the configuration.

9. The UE of claim 1, wherein the report message comprises one frequency offset value that indicates a threshold frequency offset value of the UE.

10. The UE of claim 9, wherein the at least one processor is further configured to cause the UE to:

receive an indication on a frequency offset value, wherein the frequency offset value is based at least in part on the threshold frequency offset value; and

perform the backscattering transmission of the UE based at least in part on the frequency offset value.

11. The UE of claim 1, wherein the report message indicates one or more of a type of the UE or a capability of the UE.

12. The UE of claim 1, wherein the report message comprises identity information of the UE.

13. The UE of claim 1, wherein to transmit, to the wireless device, the report message, the at least one processor is further configured to cause the UE to:

perform an uplink transmission or a sidelink transmission comprising the report message.

14. The UE of claim 1, wherein one or more of the carrier wave reception or the backscattering transmission satisfies at least one of the following:

the carrier wave reception is allocated in a DL spectrum and the corresponding backscattering transmission is allocated in a UL spectrum;

the carrier wave reception is allocated in the DL spectrum and the corresponding backscattering transmission is allocated in the DL spectrum;

the carrier wave reception is allocated in the UL spectrum and the corresponding backscattering transmission is allocated in the UL spectrum; or

the carrier wave reception is allocated in the UL spectrum and the corresponding backscattering transmission is allocated in the DL spectrum.

15. The UE of claim 1, wherein the UE comprises an ambient Internet of things (IoT) device.

16. A wireless device, comprising:

at least one memory; and

at least one processor coupled with the at least one memory and configured to cause the wireless device to:

receive, from a user equipment (UE), a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

17. The wireless device of claim 16, wherein the at least one processor is further configured to cause the wireless device to:

transmit, to the UE, a configuration that indicates one or more of a set of one or more frequency points or a set of one or more frequency offsets for one or more of the

carrier wave reception or the backscattering transmission of the UE.

18. The wireless device of claim 16, wherein wireless device comprises one of a base station, an assisting node, an intermediate node, a relay node, or a repeater, or a UE.

19. A method performed by a user equipment (UE), the method comprising:

transmitting, to a wireless device, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

20. A method performed by a wireless device, the method comprising:

receiving, from a user equipment (UE), a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

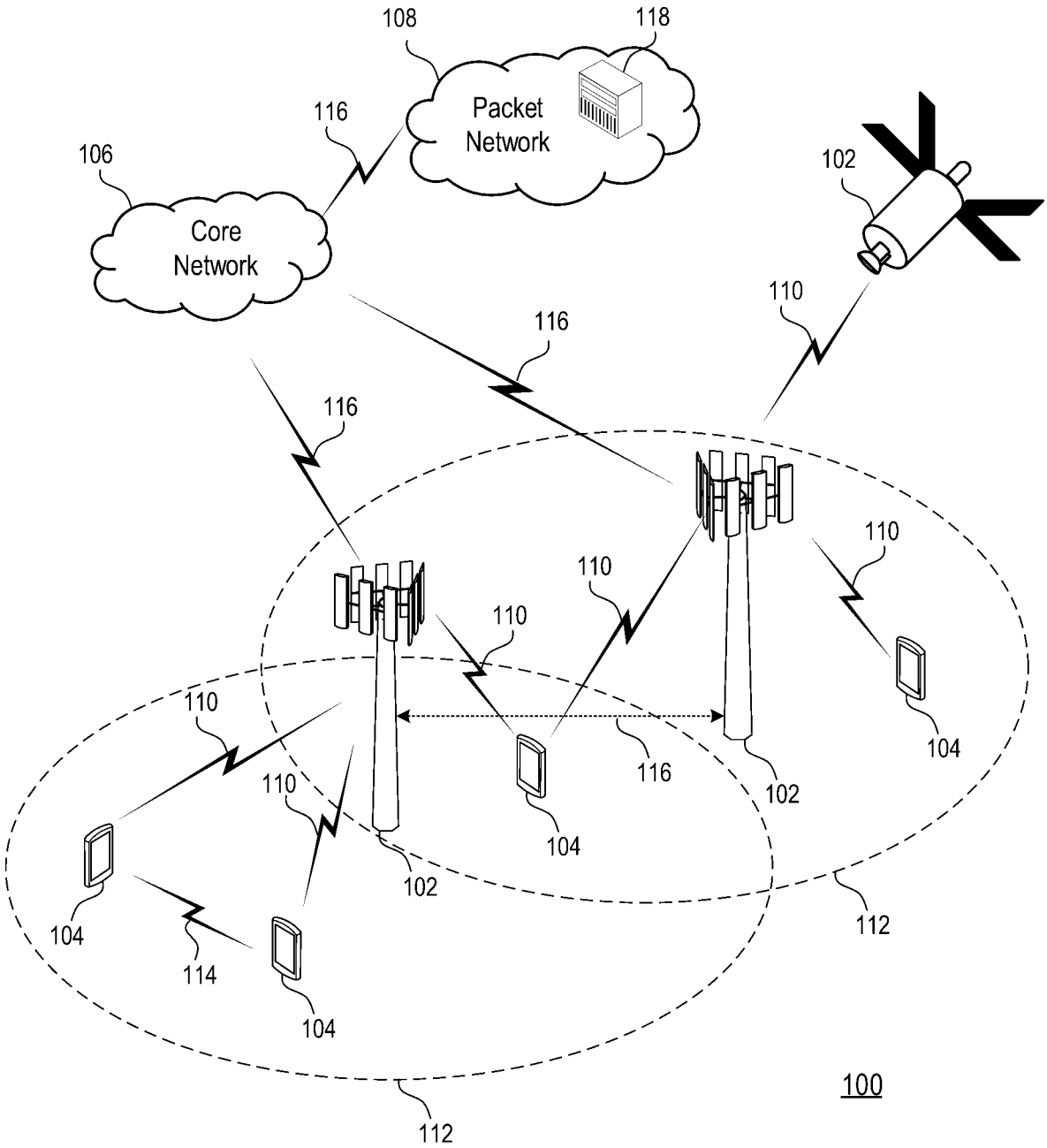

108
118
Packet Network
116
106
Core Network
102
110
116
116
110
110
110
110
110
110
116
102
104
104
110
102
104
114
104
112
100
112

FIG. 1

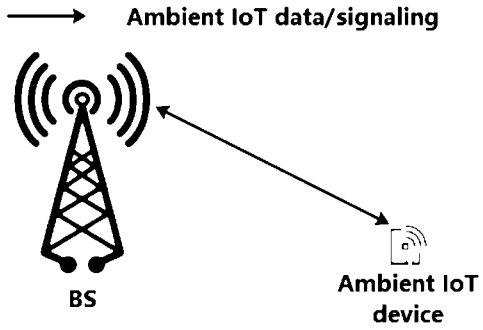

Ambient IoT data/signaling
BS
Ambient IoT device

FIG. 2A

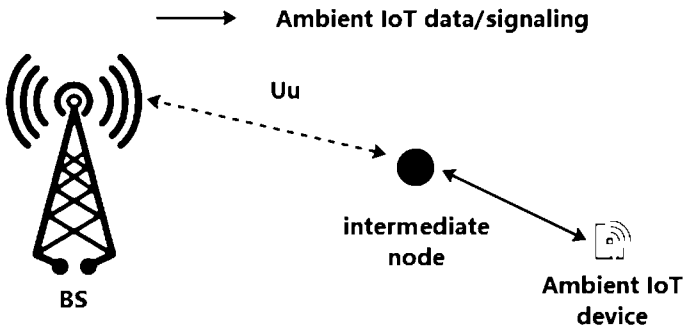

Ambient IoT data/signaling
Uu
intermediate node
BS
Ambient IoT device

FIG. 2B

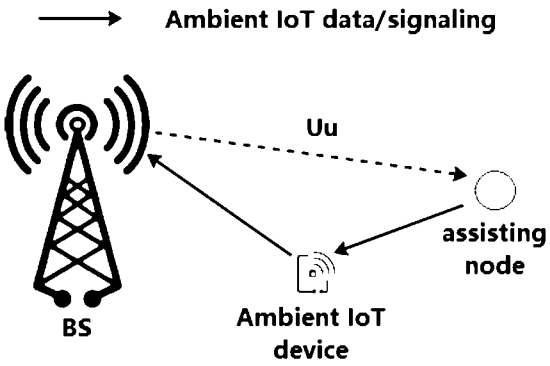


FIG. 2C

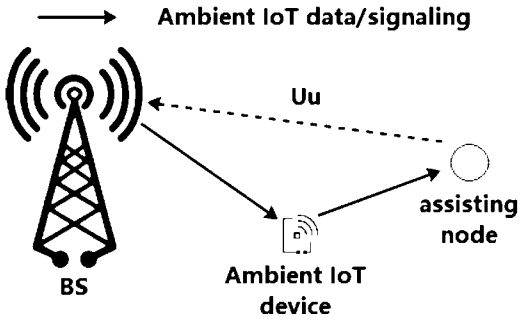


FIG. 2D

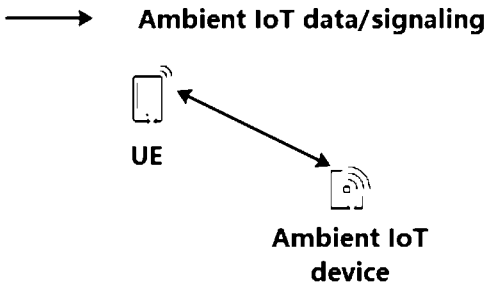


FIG. 2E

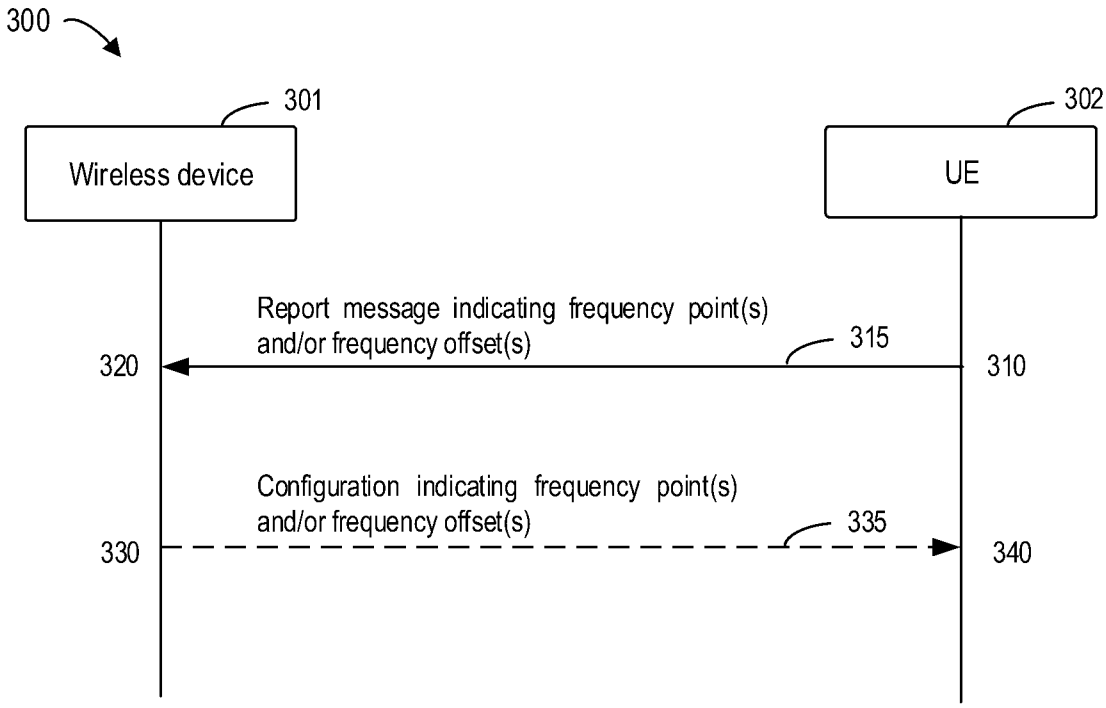

300
301
Wireless device
302
UE
Report message indicating frequency point(s) and/or frequency offset(s)
315
320
310
Configuration indicating frequency point(s) and/or frequency offset(s)
335
330
340

FIG. 3

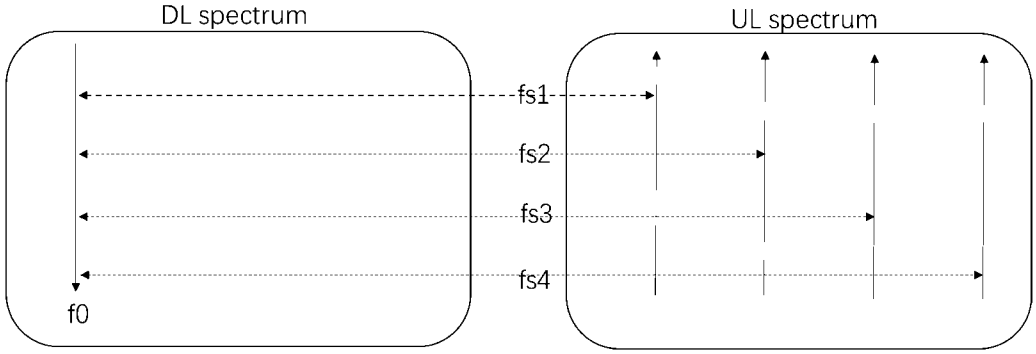

DL spectrum
UL spectrum
fs1
fs2
fs3
fs4
f0

FIG. 4A

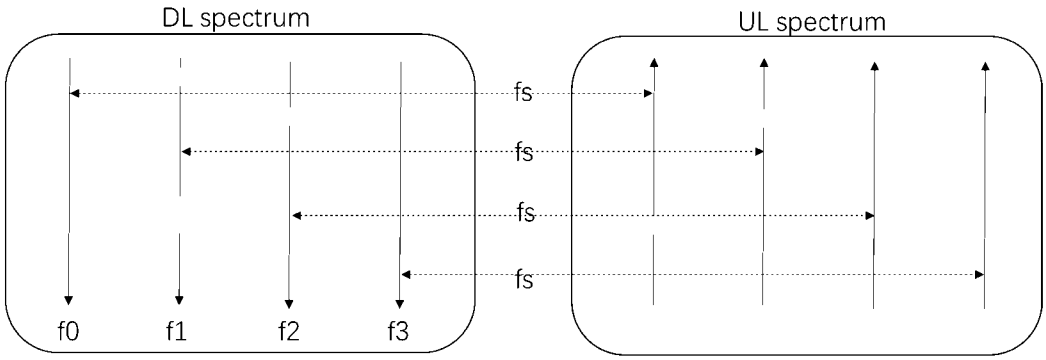

DL spectrum
UL spectrum
fs
fs
fs
fs
f0
f1
f2
f3

FIG. 4B

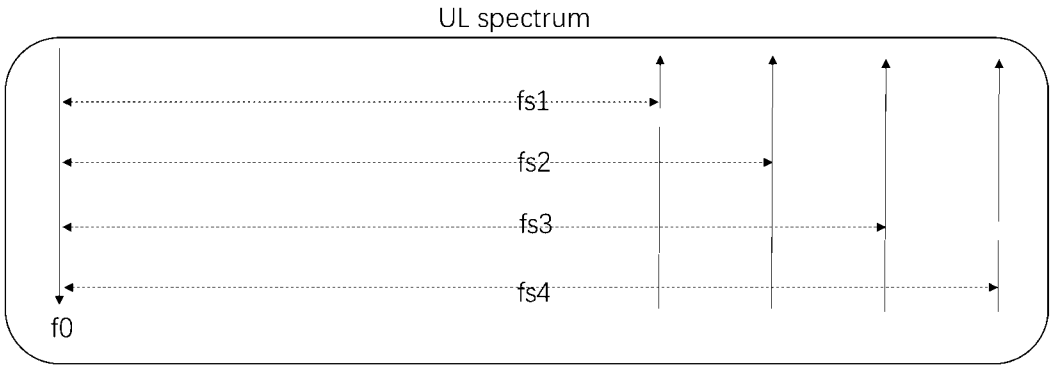

UL spectrum
fs1
fs2
fs3
fs4
f0

FIG. 4C

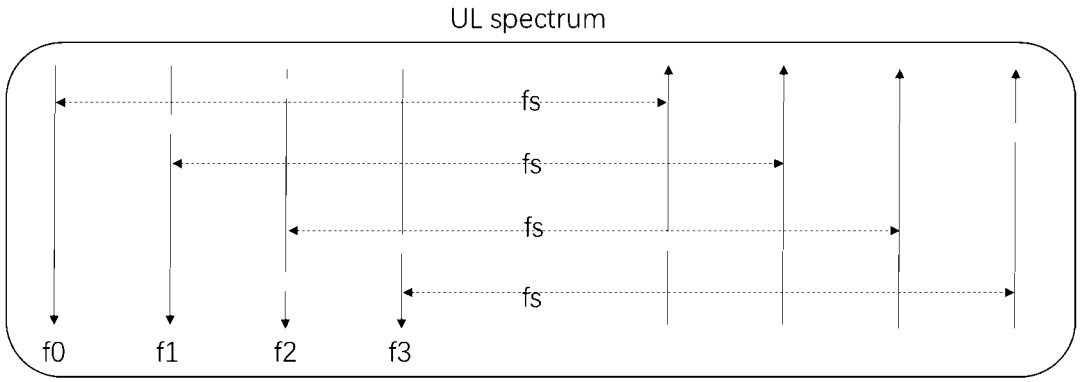

UL spectrum
fs
fs
fs
fs
f0
f1
f2
f3

FIG. 4D

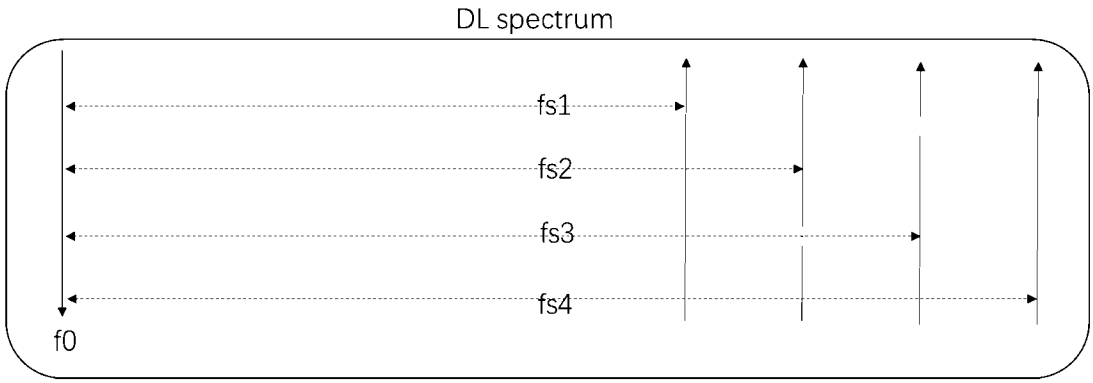

DL spectrum
fs1
fs2
fs3
fs4
f0

FIG. 4E

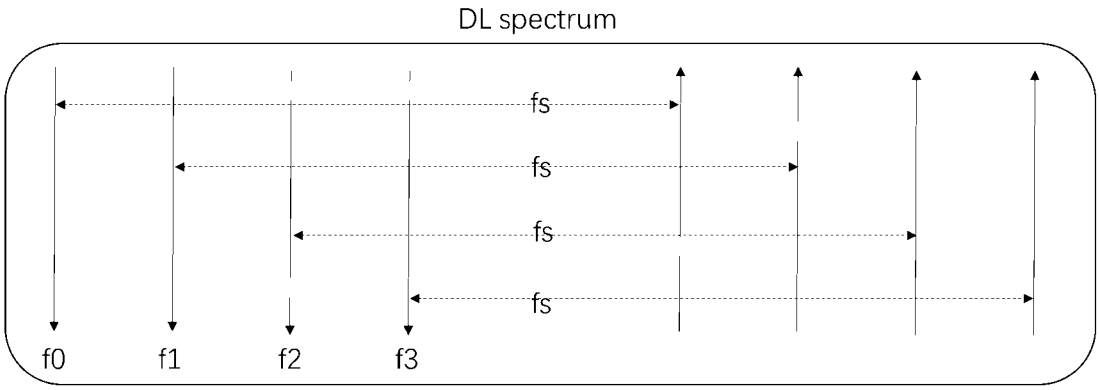

DL spectrum
fs
fs
fs
fs
f0
f1
f2
f3

FIG. 4F

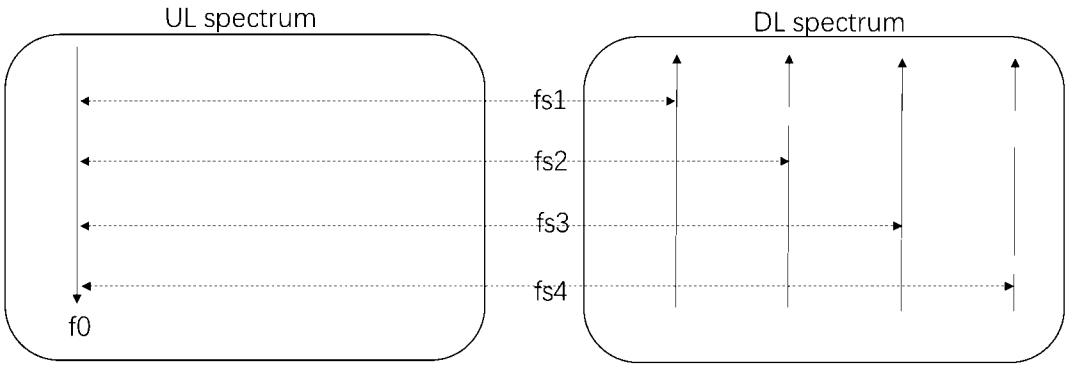

UL spectrum
DL spectrum
fs1
fs2
fs3
fs4
f0

FIG. 4G

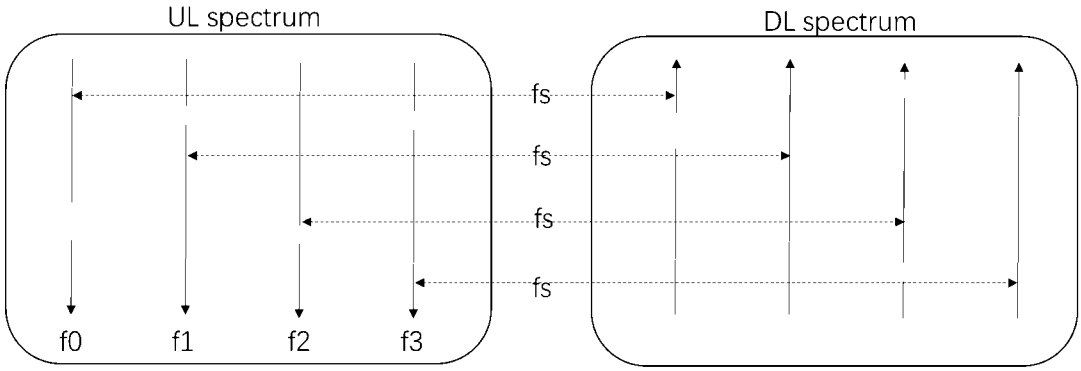

UL spectrum
DL spectrum
fs
fs
fs
fs
f0
f1
f2
f3

FIG. 4H

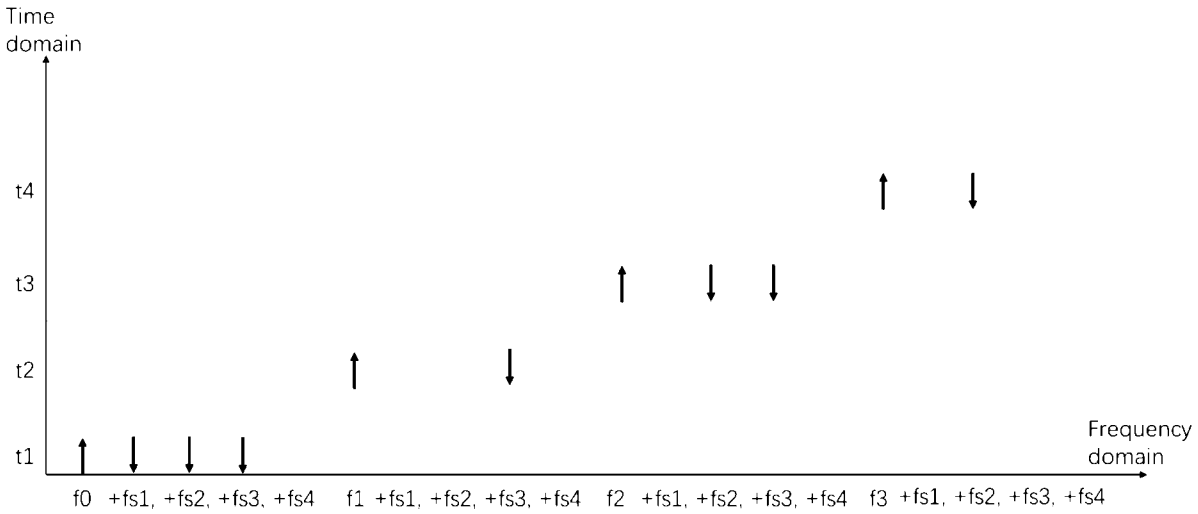

Time domain
t4
t3
t2
t1
Frequency domain
f0 +fs1, +fs2, +fs3, +fs4
f1 +fs1, +fs2, +fs3, +fs4
f2 +fs1, +fs2, +fs3, +fs4
f3 +fs1, +fs2, +fs3, +fs4

FIG. 5

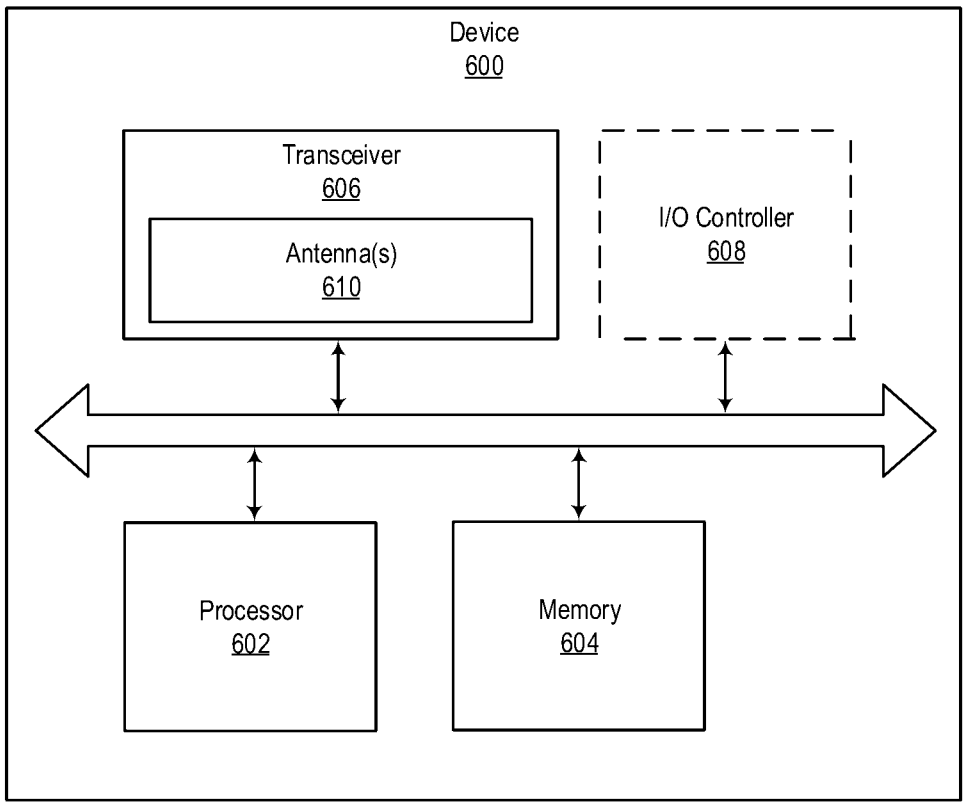

Device
600
Transceiver
606
Antenna(s)
610
I/O Controller
608
Processor
602
Memory
604

FIG. 6

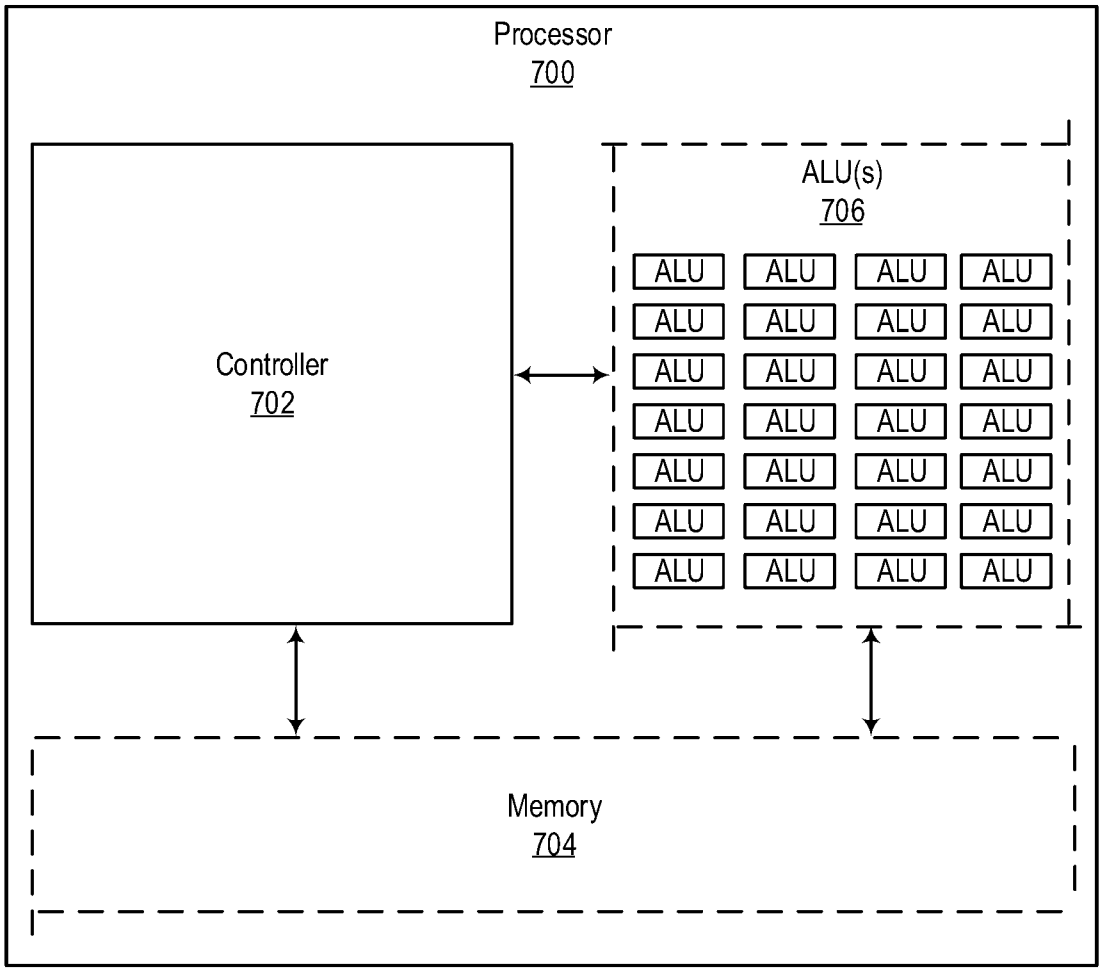


FIG. 7

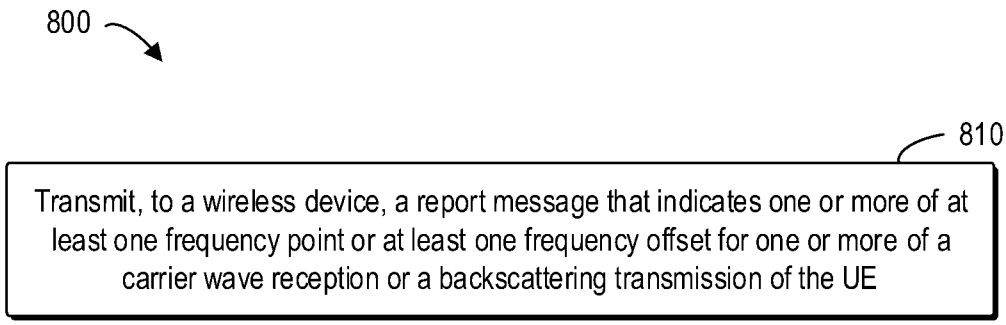

800
810
Transmit, to a wireless device, a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE

FIG. 8

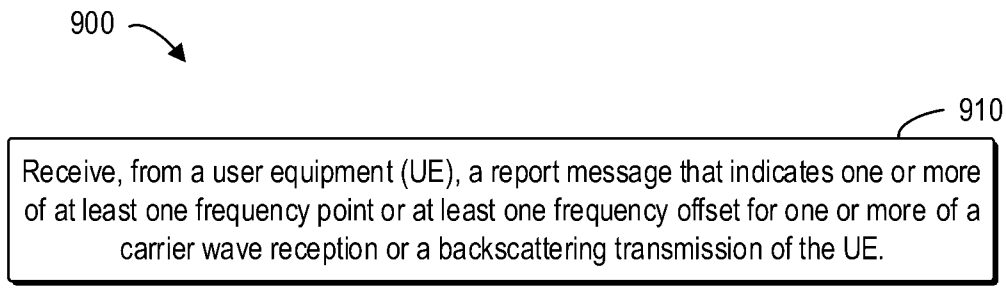

900
910
Receive, from a user equipment (UE), a report message that indicates one or more of at least one frequency point or at least one frequency offset for one or more of a carrier wave reception or a backscattering transmission of the UE.

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2024/076467

A. CLASSIFICATION OF SUBJECT MATTER

H04W4/80(2018.01)i; H04W72/02(2009.01)i; H04W72/0453(2023.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H04W,H04L,H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

3GPP,CNTXT,ENTXT,ENTXTC,VEN:frequency,offset,IOT,report+,backscatter+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2023000173 A1 (GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP LTD.) 26 January 2023 (2023-01-26) see description, paragraphs [0060]-[0543], and figures 2-21	1-20
X	WO 2023230951 A1 (QUALCOMM INC.) 07 December 2023 (2023-12-07) see description, paragraphs [0050]-[0203], and figures 1-19	1-20
X	WO 2023066318 A1 (VIVO MOBILE COMMUNICATION CO., LTD.) 27 April 2023 (2023-04-27) see description, paragraphs [0042]-[0207], and figures 1-14	1-20

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 October 2024	**24 October 2024**

Name and mailing address of the ISA/CN	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2024/076467

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2023000173 A1	26 January 2023	None	
WO 2023230951 A1	07 December 2023	None	
WO 2023066318 A1	27 April 2023	EP 4391610 A1	26 June 2024