

RESOURCE ALLOCATION FOR BACKSCATTERED

COMMUNICATION SYSTEM

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to resource allocation for a backscattered communication system.

BACKGROUND

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

[0003] 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. For IoT device, energy may be provided by harvesting radio waves, light, motion, heat, or any other suitable source, and transmission of IoT devices may be based on the backscatter. However, there are still some issues associated with resource allocation for backscattered communication system to be addressed.

SUMMARY

[0004] The present disclosure relates to methods, apparatuses, and systems that support resource allocation for a backscattered communication system.

[0005] Some implementations of the method and devices described herein include, transmitting, to a second device, a first indication that indicates at least one frequency for at least one carrier wave transmission associated with the second device; and transmitting, to at least one third device, at least one second indication that indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device, wherein the at least one backscattered signal transmission is based at least in part on the at least one carrier wave transmission. In this way, the frequency of the carrier wave transmission is indicated by the first device.

[0006] Some implementations of the method and apparatuses described herein may further include determining one or more of the set of frequency offsets or the set of frequencies; and transmitting, to the at least one third device, the one of the set of frequency offsets or the set of frequencies.

[0007] Some implementations of the method and apparatuses described herein may further include transmitting, to the second device, a third indication that schedules at least one resource in one or more of a time domain or a frequency domain for the at least one carrier wave transmission associated with the second device.

[0008] Some implementations of the method and apparatuses described herein may further include transmitting, to the at least one third device, at least one fourth indication that schedules at least one resource in one or more of a time domain or a frequency domain for the at least one backscattered signal transmission.

[0009] Some implementations of the method and apparatuses described herein may further include receiving, from the at least one third device, the at least one backscattered signal transmission on the at least one frequency associated with the at least one backscattered signal transmission.

[0010] Some implementations of the method and apparatuses described herein may further include transmitting first signaling carrying the first indication, wherein the first signaling comprises one or more of a master information block (MIB), a system information block (SIB), a radio resource control (RRC) message, a medium access

control (MAC) control element (MAC-CE), or a first downlink control information (DCI); transmitting second signaling carrying the second indication, wherein the second signaling comprises a second DCI; transmitting third signaling carrying the third indication, wherein the third signaling comprises a low power wake up signal (LP-WUS) or a third DCI; or transmitting at least one fourth signaling carrying the at least one fourth indication, wherein the at least one fourth signaling comprises a fourth DCI.

[0011] In some implementations of the method and apparatuses described herein, the first indication may indicate a first frequency associated with the at least one carrier wave transmission, wherein the at least one second indication indicates the first frequency associated with the at least one carrier wave transmission and a second frequency associated with the at least one backscattered signal transmission based at least in part on the at least one carrier wave transmission.

[0012] In some implementations of the method and apparatuses described herein, the first indication may indicate a first plurality of frequencies of a plurality of carrier wave transmissions, wherein the at least one second indication comprises a plurality of second indications, wherein a second indication among the plurality of second indications indicates a second frequency associated with a backscattered signal transmission based at least in part on the plurality of carrier waves, respectively, and wherein the second frequency is one of the first plurality of frequencies.

[0013] In some implementations of the method and apparatuses described herein, the at least one second indication may comprise one or more of the first frequency of the at least one carrier wave transmission, a frequency offset from the first frequency of the at least one carrier wave transmission, an index associated with the frequency offset, or an index associated with a frequency of a set of frequencies for the backscattered signal transmission.

[0014] In some implementations of the method and apparatuses described herein, the frequency offset may be associated with a bandwidth of the at least one third device.

[0015] In some implementations of the method and apparatuses described herein, one or more of the set of frequency offsets or the set of frequencies may be predefined.

[0016] In some implementations of the method and apparatuses described herein, the at least one resource may correspond to one or more of a time instance for the at least one

carrier wave transmission, a time interval for the at least one carrier wave transmission, or a plurality of time instances for the at least one carrier wave transmission.

[0017] In some implementations of the method and apparatuses described herein, the first device may comprise a base station, the second device may comprise a carrier wave node, or the third device comprises an Internet of things (IoT) device.

[0018] Some implementations of the method and devices described herein include, receiving, from a first device, a first indication that indicates at least one frequency for at least one carrier wave transmission associated with the second device; and transmitting, to at least one third device, at least one carrier wave transmission with the at least one frequency. In this way, the frequency of the carrier wave transmission is indicated by the first device.

[0019] Some implementations of the method and apparatuses described herein may further include receiving first signaling carrying the first indication, wherein the first signaling comprises one or more of a master information block (MIB), a system information block (SIB), a radio resource control (RRC) message, a medium access control (MAC) control element (MAC-CE), or a first downlink control information (DCI); receiving third signaling carrying the third indication, wherein the third signaling comprises a low power wake up signal (LP-WUS) or a third DCI; or detecting at least one fourth signaling carrying the at least one fourth indication, wherein the at least one fourth signaling comprises a fourth DCI.

[0020] In some implementations of the method and apparatuses described herein, the first indication may comprise one of the following: a frequency associated with the at least one a carrier wave transmission; or a plurality of frequencies of a plurality of carrier wave transmissions, wherein the plurality of frequencies may comprise at least one frequency of at least one backscattered signal transmissions associated with at least one third device.

[0021] In some implementations of the method and apparatuses described herein, transmitting the at least one carrier wave transmission may comprises receiving, from the first device, a third indication that schedules at least one resource in one or more of a time domain or a frequency domain for the at least one carrier wave transmission associated with the second device; and transmitting, to the at least one third device, the at least one carrier wave transmission based on the third indication.

[0022] In some implementations of the method and apparatuses described herein, the at least one resource may correspond to one or more of a time instance for the at least one carrier wave transmission, a time interval for the at least one carrier wave transmission or a plurality of time instances for the at least one carrier wave transmission.

[0023] In some implementations of the method and apparatuses described herein, transmitting the at least one carrier wave transmission may comprise detecting at least one fourth indication transmitted from the first device to the at least one third device, wherein the fourth indication schedules at least one resource in one or more of a time domain or a frequency domain for the at least one backscattered signal transmission; and transmitting, to the at least one third device, the at least one carrier wave transmission based on the at least one fourth indication.

[0024] In some implementations of the method and apparatuses described herein, the first device may comprise a base station, the second device may comprise a carrier wave node, or the third device comprises an Internet of things (IoT) device.

[0025] Some implementations of the method and devices described herein include, receiving, from a first device, a second indication that indicates a frequency for a backscattered signal transmission associated with the third device; and transmitting, to the first device, a backscattered signal transmission with the frequency based at least in part on at least one carrier wave transmission associated with a second device. In this way, the backscattered signal transmission is indicated by the first device.

[0026] Some implementations of the method and apparatuses described herein may further include receiving, from the first device, one of the set of frequency offsets or the set of frequencies.

[0027] Some implementations of the method and apparatuses described herein may further include receiving, from the first device, a fourth indication that schedules at least one resource in one or more of a time domain or a frequency domain for the backscattered signal transmission.

[0028] Some implementations of the method and apparatuses described herein may further include receiving second signaling carrying the second indication, wherein the second signaling comprises a second downlink control information (DCI); or receiving

fourth signaling carrying the fourth indication, wherein the fourth signaling comprises a fourth DCI.

[0029] In some implementations of the method and apparatuses described herein, the second indication may comprise one or more of a first frequency associated with the at least one carrier wave transmission, a frequency offset from the first frequency of the at least one carrier wave transmission, an index associated with the frequency offset, or an index associated with a frequency of a set of frequencies for the backscattered signal transmission.

[0030] In some implementations of the method and apparatuses described herein, the frequency offset may be associated with a bandwidth of the third device.

[0031] In some implementations of the method and apparatuses described herein, the set of frequency offsets may be predefined or determined by the first device, or the set of frequencies may be predefined or determined by the first device.

[0032] In some implementations of the method and apparatuses described herein, the first device may comprise a base station, the second device may comprise a carrier wave node, or the third device may comprise an Internet of thing (IoT) device.

[0033] Some implementations of the method and devices described herein include, detecting at least one second indication transmitted to at least one third device, wherein the at least one second indication indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device; and transmitting, to the at least one third device, at least one carrier wave transmission with the at least one frequency. In this way, the second device determines the frequency of the carrier wave transmission.

[0034] Some implementations of the method and apparatuses described herein may further include detecting second signaling carrying the second indication, wherein the second signaling comprises a second downlink control information (DCI); or detecting at least one fourth signaling carrying the at least one fourth indication, wherein the at least one fourth signaling comprises a fourth DCI.

[0035] In some implementations of the method and apparatuses described herein, transmitting the at least one carrier wave transmission may comprise detecting at least one fourth indication transmitted from a first device to at least one third device, wherein

the fourth indication schedules at least one resource in one or more of a time domain or a frequency domain for the at least one backscattered signal transmission; and transmitting, to the at least one third device, the at least one carrier wave transmission based on the at least one fourth indication.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] FIG. 1A illustrates an example of a wireless communications system that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure.

[0037] FIG. 1B illustrates an example of topology 1 associated with aspects of the present disclosure.

[0038] FIG. 1C illustrates an example of topology 2 associated with aspects of the present disclosure.

[0039] FIG. 1D illustrates another example of topology 1 in accordance with aspects of the present disclosure.

[0040] FIG. 2A illustrates an example signaling chart illustrating an example process that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure.

[0041] FIG. 2B illustrates another example signaling chart illustrating an example process that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure.

[0042] FIG. 3 illustrates an example of carrier waves in accordance with aspects of the present disclosure.

[0043] FIG. 4 illustrates another example of carrier waves in accordance with aspects of the present disclosure.

[0044] FIG. 5 illustrates another example of topology 2 in accordance with aspects of the present disclosure.

[0045] FIGS. 6-9 illustrate examples of devices that support resource allocation for a backscattered communication system in accordance with aspects of the present disclosure.

[0046] FIGS. 10-13 illustrate examples of processors that support resource allocation for a backscattered communication system in accordance with aspects of the present disclosure.

[0047] FIG. 14 illustrates a flowchart of a method that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure.

[0048] FIG. 15 illustrates a flowchart of a method that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure.

[0049] FIG. 16 illustrates a flowchart of a method that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure.

[0050] FIG. 17 illustrates a flowchart of a method that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure.

[0051] Throughout the drawings, the same or similar reference numerals represent the same or similar elements.

DETAILED DESCRIPTION

[0052] Principles of the present disclosure will now be described with reference to some embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein may be implemented in various manners other than the ones described below.

[0053] 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.

[0054] 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.

[0055] 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.

[0056] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises”, “comprising”, “has”, “having”, “includes” and/or “including”, when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

[0057] As used herein, the term “communication network” refers to a network following any suitable communication standards, such as, 5G new radio (NR), Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), Narrow Band Internet of Things (NB-IoT), and so on. Further, the communications between a user equipment and a network device in the communication network may be performed according to any suitable generation communication protocols, including but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G) communication protocols, and/or any other protocols either currently known or to be developed in the future. Embodiments of the present disclosure may be applied in various communication systems. Given the rapid

development in communications, there will also be future type communication technologies and systems in which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned systems.

[0058] As used herein, the term “network device” generally refers to a node in a communication network via which a user equipment can access the communication network and receive services therefrom. The network device may refer to a base station (BS) or an access point (AP), for example, a node B (NodeB or NB), a radio access network (RAN) node, an evolved NodeB (eNodeB or eNB), a NR NB (also referred to as a gNB), a Remote Radio Unit (RRU), a radio header (RH), an infrastructure device for a V2X (vehicle-to-everything) communication, a transmission and reception point (TRP), a reception point (RP), a remote radio head (RRH), a relay, an integrated access and backhaul (IAB) node, a low power node such as a femto base station (BS), a pico BS, and so forth, depending on the applied terminology and technology. The network device may further refer to a network function (NF) in the core network, for example, a SMF, an AMF, a PCF, a UPF or devices with same function in future network architectures, and so forth.

[0059] As used herein, the term “user equipment (UE)” generally refers to any end device that may be capable of wireless communications. By way of example rather than a limitation, a user equipment may also be referred to as a communication device, a terminal device, an end user device, a subscriber station (SS), an unmanned aerial vehicle (UAV), a portable subscriber station, a mobile station (MS), or an access terminal (AT). The user equipment may include, but is not limited to, a mobile phone, a cellular phone, a smart phone, a voice over IP (VoIP) phone, a wireless local loop phone, a tablet, a wearable user equipment, a personal digital assistant (PDA), a portable computer, a desktop computer, an image capture user equipment such as a digital camera, a gaming user equipment, a music storage and playback appliance, a vehicle-mounted wireless user equipment, a wireless endpoint, a mobile station, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), a USB dongle, a smart device, wireless customer-premises equipment (CPE), an Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device (for example, a remote surgery device), an industrial device (for example, a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless

networks, and the like. In the following description, the terms: “user equipment,” “communication device,” “terminal,” “user equipment” and “UE,” may be used interchangeably.

[0060] As used herein, the term “A-IoT device” refers to a device without batteries or with limited energy storage capabilities. For the A-IoT device, energy is provided by harvesting radio waves, light, motion, heat, or any other suitable source. A-IoT device can also be called zero-power terminals, near-zero power terminals, passive IoT device, ambient backscatter communication (AmBC) device, tag, etc. Compared with low-power and wide-coverage services, such as narrow band (NB) IoT, enhance machine type communication (eMTC), A-IoT has lower complexity and lower power consumption, and is suitable for more application scenarios.

[0061] FIG. 1A illustrates an example of a wireless communications system 100 that supports store and forward operations in accordance with aspects of the present disclosure. The wireless communications system 100 may include one or more network entities 102 (also referred to as network equipment), 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.

[0062] 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.

[0063] 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.

[0064] The one or more UEs 104 may be dispersed throughout a geographic region of the wireless communications system 100. A UE 104 may include or may be referred to as a mobile device, a wireless device, a remote device, a remote unit, a handheld device, or a subscriber device, or some other suitable terminology. In some implementations, the UE 104 may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE 104 may be referred to as an Internet-of-Things (IoT) device, an Internet-of-Everything (IoE) device, or machine-type communication (MTC) device, among other examples. In some implementations, a UE 104 may be stationary in the wireless communications system 100. In some other implementations, a UE 104 may be mobile in the wireless communications system 100.

[0065] 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. 1A. 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. 1A. 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.

[0066] 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.

[0067] 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).

[0068] 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.

[0069] 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)).

[0070] Split of functionality between a CU, a DU, and an RU may be flexible and may support different functionalities depending upon which functions (e.g., network layer functions, protocol layer functions, baseband functions, radio frequency functions, and any combinations thereof) are performed at a CU, a DU, or an RU. For example, a functional split of a protocol stack may be employed between a CU and a DU such that the CU may support one or more layers of the protocol stack and the DU may support one or more different layers of the protocol stack. In some implementations, the CU may host upper protocol layer (e.g., a layer 3 (L3), a layer 2 (L2)) functionality and signaling (e.g., Radio Resource Control (RRC), service data adaptation protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU may be connected to one or more DUs or RUs, and the one or more DUs or RUs may host lower protocol layers, such as a layer 1 (L1) (e.g., physical (PHY) layer) or an L2 (e.g., radio link control (RLC) layer, medium access control (MAC) layer) functionality and signaling, and may each be at least partially controlled by the CU 160.

[0071] 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).

[0072] 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.

[0073] 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.

[0074] 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).

[0075] 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.

[0076] 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.

[0077] 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.

[0078] Additionally or alternatively, a time interval of a resource (e.g., a communication resource) may be organized according to slots. For example, a subframe may include a number (e.g., quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communications

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

[0079] 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.

[0080] FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g., $\mu=0$), which includes 15 kHz subcarrier spacing; a second numerology (e.g., $\mu=1$), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., $\mu=2$), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third

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

[0081] Study on solutions for Ambient IoT in NR has been approved in RP-234058, and the following are the general scope, including aspects A to E as below.

[0082] Aspect A: The overall objective shall be to study a harmonized air interface design with minimized differences (where necessary) for A-IoT to enable the following types of A-IoT devices. Type I: which has a peak power consumption of approximately 1 μ W, energy storage, initial sampling frequency offset (SFO) up to 10^X ppm, neither downlink (DL) nor uplink (UL) amplification in the device. The UL transmission of the device i is backscattered on a carrier wave provided externally. Type II: which has a peak power consumption of no more than a few hundred μ W, energy storage, initial SFO up to 10^X ppm, both DL and/or UL amplification in the device. The UL transmission of the type II of an A-IoT device may be generated internally by the type II of an A-IoT device itself, or be backscattered on a carrier wave provided externally.

[0083] X is to be decided in WGs. It is to be understood that “no more than a few hundred μ W” means WGs are not tasked with setting a particular value, and that it will be for WG discussions to determine if a presented design with corresponding power consumption satisfies the “no more than a few hundred μ W” requirement. Coverage design target: maximum distance of 10-50m with device indoors as per TR 38.848: “...a range that WGs can sub-select within”. For topologies 1 & 2 (UE as intermediate node under NW control) per TR 38.848, with no RRC states, no mobility (i.e. at least no cell selection/re-selection -like function), no HARQ, no ARQ.

[0084] Aspect B: Deployment scenarios with the following characteristics, referenced to the tables in Clause 4.2.2 of TR 38.848. Deployment scenario 1 with topology 1: base station and coexistence characteristics: Micro-cell, co-site. Deployment scenario 2 with Topology 2 and UE as intermediate node, under network control: base station and coexistence characteristics: Macro-cell, co-site; and the location of intermediate node is indoor.

[0085] Aspect C: FR1 licensed spectrum in FDD. Aspect D: Spectrum deployment in-band to NR, in guard-band to LTE/NR, in standalone band(s). Aspect E: Traffic types DO-DTT, DT, with focus on rUC1 (indoor inventory) and rUC4 (indoor command). From RAN#104, the study will assess whether the harmonized air interface design (per bullet ‘A’ above) can address the DO-A (Device-originated autonomous) use case, only to

identify which part(s) of the harmonized air interface design (per bullet 'A' above) is/are not sufficient for the DO-A use case.

[0086] In RAN1-led, for the Ambient IoT DL and UL, the following are studied: frame structure, synchronization and timing, random access, numerologies, bandwidths, and multiple access; waveforms and modulations; channel coding; downlink channel/signal aspects; uplink channel/signal aspects; scheduling and timing relationships; study necessary characteristics of carrier-wave waveform for a carrier wave provided externally to the Ambient IoT device, including for interference handling at Ambient IoT UL receiver, and at NR base station. In addition, for Topology 2, no difference in physical layer design from Topology 1.

[0087] Both type I and type II of A-IoT device could be based on backscatter. In the backscatter system, the A-IoT device backscatters the carrier wave transmitted from the carrier wave node, and the backscattered signal is received by an A-IoT receiver (NR BS in topology 1 and UE in topology 2). There are massive A-IoT devices in the coverage of NR BS, an improvement of the coverage dense deployment of carrier wave nodes is also needed due to there may have multiple A-IoT devices and multiple carrier wave nodes (each carrier wave node may serve some A-IoT devices) in the coverage of the NR BS. For the transmission of a carrier wave from the carrier wave node, two approaches may be considered. The first approach is the carrier wave node always transmits the carrier wave. The second approach is that network controls the carrier wave node to transmit the carrier wave. Compared with the first approach, the second approach can control power consumption of carrier wave node better, and manage the interference among multiple carrier wave nodes or the backscattering signals better.

[0088] FIG. 1B illustrates an example of topology 1 associated with aspects of the present disclosure. As shown in FIG. 1B, the ambient IoT device 121 communicates with a BS 122 directly and bi-directionally. The communication between the BS 122 and the ambient IoT device 121 includes ambient IoT data and/or signalling. This topology 1 includes the possibility of a transmission from the BS 122 to the ambient IoT device 121 and a different possibility of a transmission from the ambient IoT device 121 to the BS 122.

[0089] FIG. 1C illustrates an example of topology 2 associated with aspects of the present disclosure. As shown in FIG. 1C, the ambient IoT device 131 communicates with

an intermediate node 132 and the BS 133 bi-directionally. In this topology, the intermediate node 131 can be a relay node, a IAB node, a UE, a repeater, etc., which is capable of ambient IoT. The intermediate node 132 transfers ambient IoT data and/or signalling between the BS 133 and the ambient IoT device 131.

[0090] FIG. 1D illustrates another example of topology 1 in accordance with aspects of the present disclosure. As shown in FIG. 1D, there are an IoT device 141, a NR BS 142 and a carrier wave node 143 in the topology 1. The main communication method is that the IoT device 141 backscatters the carrier wave with modulated information to the NR BS 142, and the carrier wave is transmitted by the carrier wave node 143.

[0091] With topology 1, it could be considered to enable network-controlled carrier wave node for backscatter system and also to allocate the resources for massive IoT devices.

[0092] In view of the above discussions, some embodiments of the present disclosure provide a solution for resource allocation for a backscattered communication system. In one aspect of the solution of the present disclosure, a first device transmits a first indication to a second device. The first indication indicates at least one frequency for at least one carrier wave transmission associated with the second device. The first device then transmits at least one second indication to at least one third device. The at least one second indication indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device, and the at least one backscattered signal transmission is based at least in part on the at least one carrier wave transmission. In this way, the frequency of the carrier wave transmission is indicated by the first device. Therefore, the transmission of the carrier wave transmission is controlled by the first device and the communication performance is improved. Principles and implementations of embodiments of the present disclosure will be described in detail below with reference to FIGS. 2A-17.

[0093] FIG. 2A illustrates a signaling chart illustrating an example process 200A in accordance with aspects of the present disclosure. The process 200A may involve the first device 201, the second device 202 and the third device 203. It would be appreciated that although the process 200A is applied in the communication environment 100 of FIG. 1A, this process may be likewise applied to other communication scenarios with similar issues.

[0094] It is to be understood that the number of the first device 201, the second device 202 or the third device 203 is only for the purpose of illustration without suggesting any limitations. The process 200A may include any suitable number of devices adapted for implementing embodiments of the present disclosure. Although not shown, it would be appreciated that one or more second devices or one or more third devices may be comprised in the process 200A.

[0095] In the process 200A, the first device 201 transmits 205 a first indication 210 to a second device 202. The first indication 210 indicates at least one frequency for at least one carrier wave transmission associated with the second device 202. Correspondingly, the second device 202 receives 215 the first indication 210 from the first device 201. In other words, a frequency of the carrier wave transmission transmitted by the second device 202 is indicated by the first device 201.

[0096] The first device 201 transmits 220 at least one second indication 225 to at least one third device including the third device 203. The at least one second indication 225 indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device, and the at least one backscattered signal transmission is based at least in part on the at least one carrier wave transmission. Correspondingly, the third device 203 receives 230 a second indication 225 from the first device 201, and the second indication 225 indicates a frequency for a backscattered signal transmission associated with the third device 203. In other words, a frequency of the backscattered signal transmission transmitted by the third device 203 is indicated by the first device 201.

[0097] In some embodiments, the first device 201 may comprise a base station, the second device 202 may comprise a carrier wave node, and the third device 203 may comprise an IoT device, e.g., an A-IoT device.

[0098] In some embodiments, the first indication may indicate a first frequency associated with the at least one carrier wave transmission, and the at least one second indication may indicate the first frequency associated with the at least one carrier wave transmission and a second frequency associated with the at least one backscattered signal transmission based at least in part on the at least one carrier wave transmission. In other words, the second device 202 may transmit a carrier wave with the first frequency in one transmission duration (e.g., slot, subframe, burst duration), and the third device 203 may

transmit a backscattered signal with the second frequency based on the carrier wave. The first frequency and the second frequency may be the same or different. For instance, a carrier wave node may transmit the carrier wave with a certain frequency and A-IoT devices perform backscattered uplink transmission on another frequency in one transmission duration (e.g., at least one slot, at least one subframe, at least one burst duration).

[0099] FIG. 3 illustrates an example of carrier waves in accordance with aspects of the present disclosure. As shown in FIG. 3, the second device 202 transmits the carrier wave with frequency f_c (which is known by the carrier wave node and the ambient IoT devices via the first indication and the second indication or a configuration). The first device 201 may also indicate the frequency of backscattered signal (f_1 , f_2 , f_3 , f_4) to the third devices including device #1, device #2, device #3, and device #4 respectively. After receiving this information on the frequency of backscattered signal (f_1 , f_2 , f_3 , f_4), each third device performs backscattered communication with its uplink receiver with a frequency shift. It is benefit to manage the interference since at the receiver side there is no interference from the carrier wave transmitted by the second device 202. It requires the capability of frequency shift for the third device 203.

[0100] Alternatively or additionally, the frequency of the carrier wave transmitted by the second device 202 may be determined in different ways. In an example, the frequency of the carrier wave transmitted by the second device 202 may be configured by the first device 201, e.g., a NR BS, with master information block (MIB)/system information block(SIB) or a RRC signaling or pre-defined. The information on a frequency of the carrier wave may be also indicated or configured to the third device 203, e.g., an ambient IoT device. In another example, the frequency of the carrier wave transmitted by the second device 202 may be indicated by the DCI transmitted from the first device 201, e.g., a NR BS, to the second device 202. The first device 201 also needs to indicate the frequency of the carrier wave transmitted by the second device 202 to the third device 203, e.g., an ambient IoT device.

[0101] In some embodiments, the first indication may indicate a first plurality of frequencies of a plurality of carrier wave transmissions, and the at least one second indication may comprise a plurality of second indications. A second indication among the plurality of second indications may indicate a second frequency associated with a

backscattered signal transmission based at least in part on the plurality of carrier waves, respectively, and the second frequency may be one of the first plurality of frequencies. In other words, the first device 201 may indicate the second frequency to the third device 203 and indicate a plurality of first frequency to the second device 202. The second device 202 may transmit the carrier wave with different frequencies, and the first device 201 may indicate the frequency of backscattered signal to the third device 203. The third device 203 may perform the backscattered uplink transmission on the indicated frequency.

[0102] For example, the first device 201, e.g., the NR BS, may indicate each third device e.g., the ambient IoT device, the frequency on which it may perform backscattered uplink transmission to its receiver. However, the second device 202 needs to transmit the carrier wave with multiple frequency and each frequency is for a third device. FIG. 4 illustrates another example of carrier waves in accordance with aspects of the present disclosure. As shown in FIG. 4, if four third devices communicate with the first device 201 in one time instance, the second device 202 may transmit the carrier wave with frequencies f_1 , f_2 , f_3 and f_4 . With the second indication of a frequency of a backscattered signal from the first device 201, the device #1, the device #2, the device #3, and the device #4 i.e., the four third devices, may perform backscattered uplink transmission with the frequencies f_1 , f_2 , f_3 and f_4 indicated in the second indications. It may cause the interference between carrier wave and backscattered signal at the receiver side, however, it has no requirement on the capability of frequency shift of the third device 203.

[0103] In addition, it is to be considered that how the second device 202 to know the information of carrier wave to be transmitted. In an example, the first device 201 may control the second device 202 to transmit carrier wave with indicated frequencies explicitly. The first device 201 may transmit an indication related to the frequencies of carrier waves to be transmitted by the second device 202. As shown in FIG. 4, the first device 201 may indicate that the second device 202 to transmit four carrier waves with frequencies f_1 , f_2 , f_3 and f_4 . The indication may be transmitted with a DCI. In another example, the second device 202 may detect the command or a DCI transmitted from the first device 201 to the third device 203 and determines the frequencies of carrier wave transmitted by the second device 202, which is described in detail in process 200B.

[0104] Alternatively or additionally, the at least one second indication may comprise one or more of the first frequency of the at least one carrier wave transmission, a

frequency offset from the first frequency of the at least one carrier wave transmission, an index associated with the frequency offset, or an index associated with a frequency of a set of frequencies for the backscattered signal transmission.

[0105] The frequency of backscattered uplink transmission from the third device 203 may be indicated by the first device 201 via a DCI, and the DCI may be modulated with on-off keying (OOK), amplitude shift keying (ASK), or frequency-shift keying (FSK). In an example, the first device 201 may indicate a frequency offset relative to the frequency of the carrier wave. The first device 201 may also indicate a set of frequency offset values to the second device 202, and the second indication indicates a frequency offset value from the configured set of frequency offset values. For example, the set could be $\{\dots, -2\Delta f, -\Delta f, 0, \Delta f, 2\Delta f, 3\Delta f, \dots\}$ and Δf may be associated to the bandwidth of the third device 203, and the first device 201 may indicate the frequency offset value with the index within the configured set of frequency offset values. In another example, the first device 201 may indicate the resource within the configured resource set. The configured resource set may be multiple resources in frequency domain. Then the first device 201 indicates the resource within the configured resource set. For example, the first device 201 may configure N resources within the resource set with frequency $\{f_1, f_2, f_3, \dots, f_N\}$. Then the first device 201 may indicate the resource within the configured resource set, e.g., with the index.

[0106] In an example, the second frequency is different from than the first frequency. In another example, the second frequency is the same as the first frequency. For example, the offset may be 0.

[0107] Additionally, the frequency offset may be associated with a bandwidth of the at least one third device. The granularity of the frequency offset may be also associated with the bandwidth of the third device 203. For example, if the bandwidth of the third device 203 is BW , the first device 201 may indicate $N \cdot BW$ frequency offset relative to the frequency of the carrier wave.

[0108] Alternatively or additionally, the first device 201 may determine one or more of the set of frequency offsets or the set of frequencies. The first device 201 may then transmit the one of the set of frequency offsets or the set of frequencies to the at least one third device. Additionally, one or more of the set of frequency offsets or the set of frequencies may be predefined.

[0109] Correspondingly, the third device 203 may receive one of the set of frequency offsets or the set of frequencies from the first device. Additionally, one or more of the set of frequency offsets may be predefined or determined by the first device, or the set of frequencies may be predefined or determined by the first device.

[0110] In addition, the first device 201 may transmit a third indication to the second device 202. The third indication may schedule at least one resource in one or more of a time domain or a frequency domain for the at least one carrier wave transmission associated with the second device. Correspondingly, the second device 202 may receive the third indication from the first device 201. Based on the third indication, the second device 202 may transmit the at least one carrier wave transmission to the third device 203.

[0111] In some embodiments, the at least one resource may correspond to one or more of a time instance for the at least one carrier wave transmission, a time interval for the at least one carrier wave transmission, or a plurality of time instances for the at least one carrier wave transmission.

[0112] Alternatively or additionally, the first device 201 may transmit at least one fourth indication to the at least one third device 203. The at least one fourth indication may schedule at least one resource in one or more of a time domain or a frequency domain for the at least one backscattered signal transmission.

[0113] Correspondingly, the third device 203 may receive a fourth indication from the first device 201. The fourth indication schedules at least one resource in one or more of a time domain or a frequency domain for the backscattered signal transmission.

[0114] In other words, the transmission of carrier wave from the second device 202 may be controlled by the first device 201 explicitly. To control the transmission of carrier wave from the second device 202, the first device 201 may also transmit an indication to the second device 202 to control the transmission of carrier wave with different granularity in time domain. In an example, the transmission of carrier wave may be waked up in one shot. The first device 201 may indicate a transmission instance (e.g., slot, subframe) for the second device 202 to transmit the carrier wave with the frequency f_c . In another example, to avoid waking up or sleeping the transmission of carrier wave frequently, the first device 201 may also indicate the second device 202 to transmit the carrier wave in a time period. Within the time period, the second device 202 may transmit the carrier wave. The first device 201 may also indicate some time instances (e.g., some

slot/frames) to the second device 202, and the second device 202 then may transmit the carrier wave with frequency f_c on these time instances.

[0115] Continuing with reference to Fig. 2A, the second device 202 transmits 235 at least one carrier wave transmission 240 with the at least one frequency to the third device 203. For instance, after receiving the second indication of frequency of backscattered signal and the frequency of the second device 202, the third device 203 backscatters the carrier wave with frequency shift according to the second indication, and the backscattered signal will be modulated with its intended transmitted information.

[0116] In some embodiments, the second device 202 may detect at least one fourth indication transmitted from the first device to the at least one third device. The fourth indication schedules at least one resource in one or more of a time domain or a frequency domain for the at least one backscattered signal transmission. Based on the at least one fourth indication, the second device 202 may transmit the at least one carrier wave transmission to the at least one third device 203.

[0117] In other words, the transmission of carrier wave from the second device 202 may be controlled by the first device 201 implicitly. In an example, the second device 202 knows which third device 203 it serves, e.g., the second device 202 knows which third device 203 performs backscattered communication with the first device 201 is depended on its transmitted carrier wave. With this assumption, the second device 202 may detect a command or a DCI transmitted from the first device 201 to third device 203. If the second device 202 detects at least one third device 203 is associated to its transmission of carrier wave, the second device 202 may transmit the carrier wave in the associated time instance which is predefined or configured in a DCI.

[0118] Continuing with reference to Fig. 2A, after receiving 245 the carrier wave transmission 240, based at least in part on at least one carrier wave transmission associated with a second device, the third device 203 transmits 250 a backscattered signal transmission 550 with the frequency to the first device 201.

[0119] Correspondingly, the first device 201 may further receive 260 the at least one backscattered signal transmission from the at least one third device. The at least one backscattered signal transmission is transmitted on the at least one frequency associated with the at least one backscattered signal transmission.

[0120] In some embodiments, the first indication may be carried by first signaling, and the first signaling may comprise one or more of a master information block (MIB), a system information block (SIB), a radio resource control (RRC) message, a medium access control (MAC) control element (MAC-CE), or a first downlink control information (DCI). In some embodiments, the second indication may be carried by second signaling, and the second signaling may comprise a second DCI. In some embodiments, the third indication may be carried by third signaling, and the third signaling may comprise a low power wake up signal (LP-WUS), e.g., OOK signal, or a third DCI. In some embodiments, the fourth indication may be carried by fourth signaling, and the fourth signaling may comprise a fourth DCI.

[0121] FIG. 2B illustrates another example signaling chart illustrating an example process 200B in accordance with aspects of the present disclosure. The process 200B may involve the second device 202 and the third device 203. It would be appreciated that although the process 200B is applied in the communication environment 100 of FIG. 1A, this process may be likewise applied to other communication scenarios with similar issues.

[0122] It is to be understood that the number of the second device 202 or the third device 203 is only for the purpose of illustration without suggesting any limitations. The process 200B may include any suitable number of devices adapted for implementing embodiments of the present disclosure. Although not shown, it would be appreciated that one or more third devices may be comprised in the process 200B.

[0123] In the process 200B, the second device 202 detects 265 at least one second indication transmitted to at least one third device including the third device 203. The at least one second indication indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device.

[0124] The second device 202 transmits 270 at least one carrier wave transmission 275 with the at least one frequency to the at least one third device including the third device 203. Correspondingly, the third device 203 receives 280 the carrier wave transmission 275 from the second device 202.

[0125] For example, the second device 202 may detect a command or a DCI transmitted from the first device 201 to the third device 203 and determines the frequencies of carrier wave transmitted by the second device 202. There is an assumption that the second device 202 has knowledge on the association between the second device

202 and third devices. In an example, a carrier wave node knows which Ambient IoT device need the carrier wave transmitted by it to perform backscatter communication between this Ambient IoT device and the NR BS. The carrier wave node then detects the command/DCI transmitted from the NR BS to Ambient IoT device, and if the carrier wave node detects that the command/DCI targets to the Ambient IoT device served by it, the carrier wave node may transmit the carrier wave with the frequency indicated by the command/DCI associated to the Ambient IoT device.

[0126] In some embodiments, in order to transmit the at least one carrier wave transmission, the second device 202 may detect at least one fourth indication transmitted from a first device to at least one third device. The fourth indication schedules at least one resource in one or more of a time domain or a frequency domain for the at least one backscattered signal transmission. Based on the at least one fourth indication, the second device 202 then may transmit the at least one carrier wave transmission to the at least one third device.

[0127] In some embodiments, the second indication may be carried by second signaling, and the second signaling may comprise a second downlink control information (DCI). In some embodiments, the at least one fourth indication may be carried by at least one fourth signaling, and the at least one fourth signaling may comprise a fourth DCI.

[0128] In order to expand the coverage of the communication between NR BS and IoT devices, there may be an immediate node (e.g., a UE) between the communication of a NR BS and an IoT device. FIG. 5 illustrates another example of topology 2 in accordance with aspects of the present disclosure. As shown in FIG. 5, there are an A-IoT device 501, a NR BS 502, a carrier wave node 503 and a UE 504 (i.e., the immediate node) in the topology 2. The backscattered signal is transmitted from the A-IoT device 501 to the UE 504. The topology 2 may include any suitable number of devices adapted for implementing embodiments of the present disclosure. Although not shown, it would be appreciated that one or more A-IoT devices may be comprised in the topology 2.

[0129] In topology 2, the resource for the uplink communication transmitted from A-IoT 501 and the UE 504 is allocated by the NR BS 502. However, whether the resource for the communication between A-IoT device and UE is fully controlled by the NR BS 502 need to be further discussed. There may have two examples as following.

[0130] In the first example, the NR BS 502 fully controls the resource for the communication between the UE 504 and one or more A-IoT devices. In this example, the NR BS 502 indicates information of the overall allocated resource (including time and frequency information) and the resource allocated to one or more A-IoT devices including the A-IoT device 501 to the UE 504. Then the UE 504 indicates or forwards the information to the one or more A-IoT devices including the A-IoT device 501. For the control of the carrier wave transmission, the embodiments of process 200A could be also applied in topology 2.

[0131] In the second example, the NR BS 502 allocates overall resource for the communication between the UE 504 and one or more A-IoT devices. However, the resource used by the communication between the UE 504 and an A-IoT device is determined by the UE 504. In this case, the NR BS 502 may allocate resource between the UE 504 and the A-IoT devices via, for example, a DCI or configured grant for the resource allocation. Then the UE 504 determines the exact resource for the communication between the UE 504 and a certain A-IoT device (e.g., A-IoT device 501). However, different A-IoT devices may be served by different carrier wave nodes. In this example, following options could be considered to control the transmission of carrier waves.

[0132] In the first option, the NR BS 502 indicates to the UE 504 an association between the carrier wave node 503 and one or more A-IoT devices including the A-IoT device 501. After determining the resource for the communication between the UE 504 and the A-IoT device 501, the UE 504 transmits a request to the NR BS 502 to trigger the transmission of carrier waves from the carrier wave node 503. The request may be related to the time instance and/or frequency of carrier wave.

[0133] In the second option, the carrier wave node 503 detects the DCI or a command transmitted from the UE 504 to one or more A-IoT devices including the A-IoT device 501 and determines the frequencies of carrier wave transmitted by the carrier wave node 503. In this option, there is an assumption that carrier wave node 503 has knowledge on an association between the carrier wave node 503 and the one or more A-IoT devices, e.g., the carrier wave node 503 knows which A-IoT device need the carrier wave transmitted by it to perform backscatter communication between this A-IoT and the UE 504. The carrier wave node 503 detects the command or DCI transmitted from the UE

504 to the A-IoT device 501. If the carrier wave node 503 detects that the command/DCI targets the A-IoT device 501 served by it, the carrier wave node 503 may transmit the carrier wave with the frequency indicated by the command/DCI to the A-IoT device 501.

[0134] FIG. 6 illustrates an example of a device 600 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The device 600 may be an example of a 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).

[0135] 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.

[0136] 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).

[0137] For example, the processor 602 may support wireless communication at the device 600 in accordance with examples as disclosed herein. The processor 602 may be configured to operable to support a means for transmitting, to a second device, a first

indication that indicates at least one frequency for at least one carrier wave transmission associated with the second device; and means for transmitting, to at least one third device, at least one second indication that indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device, wherein the at least one backscattered signal transmission is based at least in part on the at least one carrier wave transmission. The processor 602 may be configured to operable to support other means for other implementations of method 1400.

[0138] 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.

[0139] 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.

[0140] The I/O controller 608 may manage input and output signals for the device 600. The I/O controller 608 may also manage peripherals not integrated into the device 600. In some implementations, the I/O controller 608 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 608 may utilize an operating system such as iOS®, ANDROID®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In some

implementations, the I/O controller 608 may be implemented as part of a processor, such as the processor 606. In some implementations, a user may interact with the device 600 via the I/O controller 608 or via hardware components controlled by the I/O controller 608.

[0141] In some implementations, the device 600 may include a single antenna 610. However, in some other implementations, the device 600 may have more than one antenna 610 (i.e., multiple antennas), including multiple antenna panels or antenna arrays, which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver 606 may communicate bi-directionally, via the one or more antennas 610, wired, or wireless links as described herein. For example, the transceiver 606 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 606 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 610 for transmission, and to demodulate packets received from the one or more antennas 610. The transceiver 606 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0142] 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.

[0143] 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.

[0144] FIG. 7 illustrates an example of a device 700 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The device 700 may be an example of UE 104 as described herein. The device 700 may support wireless communication with one or more network entities 102, UEs 104, or any combination thereof. The device 700 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 702, a memory 704, a transceiver 706, and, optionally, an I/O controller 708. These components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[0145] The processor 702, the memory 704, the transceiver 706, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. For example, the processor 702, the memory 704, the transceiver 706, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0146] In some implementations, the processor 702, the memory 704, the transceiver 706, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA) or other programmable logic device, a discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure. In some implementations, the processor 702 and the memory 704 coupled with the processor 702 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 702, instructions stored in the memory 704).

[0147] For example, the processor 702 may support wireless communication at the device 700 in accordance with examples as disclosed herein. The processor 702 may be configured to operable to support a means for receiving, from a first device, a first

indication that indicates at least one frequency for at least one carrier wave transmission associated with the second device; and means for transmitting, to at least one third device, at least one carrier wave transmission with the at least one frequency. The processor 702 may be configured to operable to support other means for other implementations of method 1500.

[0148] The processor 702 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some implementations, the processor 702 may be configured to operate a memory array using a memory controller. In some other implementations, a memory controller may be integrated into the processor 702. The processor 702 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 704) to cause the device 700 to perform various functions of the present disclosure.

[0149] The memory 704 may include random access memory (RAM) and read-only memory (ROM). The memory 704 may store computer-readable, computer-executable code including instructions that, when executed by the processor 702 cause the device 700 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some implementations, the code may not be directly executable by the processor 702 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 704 may include, among other things, a basic I/O system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0150] The I/O controller 708 may manage input and output signals for the device 700. The I/O controller 708 may also manage peripherals not integrated into the device 700. In some implementations, the I/O controller 708 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 708 may utilize an operating system such as iOS®, ANDROID®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In some implementations, the I/O controller 708 may be implemented as part of a processor, such as the processor 706. In some implementations, a user may interact with the device 700

via the I/O controller 708 or via hardware components controlled by the I/O controller 708.

[0151] In some implementations, the device 700 may include a single antenna 710. However, in some other implementations, the device 700 may have more than one antenna 710 (i.e., multiple antennas), including multiple antenna panels or antenna arrays, which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver 706 may communicate bi-directionally, via the one or more antennas 710, wired, or wireless links as described herein. For example, the transceiver 706 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 706 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 710 for transmission, and to demodulate packets received from the one or more antennas 710. The transceiver 706 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0152] A transmit chain may be configured to generate and transmit signals (e.g., control information, data, packets). The transmit chain may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmit chain may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmit chain may also include one or more antennas 710 for transmitting the amplified signal into the air or wireless medium.

[0153] A receive chain may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receive chain may include one or more antennas 710 for receive the signal over the air or wireless medium. The receive chain may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receive chain may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receive chain

may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0154] FIG. 8 illustrates an example of a device 800 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The device 800 may be an example of a UE 104 as described herein. The device 800 may support wireless communication with one or more network entities 102, UEs 104, or any combination thereof. The device 800 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 802, a memory 804, a transceiver 806, and, optionally, an I/O controller 808. 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).

[0155] The processor 802, the memory 804, the transceiver 806, 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 802, the memory 804, the transceiver 806, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0156] In some implementations, the processor 802, the memory 804, the transceiver 806, 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 802 and the memory 804 coupled with the processor 802 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 802, instructions stored in the memory 804).

[0157] For example, the processor 802 may support wireless communication at the device 800 in accordance with examples as disclosed herein. The processor 802 may be configured to operable to support a means for receiving, from a first device, a second indication that indicates a frequency for a backscattered signal transmission associated

with the third device; and means for transmitting, to the first device, a backscattered signal transmission with the frequency based at least in part on at least one carrier wave transmission associated with a second device.

[0158] . The processor 802 may be configured to operable to support other means for other implementations of method 1600.

[0159] The processor 802 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 802 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 802. The processor 802 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 804) to cause the device 800 to perform various functions of the present disclosure.

[0160] The memory 804 may include random access memory (RAM) and read-only memory (ROM). The memory 804 may store computer-readable, computer-executable code including instructions that, when executed by the processor 802 cause the device 800 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some implementations, the code may not be directly executable by the processor 802 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 804 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.

[0161] The I/O controller 808 may manage input and output signals for the device 800. The I/O controller 808 may also manage peripherals not integrated into the device 800. In some implementations, the I/O controller 808 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 808 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 808 may be implemented as part of a processor, such as the processor 806. In some implementations, a user may interact with the device 800

via the I/O controller 808 or via hardware components controlled by the I/O controller 808.

[0162] In some implementations, the device 800 may include a single antenna 810. However, in some other implementations, the device 800 may have more than one antenna 810 (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 806 may communicate bi-directionally, via the one or more antennas 810, wired, or wireless links as described herein. For example, the transceiver 806 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 806 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 810 for transmission, and to demodulate packets received from the one or more antennas 810. The transceiver 806 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0163] 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 810 for transmitting the amplified signal into the air or wireless medium.

[0164] 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 810 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.

[0165] FIG. 9 illustrates an example of a device 900 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The device 900 may be an example of a UE 104 as described herein. The device 900 may support wireless communication with one or more network entities 102, UEs 104, or any combination thereof. The device 900 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 902, a memory 904, a transceiver 906, and, optionally, an I/O controller 908. These components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[0166] The processor 902, the memory 904, the transceiver 906, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. For example, the processor 902, the memory 904, the transceiver 906, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0167] In some implementations, the processor 902, the memory 904, the transceiver 906, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA) or other programmable logic device, a discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure. In some implementations, the processor 902 and the memory 904 coupled with the processor 902 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 902, instructions stored in the memory 904).

[0168] For example, the processor 902 may support wireless communication at the device 900 in accordance with examples as disclosed herein. The processor 902 may be configured to operable to support a means for detecting at least one second indication transmitted to at least one third device, wherein the at least one second indication indicates

at least one frequency for at least one backscattered signal transmission associated with the at least one third device; and means for transmitting, to the at least one third device, at least one carrier wave transmission with the at least one frequency.

[0169] The processor 902 may be configured to operable to support other means for other implementations of method 1700.

[0170] The processor 902 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some implementations, the processor 902 may be configured to operate a memory array using a memory controller. In some other implementations, a memory controller may be integrated into the processor 902. The processor 902 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 904) to cause the device 900 to perform various functions of the present disclosure.

[0171] The memory 904 may include random access memory (RAM) and read-only memory (ROM). The memory 904 may store computer-readable, computer-executable code including instructions that, when executed by the processor 902 cause the device 900 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some implementations, the code may not be directly executable by the processor 902 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 904 may include, among other things, a basic I/O system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0172] The I/O controller 908 may manage input and output signals for the device 900. The I/O controller 908 may also manage peripherals not integrated into the device 900. In some implementations, the I/O controller 908 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 908 may utilize an operating system such as iOS®, ANDROID®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In some implementations, the I/O controller 908 may be implemented as part of a processor, such as the processor 906. In some implementations, a user may interact with the device 900

via the I/O controller 908 or via hardware components controlled by the I/O controller 908.

[0173] In some implementations, the device 900 may include a single antenna 910. However, in some other implementations, the device 900 may have more than one antenna 910 (i.e., multiple antennas), including multiple antenna panels or antenna arrays, which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver 906 may communicate bi-directionally, via the one or more antennas 910, wired, or wireless links as described herein. For example, the transceiver 906 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 906 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 910 for transmission, and to demodulate packets received from the one or more antennas 910. The transceiver 906 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0174] A transmit chain may be configured to generate and transmit signals (e.g., control information, data, packets). The transmit chain may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmit chain may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmit chain may also include one or more antennas 910 for transmitting the amplified signal into the air or wireless medium.

[0175] A receive chain may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receive chain may include one or more antennas 910 for receive the signal over the air or wireless medium. The receive chain may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receive chain may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receive chain

may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0176] FIG. 10 illustrates an example of a processor 1000 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The processor 1000 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 1000 may include a controller 1002 configured to perform various operations in accordance with examples as described herein. The processor 1000 may optionally include at least one memory 1004. Additionally, or alternatively, the processor 1000 may optionally include one or more arithmetic-logic units (ALUs) 1000. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[0177] The processor 1000 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g., receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 1000) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

[0178] The controller 1002 may be configured to manage and coordinate various operations (e.g., signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 1000 to cause the processor 1000 to support various operations in accordance with examples as described herein. For example, the controller 1002 may operate as a control unit of the processor 1000, generating control signals that manage the operation of various components of the processor 1000. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0179] The controller 1002 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 1004 and determine subsequent instruction(s) to be executed to cause the processor 1000 to support various operations in accordance with examples as described herein. The controller 1002 may be configured to track memory address of instructions associated with the memory 1004. The controller 1002 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 1002 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 1000 to cause the processor 1000 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 1002 may be configured to manage flow of data within the processor 1000. The controller 1002 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 1000.

[0180] The memory 1004 may include one or more caches (e.g., memory local to or included in the processor 1000 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 1004 may reside within or on a processor chipset (e.g., local to the processor 1000). In some other implementations, the memory 1004 may reside external to the processor chipset (e.g., remote to the processor 1000).

[0181] The memory 1004 may store computer-readable, computer-executable code including instructions that, when executed by the processor 1000, cause the processor 1000 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 1002 and/or the processor 1000 may be configured to execute computer-readable instructions stored in the memory 1004 to cause the processor 1000 to perform various functions (e.g., functions or tasks supporting transmit power prioritization). For example, the processor 1000 and/or the controller 1002 may be coupled with or to the memory 1004, the processor 1000, the controller 1002, and the memory 1004 may be configured to perform various functions described herein. In some examples, the processor 1000 may include multiple processors and the memory 1004 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[0182] The one or more ALUs 1000 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 1000 may reside within or on a processor chipset (e.g., the processor 1000). In some other implementations, the one or more ALUs 1000 may reside external to the processor chipset (e.g., the processor 1000). One or more ALUs 1000 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 1000 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 1000 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 1000 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 1000 to handle conditional operations, comparisons, and bitwise operations.

[0183] The processor 1000 may support wireless communication in accordance with examples as disclosed herein. The processor 1002 may be configured to or operable to support a means for transmitting, to a second device, a first indication that indicates at least one frequency for at least one carrier wave transmission associated with the second device; and means for transmitting, to at least one third device, at least one second indication that indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device, wherein the at least one backscattered signal transmission is based at least in part on the at least one carrier wave transmission.. The processor 1000 may be configured to or operable to support other means for other implementations of method 1400.

[0184] FIG. 11 illustrates an example of a processor 1100 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The processor 1100 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 1100 may include a controller 1102 configured to perform various operations in accordance with examples as described herein. The processor 1100 may optionally include at least one memory 1104. Additionally, or alternatively, the processor 1100 may optionally include one or more arithmetic-logic units (ALUs) 1100. 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).

[0185] The processor 1100 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 1100) 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).

[0186] The controller 1102 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 1100 to cause the processor 1100 to support various operations in accordance with examples as described herein. For example, the controller 1102 may operate as a control unit of the processor 1100, generating control signals that manage the operation of various components of the processor 1100. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0187] The controller 1102 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 1104 and determine subsequent instruction(s) to be executed to cause the processor 1100 to support various operations in accordance with examples as described herein. The controller 1102 may be configured to track memory address of instructions associated with the memory 1104. The controller 1102 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 1102 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 1100 to cause the processor 1100 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 1102 may be configured to manage flow of data within the processor 1100. The controller 1102 may

be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 1100.

[0188] The memory 1104 may include one or more caches (e.g., memory local to or included in the processor 1100 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 1104 may reside within or on a processor chipset (e.g., local to the processor 1100). In some other implementations, the memory 1104 may reside external to the processor chipset (e.g., remote to the processor 1100).

[0189] The memory 1104 may store computer-readable, computer-executable code including instructions that, when executed by the processor 1100, cause the processor 1100 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 1102 and/or the processor 1100 may be configured to execute computer-readable instructions stored in the memory 1104 to cause the processor 1100 to perform various functions (e.g., functions or tasks supporting transmit power prioritization). For example, the processor 1100 and/or the controller 1102 may be coupled with or to the memory 1104, the processor 1100, the controller 1102, and the memory 1104 may be configured to perform various functions described herein. In some examples, the processor 1100 may include multiple processors and the memory 1104 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.

[0190] The one or more ALUs 1100 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 1100 may reside within or on a processor chipset (e.g., the processor 1100). In some other implementations, the one or more ALUs 1100 may reside external to the processor chipset (e.g., the processor 1100). One or more ALUs 1100 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 1100 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 1100 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 1100 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 1100 to handle conditional operations, comparisons, and bitwise operations.

[0191] The processor 1100 may support wireless communication in accordance with examples as disclosed herein. The processor 1102 may be configured to or operable to support a means for receiving, from a first device, a first indication that indicates at least one frequency for at least one carrier wave transmission associated with the second device; and means for transmitting, to at least one third device, at least one carrier wave transmission with the at least one frequency. The processor 1100 may be configured to or operable to support other means for other implementations of method 1500.

[0192] FIG. 12 illustrates an example of a processor 1200 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The processor 1200 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 1200 may include a controller 1202 configured to perform various operations in accordance with examples as described herein. The processor 1200 may optionally include at least one memory 1204. Additionally, or alternatively, the processor 1200 may optionally include one or more arithmetic-logic units (ALUs) 1200. 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).

[0193] The processor 1200 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 1200) 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).

[0194] The controller 1202 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 1200 to cause the processor 1200 to support various operations in accordance with examples as described herein. For example, the controller 1202 may operate as a control unit of the processor 1200, generating control signals that manage the operation of various components of the processor 1200. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0195] The controller 1202 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 1204 and determine subsequent instruction(s) to be executed to cause the processor 1200 to support various operations in accordance with examples as described herein. The controller 1202 may be configured to track memory address of instructions associated with the memory 1204. The controller 1202 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 1202 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 1200 to cause the processor 1200 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 1202 may be configured to manage flow of data within the processor 1200. The controller 1202 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 1200.

[0196] The memory 1204 may include one or more caches (e.g., memory local to or included in the processor 1200 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 1204 may reside within or on a processor chipset (e.g., local to the processor 1200). In some other implementations, the memory 1204 may reside external to the processor chipset (e.g., remote to the processor 1200).

[0197] The memory 1204 may store computer-readable, computer-executable code including instructions that, when executed by the processor 1200, cause the processor 1200 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 1202 and/or the processor 1200 may be configured to execute computer-readable instructions stored in the memory 1204 to cause the processor 1200 to perform various functions (e.g., functions or tasks supporting transmit power prioritization). For example, the processor 1200 and/or the controller 1202 may be coupled with or to the memory 1204, the processor 1200, the controller 1202, and the memory 1204 may be configured to perform various functions described herein. In some examples, the processor 1200 may include multiple processors and the memory 1204 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.

[0198] The one or more ALUs 1200 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 1200 may reside within or on a processor chipset (e.g., the processor 1200). In some other implementations, the one or more ALUs 1200 may reside external to the processor chipset (e.g., the processor 1200). One or more ALUs 1200 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 1200 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 1200 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 1200 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 1200 to handle conditional operations, comparisons, and bitwise operations.

[0199] The processor 1200 may support wireless communication in accordance with examples as disclosed herein. The processor 1202 may be configured to or operable to support a means for receiving, from a first device, a second indication that indicates a frequency for a backscattered signal transmission associated with the third device; and means for transmitting, to the first device, a backscattered signal transmission with the frequency based at least in part on at least one carrier wave transmission associated with a second device. The processor 1200 may be configured to or operable to support other means for other implementations of method 1600.

[0200] FIG. 13 illustrates an example of a processor 1300 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The processor 1300 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 1300 may include a controller 1302 configured to perform various operations in accordance with examples as described herein. The processor 1300 may optionally include at least one memory 1304. Additionally, or alternatively, the processor 1300 may optionally include one or more arithmetic-logic units (ALUs) 1300. 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).

[0201] The processor 1300 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 1300) 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).

[0202] The controller 1302 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 1300 to cause the processor 1300 to support various operations in accordance with examples as described herein. For example, the controller 1302 may operate as a control unit of the processor 1300, generating control signals that manage the operation of various components of the processor 1300. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0203] The controller 1302 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 1304 and determine subsequent instruction(s) to be

executed to cause the processor 1300 to support various operations in accordance with examples as described herein. The controller 1302 may be configured to track memory address of instructions associated with the memory 1304. The controller 1302 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 1302 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 1300 to cause the processor 1300 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 1302 may be configured to manage flow of data within the processor 1300. The controller 1302 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 1300.

[0204] The memory 1304 may include one or more caches (e.g., memory local to or included in the processor 1300 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 1304 may reside within or on a processor chipset (e.g., local to the processor 1300). In some other implementations, the memory 1304 may reside external to the processor chipset (e.g., remote to the processor 1300).

[0205] The memory 1304 may store computer-readable, computer-executable code including instructions that, when executed by the processor 1300, cause the processor 1300 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 1302 and/or the processor 1300 may be configured to execute computer-readable instructions stored in the memory 1304 to cause the processor 1300 to perform various functions (e.g., functions or tasks supporting transmit power prioritization). For example, the processor 1300 and/or the controller 1302 may be coupled with or to the memory 1304, the processor 1300, the controller 1302, and the memory 1304 may be configured to perform various functions described herein. In some examples, the processor 1300 may include multiple processors and the memory 1304 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.

[0206] The one or more ALUs 1300 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 1300 may reside within or on a processor chipset (e.g., the processor 1300). In some other implementations, the one or more ALUs 1300 may reside external to the processor chipset (e.g., the processor 1300). One or more ALUs 1300 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 1300 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 1300 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 1300 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 1300 to handle conditional operations, comparisons, and bitwise operations.

[0207] The processor 1300 may support wireless communication in accordance with examples as disclosed herein. The processor 1302 may be configured to or operable to support a means for detecting at least one second indication transmitted to at least one third device, wherein the at least one second indication indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device; and means for transmitting, to the at least one third device, at least one carrier wave transmission with the at least one frequency. The processor 1300 may be configured to or operable to support other means for other implementations of method 1700.

[0208] FIG. 14 illustrates a flowchart of a method 1400 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The operations of the method 1400 may be implemented by a device or its components as described herein. For example, the operations of the method 1400 may be performed by a network entity 102 as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0209] At 1405, the method may include transmitting, to a second device, a first indication that indicates at least one frequency for at least one carrier wave transmission

associated with the second device. The operations of 1405 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1405 may be performed by a device as described with reference to FIG. 1A.

[0210] At 1410, the method may include transmitting, to at least one third device, at least one second indication that indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device, wherein the at least one backscattered signal transmission is based at least in part on the at least one carrier wave transmission. The operations of 1410 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1410 may be performed by a device as described with reference to FIG. 1A.

[0211] In some embodiment, the first indication may indicate a first frequency associated with the at least one carrier wave transmission, wherein the at least one second indication may indicate the first frequency associated with the at least one carrier wave transmission and a second frequency associated with the at least one backscattered signal transmission based at least in part on the at least one carrier wave transmission.

[0212] In some embodiment, the first indication may indicate a first plurality of frequencies of a plurality of carrier wave transmissions, wherein the at least one second indication may comprise a plurality of second indications, wherein a second indication among the plurality of second indications indicates a second frequency associated with a backscattered signal transmission based at least in part on the plurality of carrier waves, respectively, and wherein the second frequency is one of the first plurality of frequencies.

[0213] In some embodiment, the at least one second indication may comprise one or more of the first frequency of the at least one carrier wave transmission, a frequency offset from the first frequency of the at least one carrier wave transmission, an index associated with the frequency offset, or an index associated with a frequency of a set of frequencies for the backscattered signal transmission.

[0214] In some embodiment, the frequency offset may be associated with a bandwidth of the at least one third device.

[0215] In some embodiment, the method may further include determining one or more of the set of frequency offsets or the set of frequencies; and transmitting, to the at least one third device, the one of the set of frequency offsets or the set of frequencies.

[0216] In some embodiment, one or more of the set of frequency offsets or the set of frequencies may be predefined.

[0217] In some embodiment, the method may further include transmitting, to the second device, a third indication that schedules at least one resource in one or more of a time domain or a frequency domain for the at least one carrier wave transmission associated with the second device.

[0218] In some embodiment, the at least one resource may correspond to one or more of a time instance for the at least one carrier wave transmission, a time interval for the at least one carrier wave transmission, or a plurality of time instances for the at least one carrier wave transmission.

[0219] In some embodiment, the method may further include transmitting, to the at least one third device, at least one fourth indication that schedules at least one resource in one or more of a time domain or a frequency domain for the at least one backscattered signal transmission.

[0220] In some embodiment, the method may further include receiving, from the at least one third device, the at least one backscattered signal transmission on the at least one frequency associated with the at least one backscattered signal transmission.

[0221] In some embodiment, the first device may comprise a base station, the second device may comprise a carrier wave node, or the third device comprises an Internet of things (IoT) device.

[0222] In some embodiment, the first device may transmit first signaling carrying the first indication, wherein the first signaling may comprise one or more of a master information block (MIB), a system information block (SIB), a radio resource control (RRC) message, a medium access control (MAC) control element (MAC-CE), or a first downlink control information (DCI). In some embodiment, the first device may transmit second signaling carrying the second indication, wherein the second signaling may comprise a second DCI. In some embodiment, the first device may transmit third signaling carrying the third indication, wherein the third signaling may comprise a low power wake up signal (LP-WUS) or a third DCI. In some embodiment, the first device may transmit at least one fourth signaling carrying the at least one fourth indication, wherein the at least one fourth signaling may comprise a fourth DCI.

[0223] FIG. 15 illustrates a flowchart of a method 1500 that supports that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The operations of the method 1500 may be implemented by a device or its components as described herein. For example, the operations of the method 1500 may be performed by a UE 104 as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0224] At 1505, the method may include receiving, from a first device, a first indication that indicates at least one frequency for at least one carrier wave transmission associated with the second device. The operations of 1505 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1505 may be performed by a device as described with reference to FIG. 1A.

[0225] At 1510, the method may include transmitting, to at least one third device, at least one carrier wave transmission with the at least one frequency. The operations of 1510 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1510 may be performed by a device as described with reference to FIG. 1A.

[0226] In some embodiment, the first indication may comprise one of the following: a frequency associated with the at least one a carrier wave transmission; or a plurality of frequencies of a plurality of carrier wave transmissions, wherein the plurality of frequencies may comprise at least one frequency of at least one backscattered signal transmissions associated with at least one third device.

[0227] In some embodiment, the method may further include transmitting the at least one carrier wave transmission by: receiving, from the first device, a third indication that schedules at least one resource in one or more of a time domain or a frequency domain for the at least one carrier wave transmission associated with the second device; and transmitting, to the at least one third device, the at least one carrier wave transmission based on the third indication.

[0228] In some embodiment, the at least one resource may correspond to one or more of a time instance for the at least one carrier wave transmission, a time interval for the at

least one carrier wave transmission or a plurality of time instances for the at least one carrier wave transmission.

[0229] In some embodiment, the method may further include transmitting the at least one carrier wave transmission by: detecting at least one fourth indication transmitted from the first device to the at least one third device, wherein the fourth indication schedules at least one resource in one or more of a time domain or a frequency domain for the at least one backscattered signal transmission; and transmitting, to the at least one third device, the at least one carrier wave transmission based on the at least one fourth indication.

[0230] In some embodiment, the first device may comprise a base station. In some embodiment, the second device may comprise a carrier wave node. In some embodiment, the third device may comprise an Internet of things (IoT) device.

[0231] In some embodiment, the method may further include receiving first signaling carrying the first indication, wherein the first signaling may comprises one or more of a master information block (MIB), a system information block (SIB), a radio resource control (RRC) message, a medium access control (MAC) control element (MAC-CE), or a first downlink control information (DCI). In some embodiment, the method may further include receiving third signaling carrying the third indication, wherein the third signaling may comprise a low power wake up signal (LP-WUS) or a third DCI. In some embodiment, the method may further include detecting at least one fourth signaling carrying the at least one fourth indication, wherein the at least one fourth signaling may comprise a fourth DCI.

[0232] FIG. 16 illustrates a flowchart of a method 1600 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The operations of the method 1600 may be implemented by a device or its components as described herein. For example, the operations of the method 1600 may be performed by a UE 104 as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0233] At 1605, the method may include receiving, from a first device, a second indication that indicates a frequency for a backscattered signal transmission associated with the third device. The operations of 1605 may be performed in accordance with

examples as described herein. In some implementations, aspects of the operations of 1605 may be performed by a device as described with reference to FIG. 1A.

[0234] At 1610, the method may include transmitting, to the first device, a backscattered signal transmission with the frequency based at least in part on at least one carrier wave transmission associated with a second device. The operations of 1610 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1610 may be performed by a device as described with reference to FIG. 1A.

[0235] In some embodiment, the second indication may comprise one or more of a first frequency associated with the at least one carrier wave transmission, a frequency offset from the first frequency of the at least one carrier wave transmission, an index associated with the frequency offset, or an index associated with a frequency of a set of frequencies for the backscattered signal transmission.

[0236] In some embodiment, the frequency offset may be associated with a bandwidth of the third device. In some embodiment, the method may further include receiving, from the first device, one of the set of frequency offsets or the set of frequencies.

[0237] In some embodiment, the set of frequency offsets may be predefined or determined by the first device. In some embodiment, the set of frequencies may be predefined or determined by the first device.

[0238] In some embodiment, the method may further include receiving, from the first device, a fourth indication that schedules at least one resource in one or more of a time domain or a frequency domain for the backscattered signal transmission.

[0239] In some embodiment, the first device may comprise a base station. In some embodiment, the second device may comprise a carrier wave node. In some embodiment, the third device may comprise an Internet of thing (IoT) device.

[0240] In some embodiment, the method may further include receiving second signaling carrying the second indication, wherein the second signaling may comprise a second downlink control information (DCI). In some embodiment, the method may further include receiving fourth signaling carrying the fourth indication, wherein the fourth signaling may comprise a fourth DCI.

[0241] FIG. 17 illustrates a flowchart of a method 1700 that supports resource allocation for a backscattered communication system in accordance with aspects of the present disclosure. The operations of the method 1700 may be implemented by a device or its components as described herein. For example, the operations of the method 1700 may be performed by a UE 104 as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0242] At 1705, the method may include detecting at least one second indication transmitted to at least one third device, wherein the at least one second indication indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device. The operations of 1705 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1705 may be performed by a device as described with reference to FIG. 1A.

[0243] At 1710, the method may include transmitting, to the at least one third device, at least one carrier wave transmission with the at least one frequency. The operations of 1710 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1710 may be performed by a device as described with reference to FIG. 1A.

[0244] In some embodiment, the method may further include transmitting the at least one carrier wave transmission by: detecting at least one fourth indication transmitted from a first device to at least one third device, wherein the fourth indication schedules at least one resource in one or more of a time domain or a frequency domain for the at least one backscattered signal transmission; and transmitting, to the at least one third device, the at least one carrier wave transmission based on the at least one fourth indication.

[0245] In some embodiment, the method may further include detecting second signaling carrying the second indication, wherein the second signaling comprises a second downlink control information (DCI); or detecting at least one fourth signaling carrying the at least one fourth indication, wherein the at least one fourth signaling comprises a fourth DCI.

[0246] 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.

[0247] 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.

[0248] 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.

[0249] 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.

[0250] 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.

[0251] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

What is claimed is:

1. A first device comprising:

at least one memory; and

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

transmit, to a second device, a first indication that indicates at least one frequency for at least one carrier wave transmission associated with the second device; and

transmit, to at least one third device, at least one second indication that indicates at least one frequency for at least one backscattered signal transmission associated with the at least one third device, wherein the at least one backscattered signal transmission is based at least in part on the at least one carrier wave transmission.

2. The first device of claim 1, wherein the first indication indicates a first frequency associated with the at least one carrier wave transmission, wherein the at least one second indication indicates the first frequency associated with the at least one carrier wave transmission and a second frequency associated with the at least one backscattered signal transmission based at least in part on the at least one carrier wave transmission.

3. The first device of claim 1, wherein the first indication indicates a first plurality of frequencies of a plurality of carrier wave transmissions, wherein the at least one second indication comprises a plurality of second indications, wherein a second indication among the plurality of second indications indicates a second frequency associated with a backscattered signal transmission based at least in part on the plurality of carrier waves, respectively, and wherein the second frequency is one of the first plurality of frequencies.

4. The first device of claim 2, wherein the at least one second indication comprises one or more of the first frequency of the at least one carrier wave transmission, a frequency offset from the first frequency of the at least one carrier wave transmission, an index associated with the frequency offset, or an index associated with a frequency of a set of frequencies for the backscattered signal transmission.

5. The first device of claim 4, wherein the frequency offset is associated with a bandwidth of the at least one third device.

6. The first device of claim 4, wherein the at least one processor is further configured to cause the first device to:

determine one or more of the set of frequency offsets or the set of frequencies;
and

transmit, to the at least one third device, the one of the set of frequency offsets or the set of frequencies.

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

transmit, to the second device, a third indication that schedules at least one resource in one or more of a time domain or a frequency domain for the at least one carrier wave transmission associated with the second device.

8. The first device of claim 7, wherein the at least one resource corresponds to one or more of a time instance for the at least one carrier wave transmission, a time interval for the at least one carrier wave transmission, or a plurality of time instances for the at least one carrier wave transmission.

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

transmit, to the at least one third device, at least one fourth indication that schedules at least one resource in one or more of a time domain or a frequency domain for the at least one backscattered signal transmission.

10. The first device of any of claims 1-9, wherein one or more of the first device comprises a base station, the second device comprises a carrier wave node, or the third device comprises an Internet of things (IoT) device.

11. A second device comprising:

at least one memory; and

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

receive, from a first device, a first indication that indicates at least one frequency for at least one carrier wave transmission associated with the second device; and

transmit, to at least one third device, at least one carrier wave transmission with the at least one frequency.

12. The second device of claim 11, wherein the first indication comprises one of the following:

a frequency associated with the at least one a carrier wave transmission; or a plurality of frequencies of a plurality of carrier wave transmissions, wherein the plurality of frequencies comprise at least one frequency of at least one backscattered signal transmissions associated with at least one third device.

13. The second device of claim 11, wherein the at least one processor is further configured to cause the second device to transmit the at least one carrier wave transmission by:

receiving, from the first device, a third indication that schedules at least one resource in one or more of a time domain or a frequency domain for the at least one carrier wave transmission associated with the second device; and

transmitting, to the at least one third device, the at least one carrier wave transmission based on the third indication.

14. The second device of claim 13, wherein the at least one resource corresponds to one or more of a time instance for the at least one carrier wave transmission, a time interval for the at least one carrier wave transmission or a plurality of time instances for the at least one carrier wave transmission.

15. A third device comprising:

at least one memory; and

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

receive, from a first device, a second indication that indicates a frequency for a backscattered signal transmission associated with the third device; and

transmit, to the first device, a backscattered signal transmission with the frequency based at least in part on at least one carrier wave transmission associated with a second device.

16. The third device of claim 15, wherein the second indication comprises one or more of a first frequency associated with the at least one carrier wave transmission, a frequency offset from the first frequency of the at least one carrier wave transmission, an index associated with the frequency offset, or an index associated with a frequency of a set of frequencies for the backscattered signal transmission.

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

receive, from the first device, one of the set of frequency offsets or the set of frequencies.

18. The third device of claim 17, wherein one or more of the set of frequency offsets is predefined or determined by the first device, or the set of frequencies is predefined or determined by the first device.

19. The third device of claim 15, wherein the at least one processor is further configured to cause the third device to:

receive, from the first device, a fourth indication that schedules at least one resource in one or more of a time domain or a frequency domain for the backscattered signal transmission.

20. The third device of any of claims 15-19, wherein one or more of the first device comprises a base station, the second device comprises a carrier wave node, or the third device comprises an Internet of thing (IoT) device.