US 20250260262A1

(19) **United States**
(12) **Patent Application Publication**
GUPTA et al.
(10) **Pub. No.: US 2025/0260262 A1**
(43) **Pub. Date: Aug. 14, 2025**

(54) **SIGNAL ROUNDS FOR ENERGY HARVESTING-CAPABLE DEVICES**

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(21) Appl. No.: **19/052,158**

(22) Filed: **Feb. 12, 2025**

Related U.S. Application Data

(60) Provisional application No. 63/553,327, filed on Feb. 14, 2024.

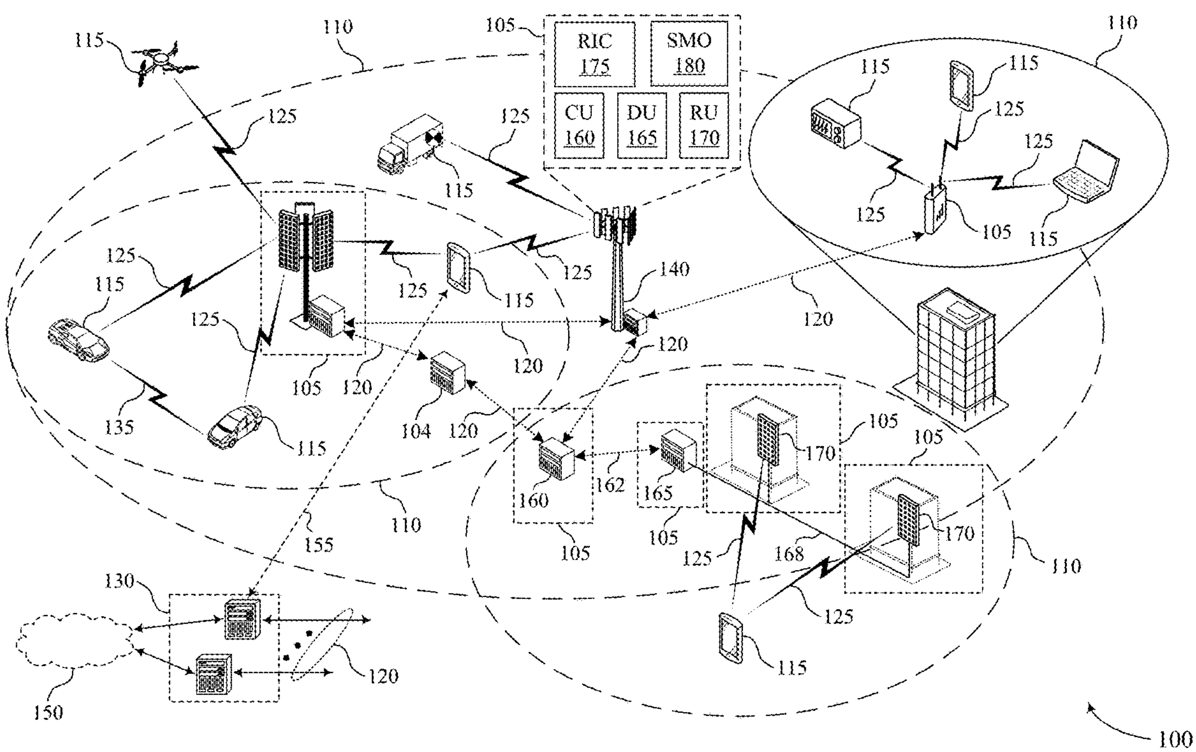
Publication Classification

(51) **Int. Cl.**
H02J 50/00 (2016.01)
H04W 4/38 (2018.01)

(52) **U.S. Cl.**
CPC ***H02J 50/001*** (2020.01); *H04W 4/38* (2018.02)

(57) **ABSTRACT**

Some wireless communications systems may support deployment of ambient internet of things (IoT) devices, which include relatively low power and low complexity devices that are capable of harvesting energy from different sources, including radio frequency (RF) waves, solar energy, heat, or other ambient sources. Energy harvesting (EH)-capable devices such as ambient IoT devices may be used for applications such as inventory tracking, sensing, positioning, or command systems. Ambient IoT devices may be deployed for inventory reading or tracking. In some of the approaches described herein, unsynchronized duty cycle-based operations at EH-capable devices (e.g., ambient IoT devices) and multiple queries in a round from a reader may be utilized. For example, some of the techniques described herein may provide approaches for efficiently multiplexing multiple queries from different inventory rounds. For example, an inventory round may include multiple signaling instances to query one or more ambient IoT devices.



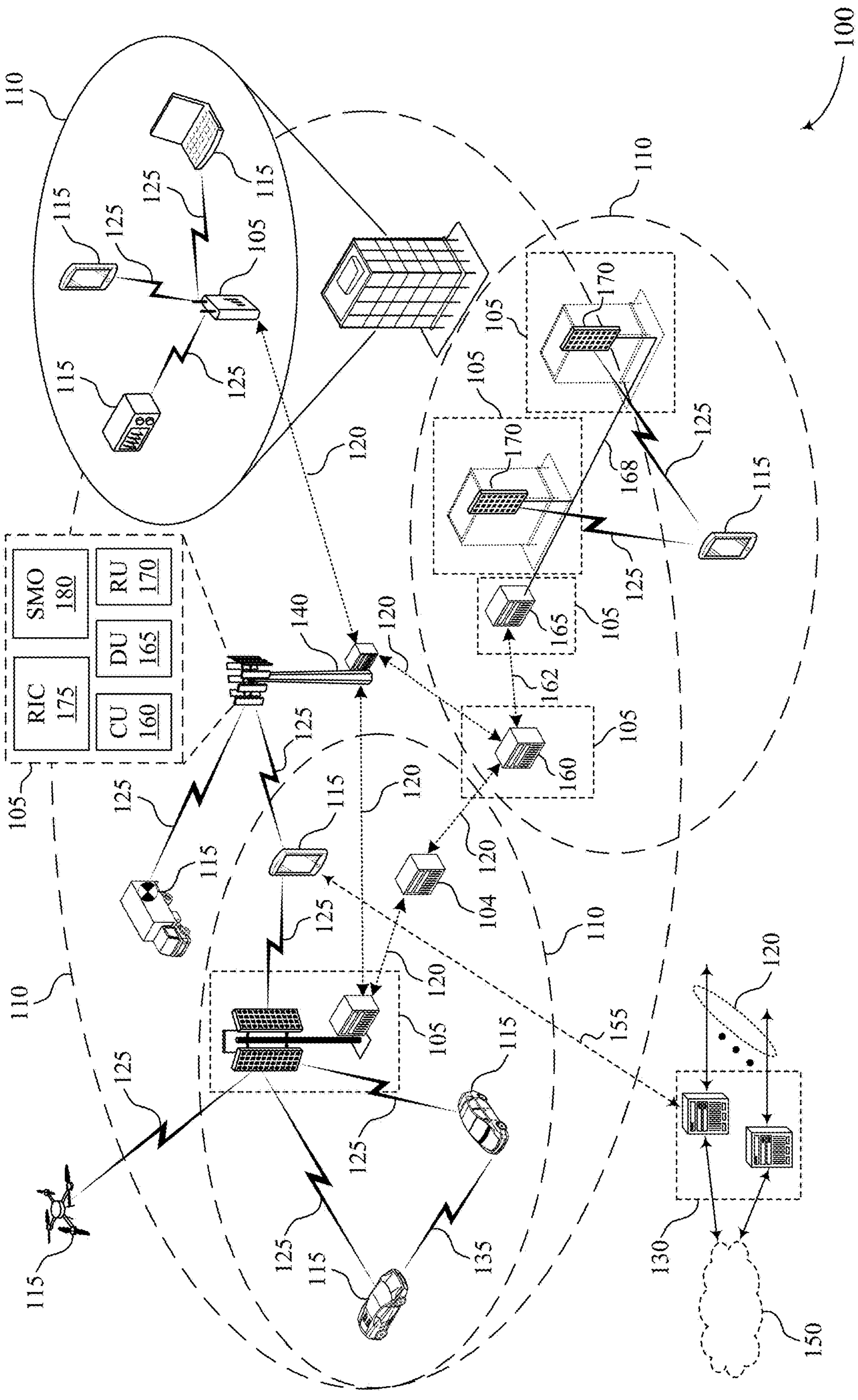


FIG. 1

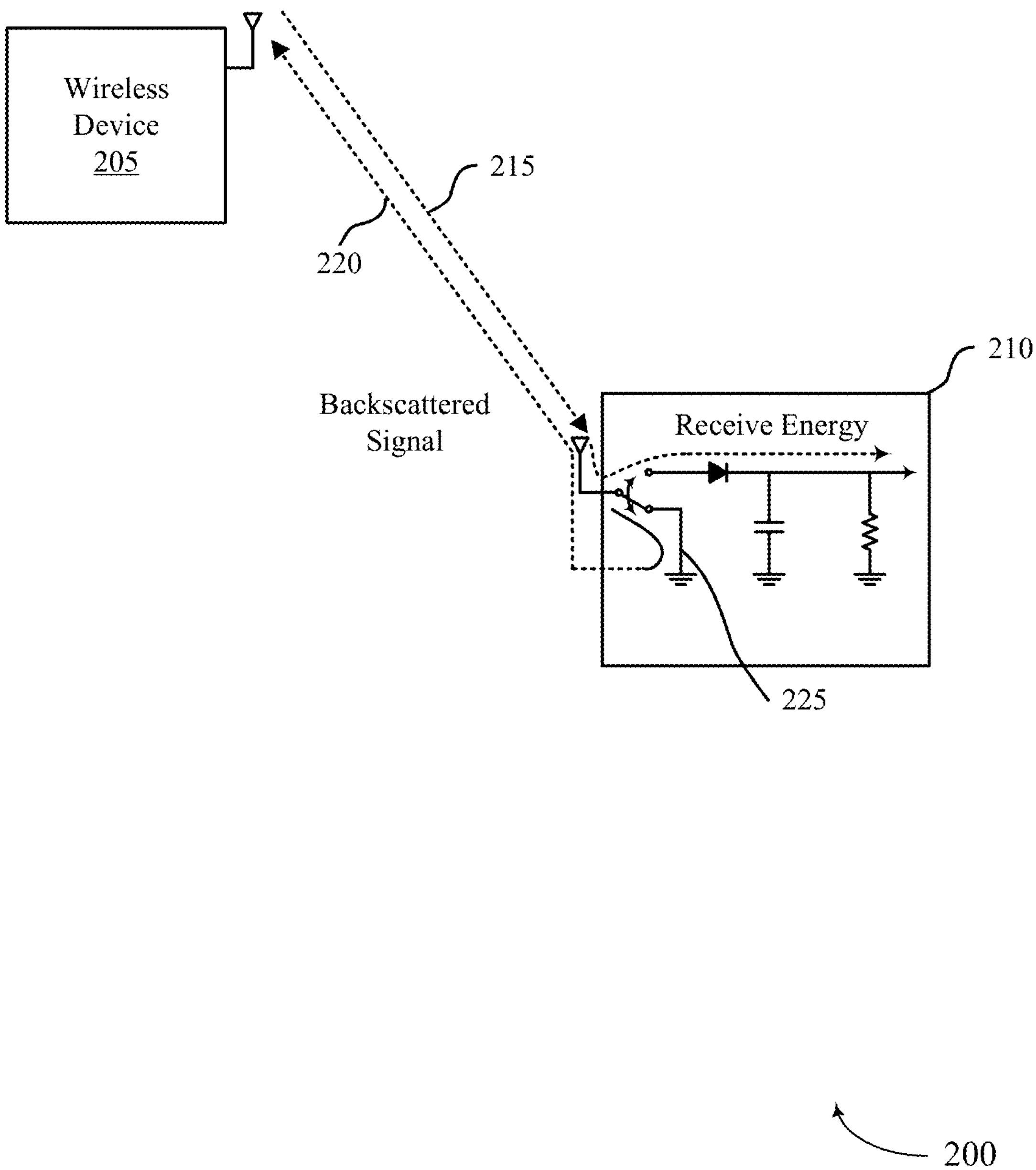

Wireless
Device
205
215
220
210
Backscattered
Signal
Receive Energy
225
200

FIG. 2

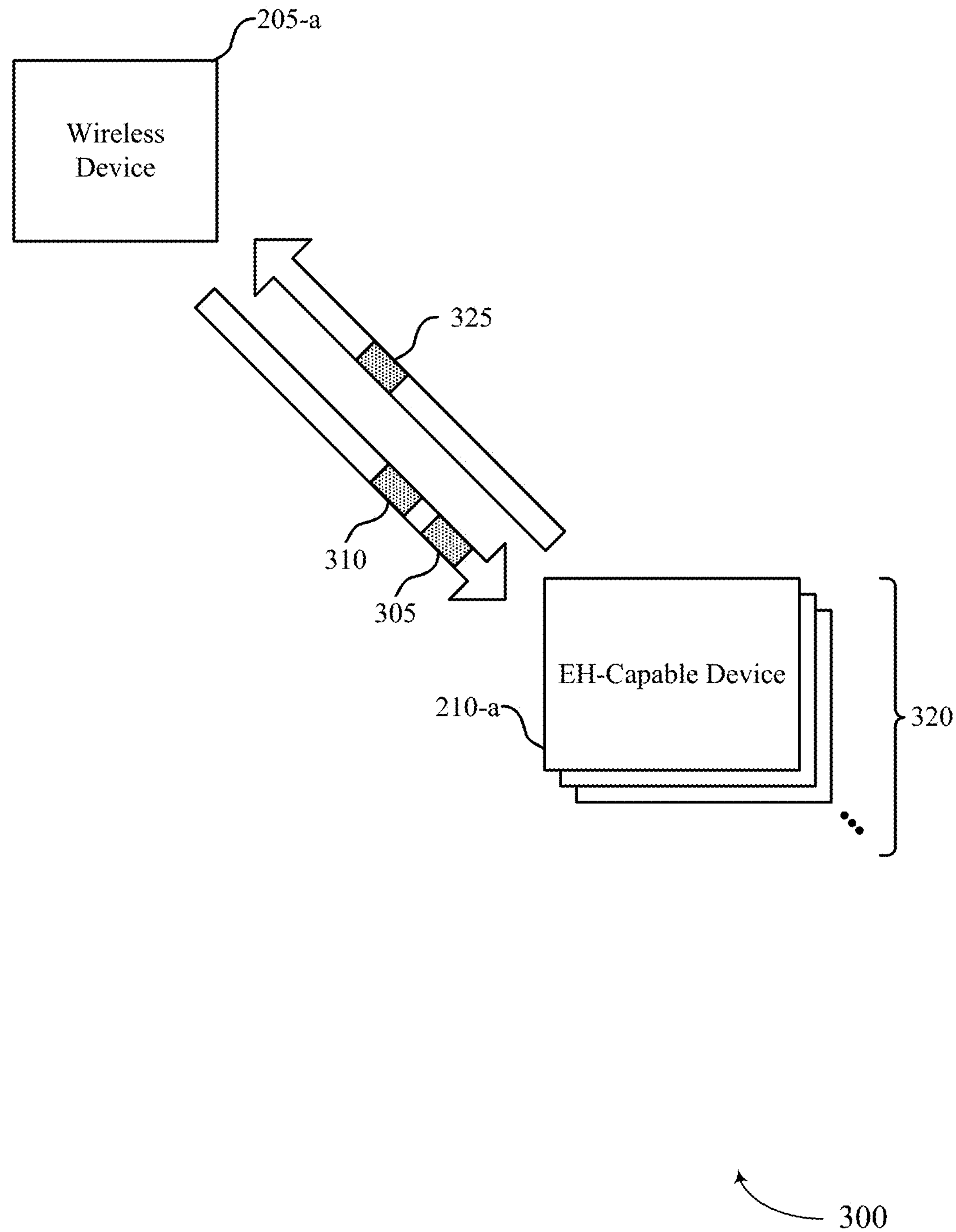

205-a
Wireless
Device
325
310
305
EH-Capable Device
210-a
320
300

FIG. 3

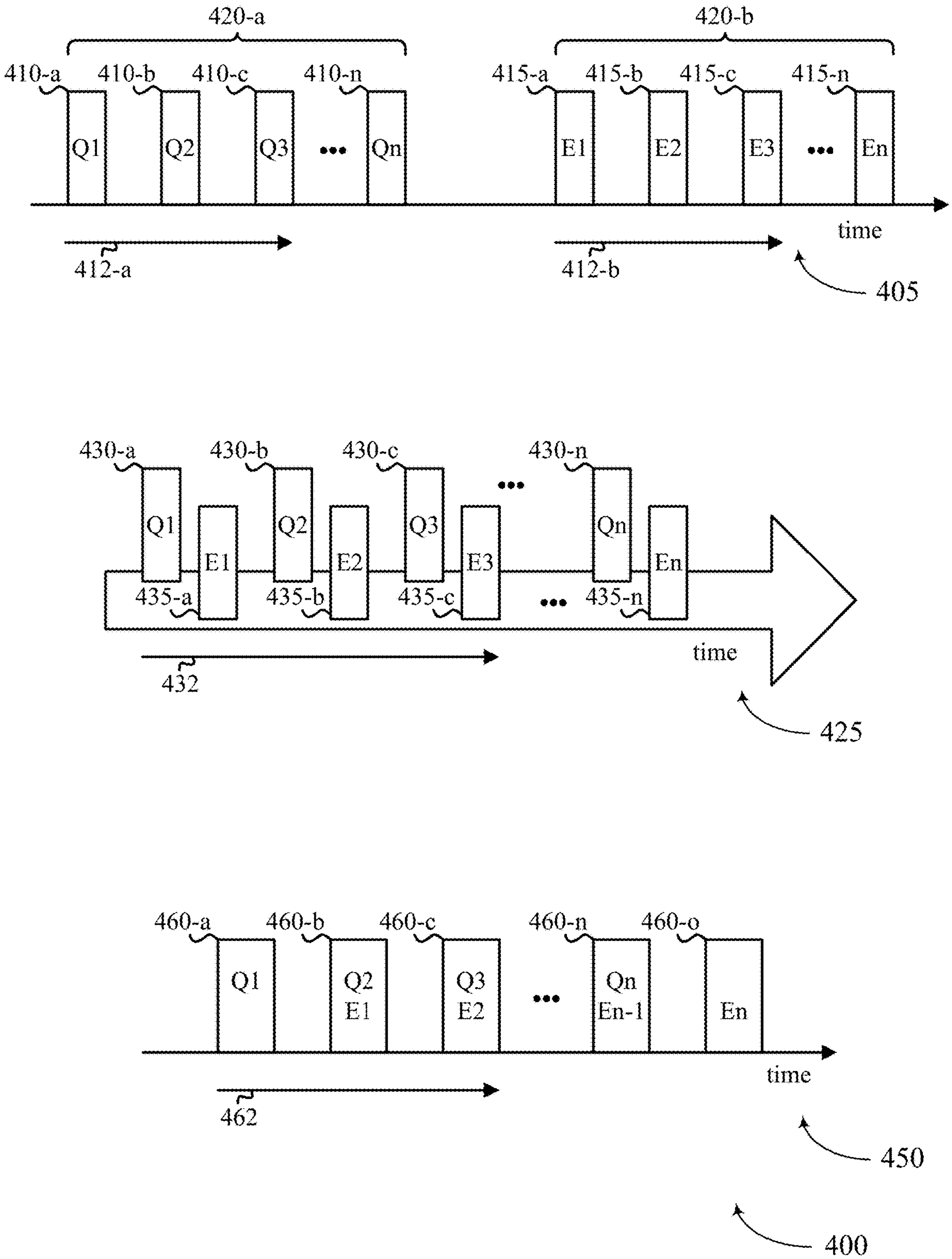

420-a
420-b
410-a
410-b
410-c
410-n
415-a
415-b
415-c
415-n
Q1
Q2
Q3
Qn
E1
E2
E3
En
time
412-a
412-b
405
430-a
430-b
430-c
430-n
Q1
Q2
Q3
Qn
E1
E2
E3
En
435-a
435-b
435-c
435-n
time
432
425
460-a
460-b
460-c
460-n
460-o
Q1
Q2
E1
Q3
E2
Qn
En-1
En
time
462
450
400

FIG. 4

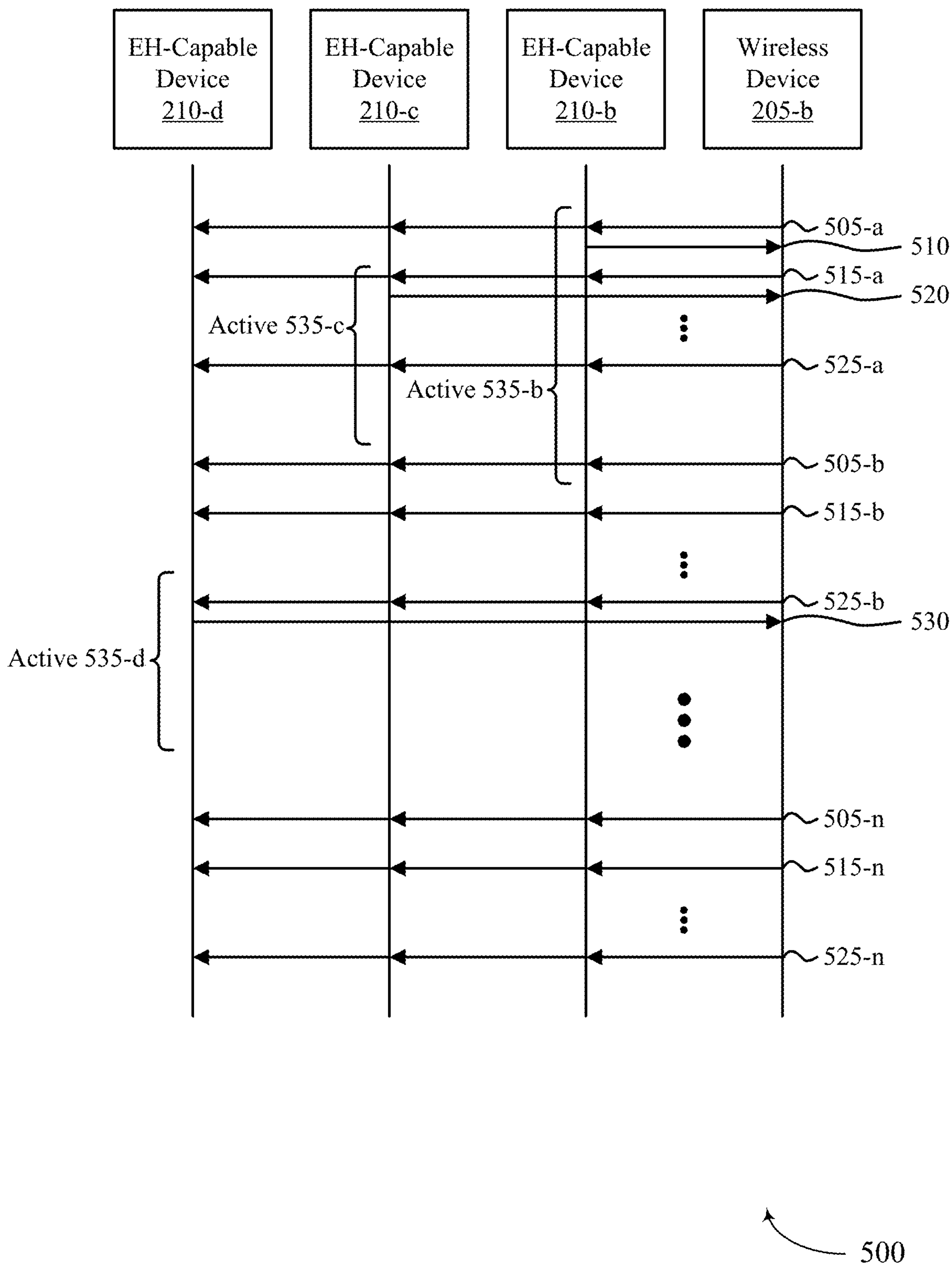

EH-Capable Device 210-d
EH-Capable Device 210-c
EH-Capable Device 210-b
Wireless Device 205-b
505-a
510
515-a
520
Active 535-c
525-a
Active 535-b
505-b
515-b
525-b
530
Active 535-d
505-n
515-n
525-n
500

FIG. 5

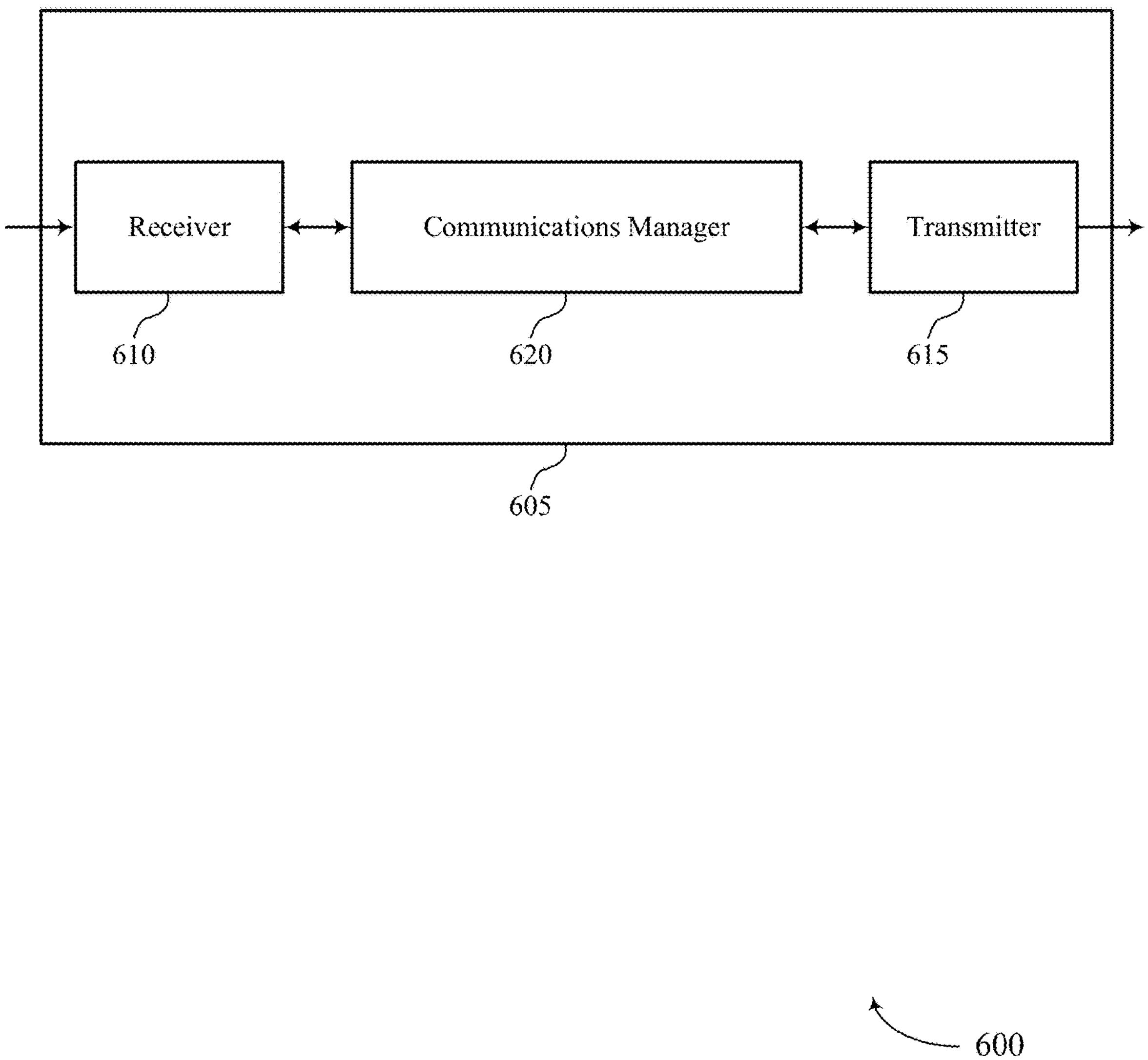

Receiver
Communications Manager
Transmitter
610
620
615
605
600

FIG. 6

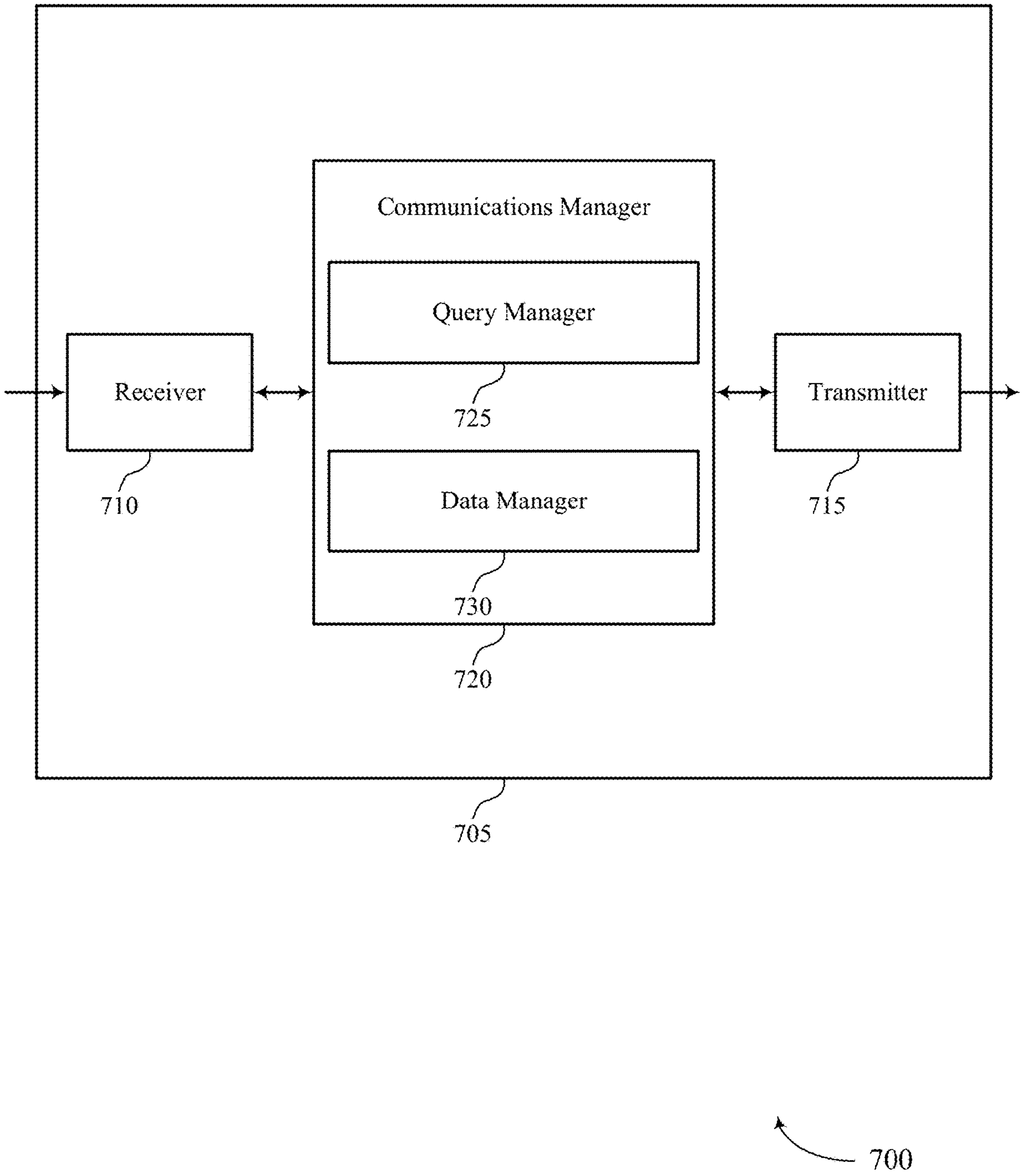

Communications Manager
Query Manager
725
Receiver
Transmitter
710
715
Data Manager
730
720
705
700

FIG. 7

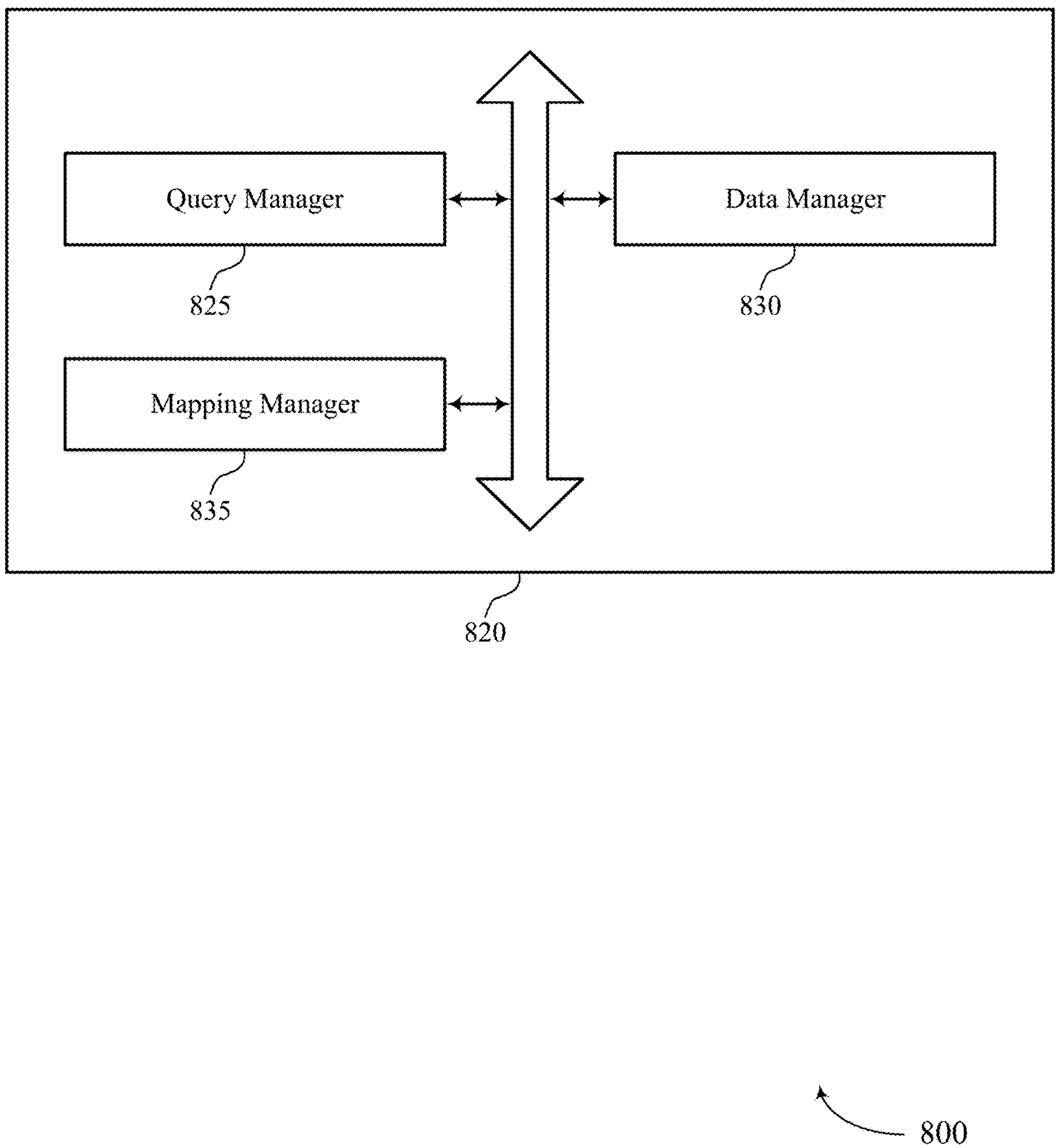

Query Manager
Data Manager
Mapping Manager
825
830
835
820
800

FIG. 8

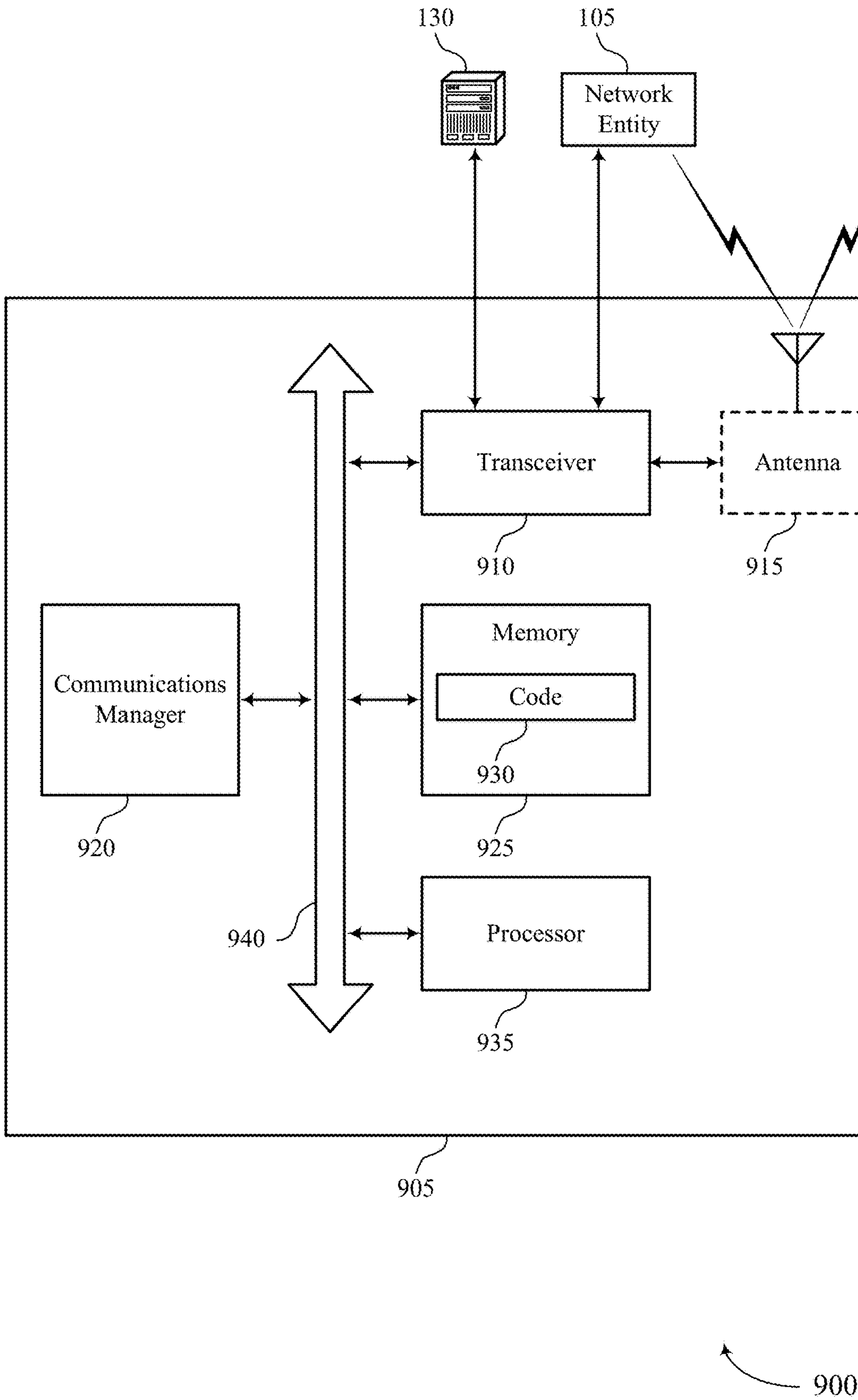

130
105
Network Entity
115
Transceiver
Antenna
910
915
Memory
Code
930
925
Communications Manager
920
940
Processor
935
905
900

FIG. 9

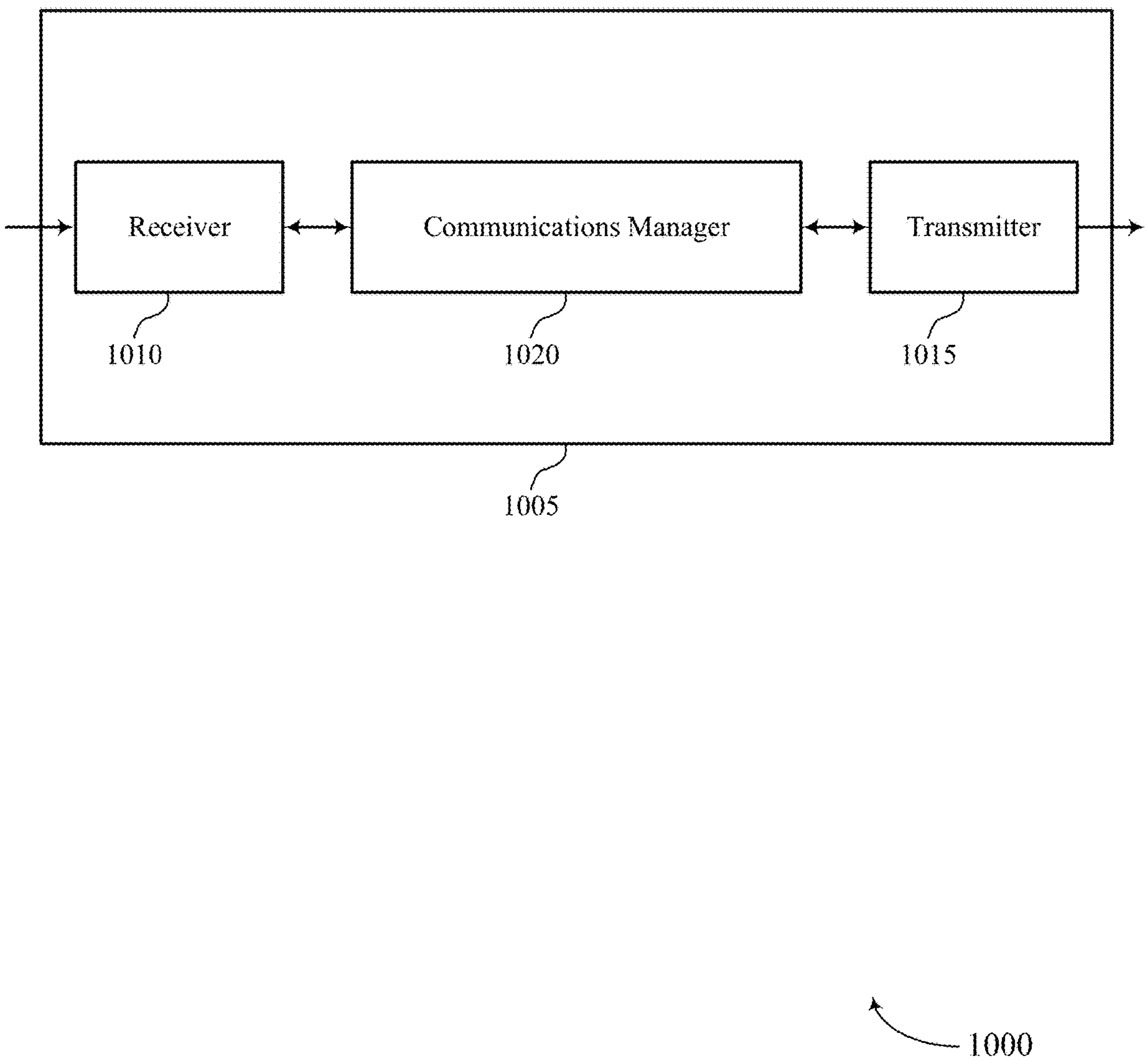

Receiver
Communications Manager
Transmitter
1010
1020
1015
1005
1000

FIG. 10

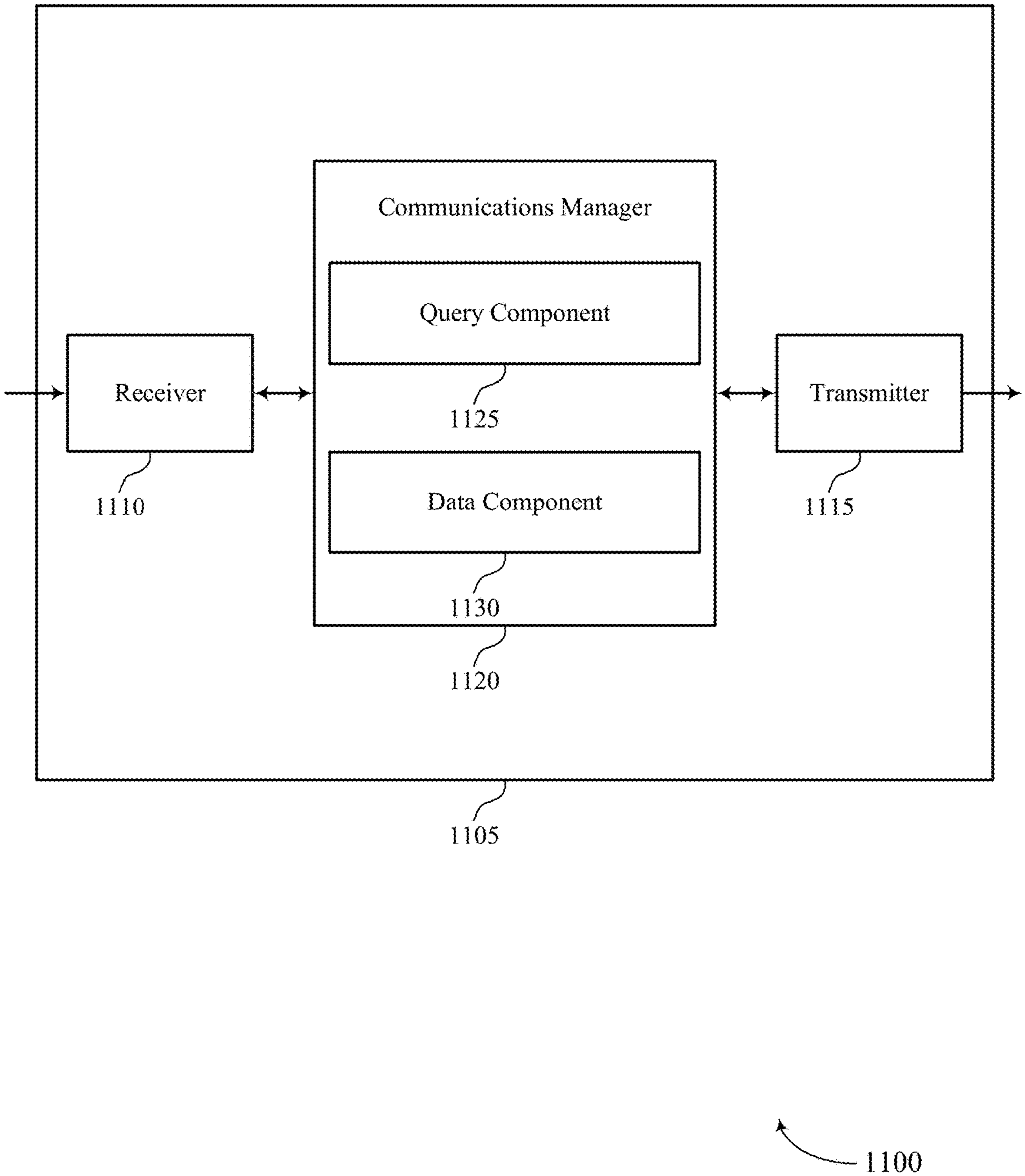

Communications Manager
Query Component
1125
Receiver
Transmitter
Data Component
1110
1115
1130
1120
1105
1100

FIG. 11

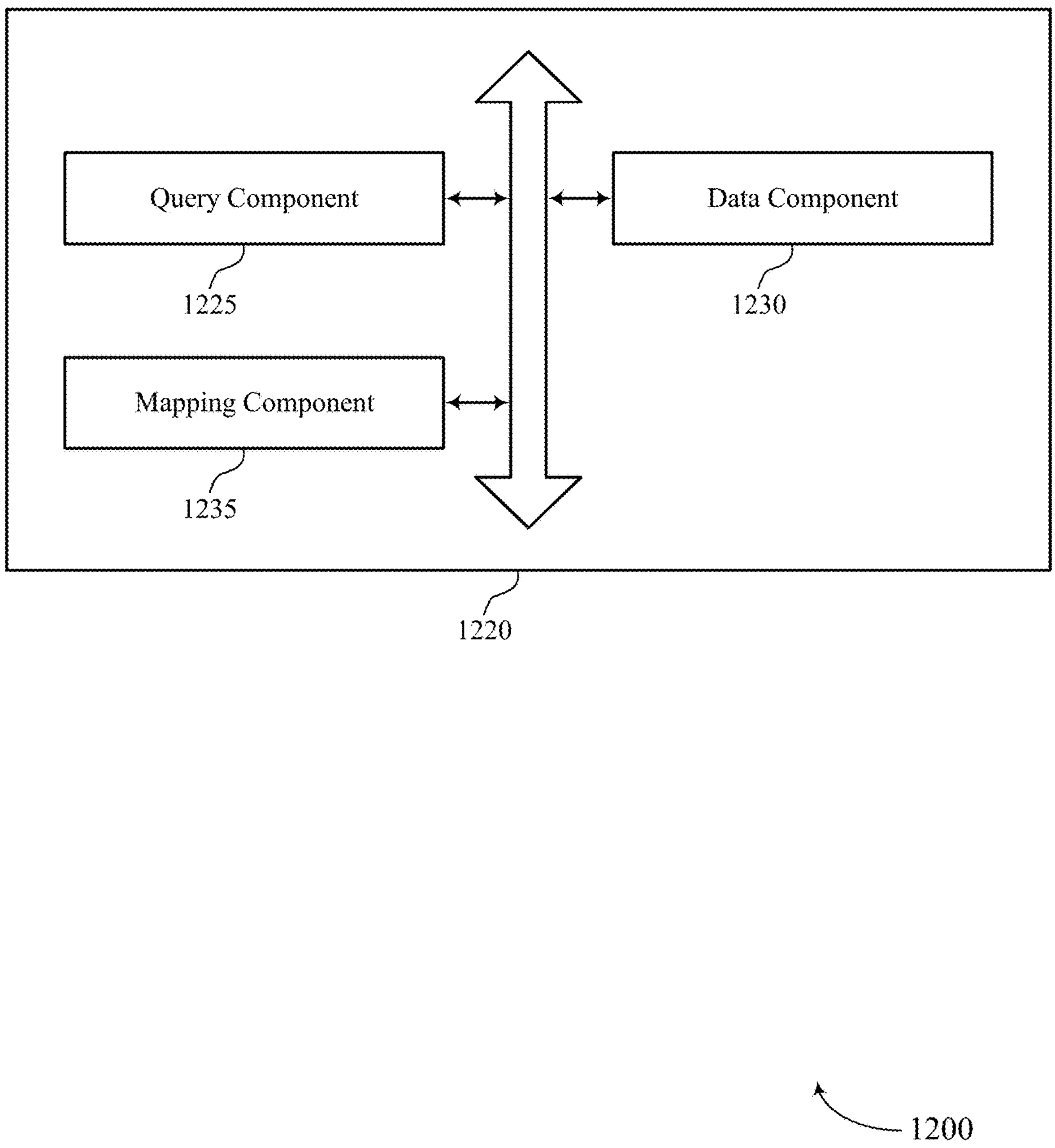

Query Component
Data Component
1225
1230
Mapping Component
1235
1220
1200

FIG. 12

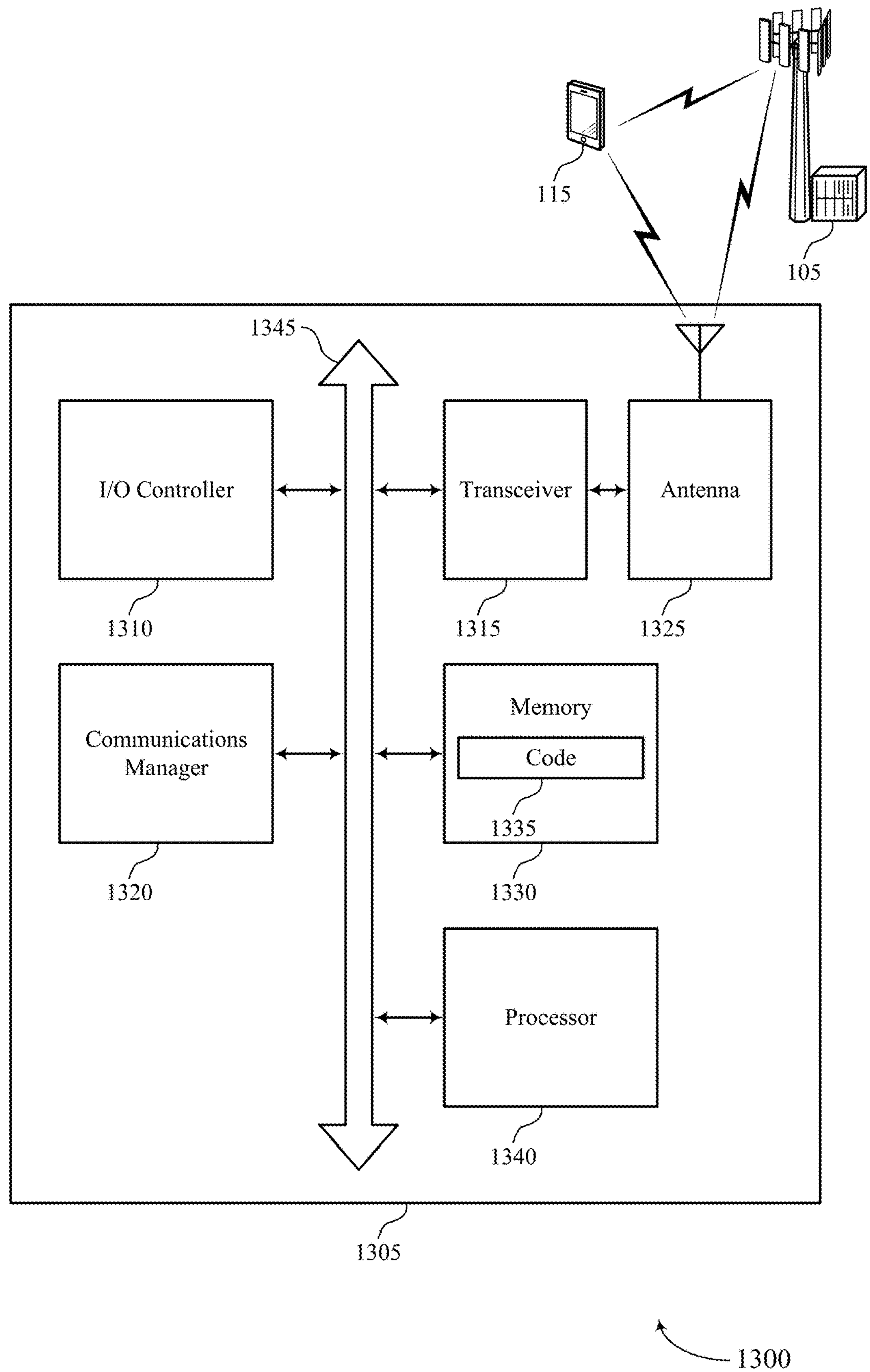

115
105
1345
I/O Controller
Transceiver
Antenna
1310
1315
1325
Communications Manager
Memory
Code
1335
1320
1330
Processor
1340
1305
1300

FIG. 13

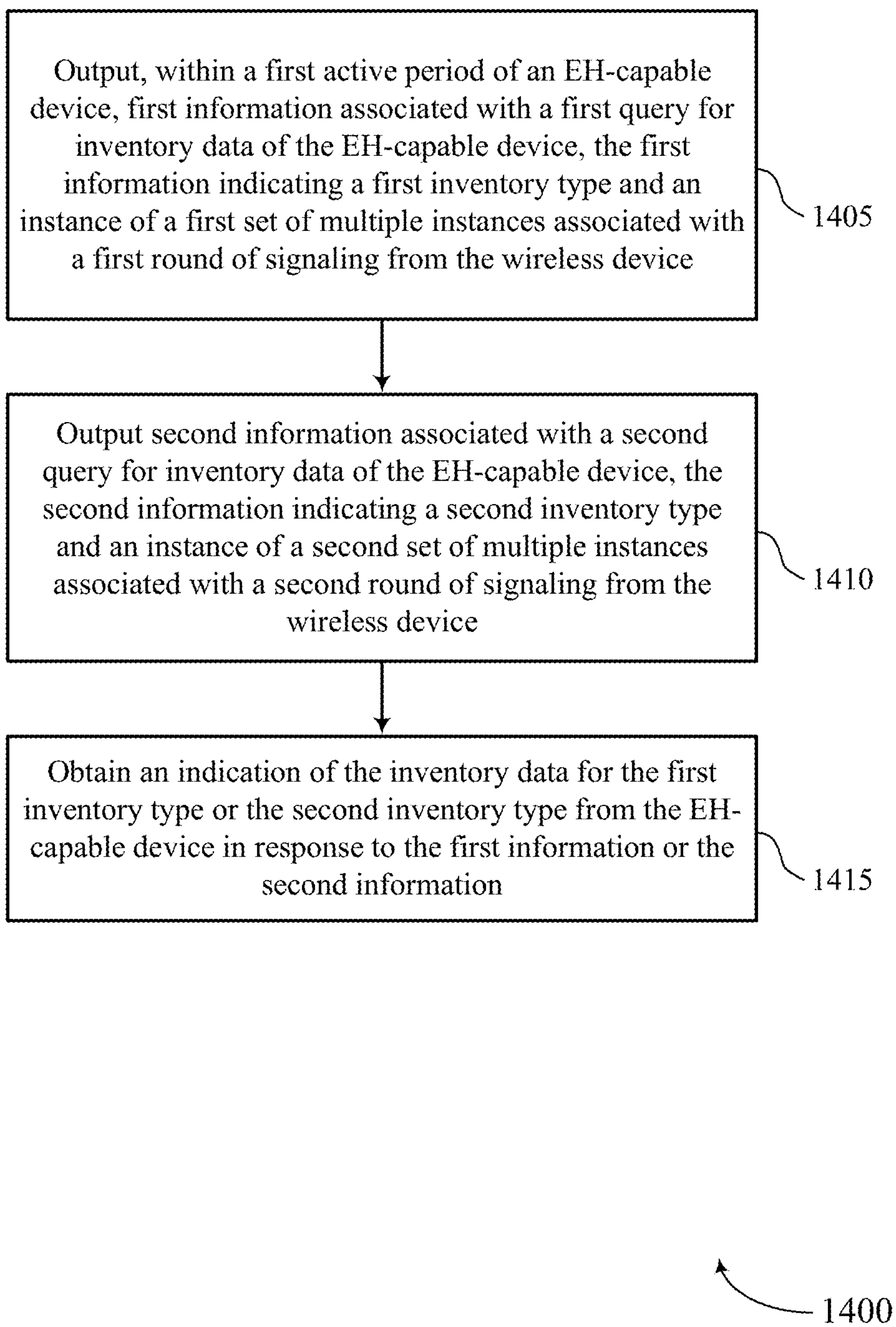

Output, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device
1405
Output second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device
1410
Obtain an indication of the inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information
1415
1400

FIG. 14

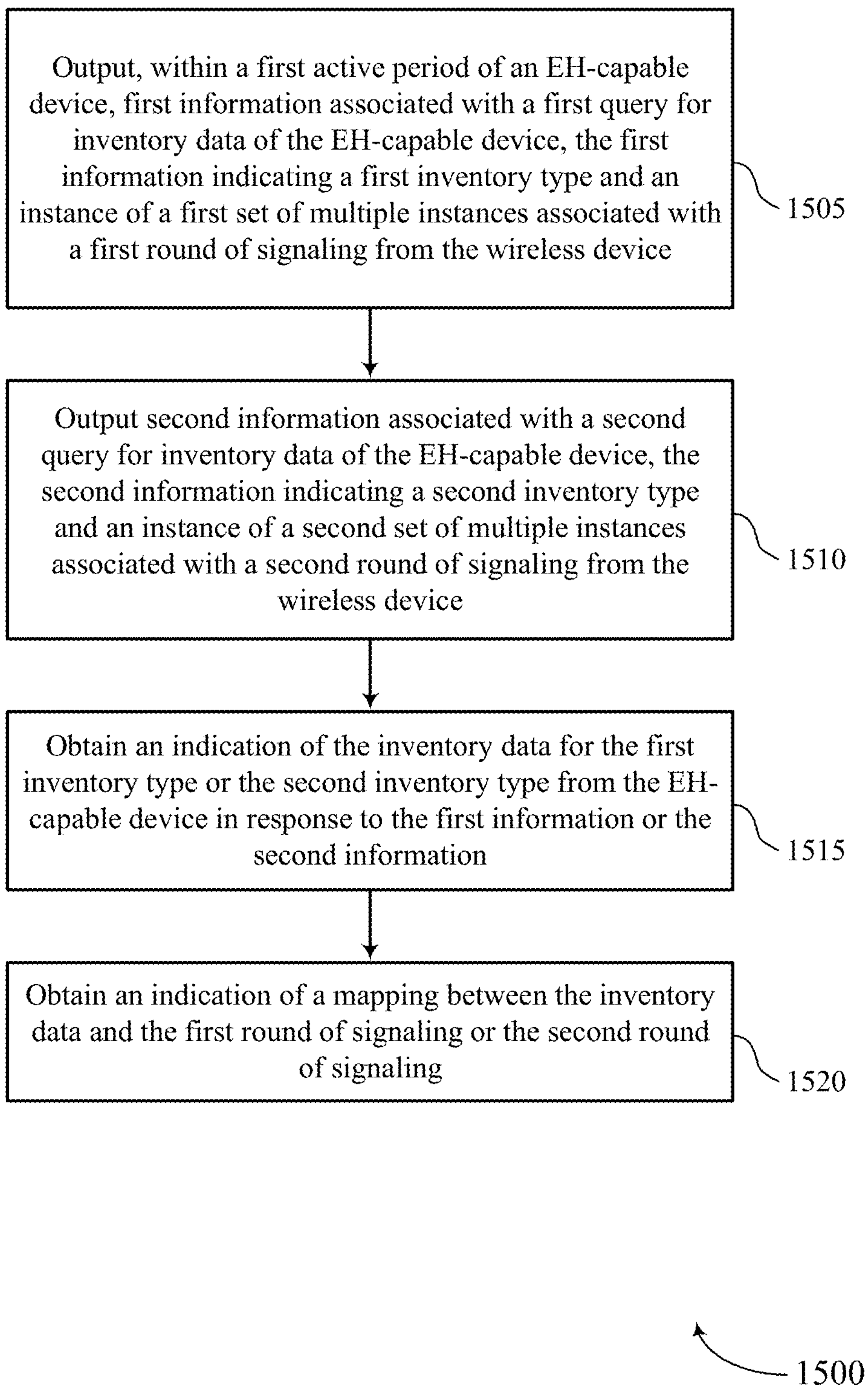

Output, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device
1505
Output second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device
1510
Obtain an indication of the inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information
1515
Obtain an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling
1520
1500

FIG. 15

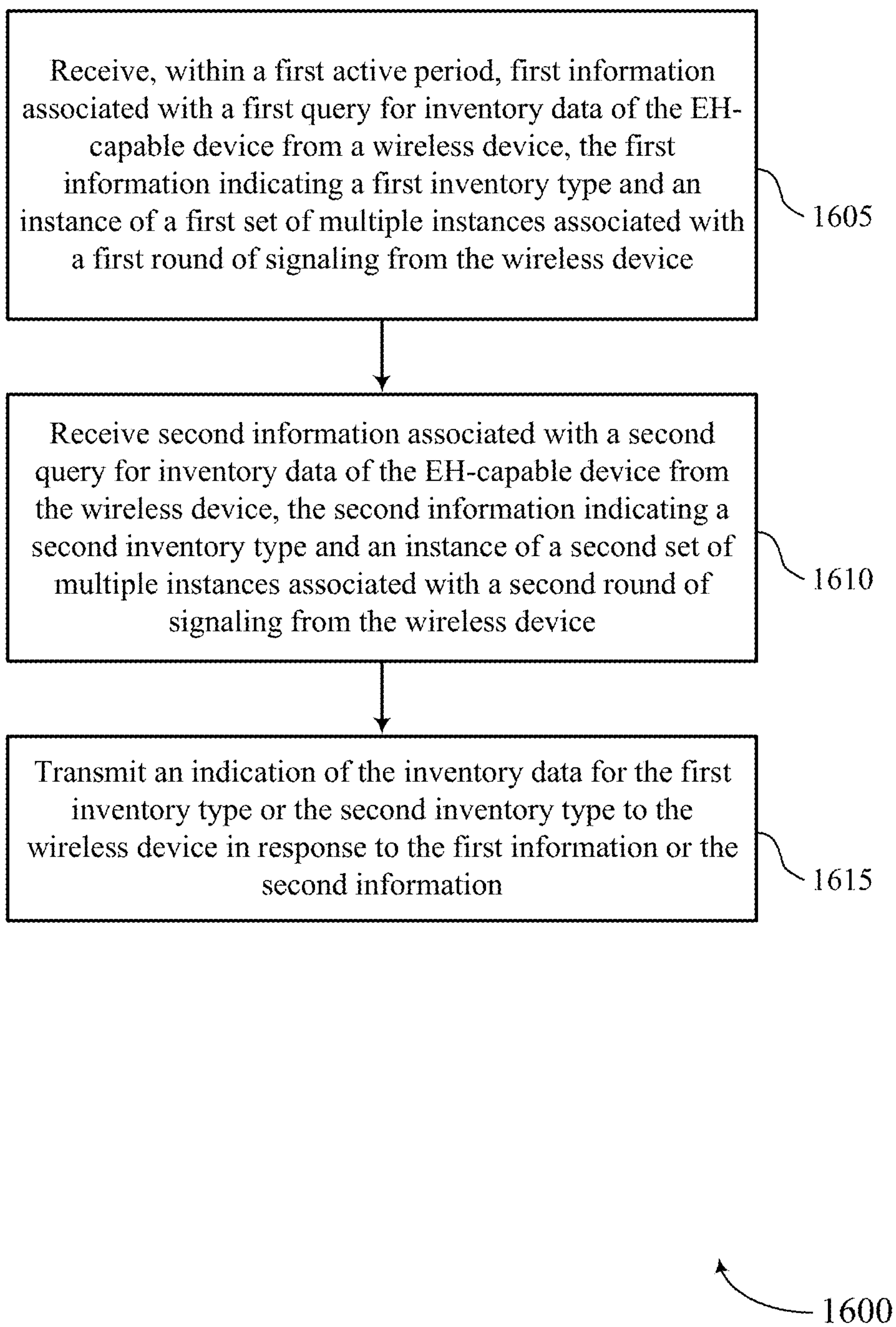

Receive, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device
1605
Receive second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device
1610
Transmit an indication of the inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information
1615
1600

FIG. 16

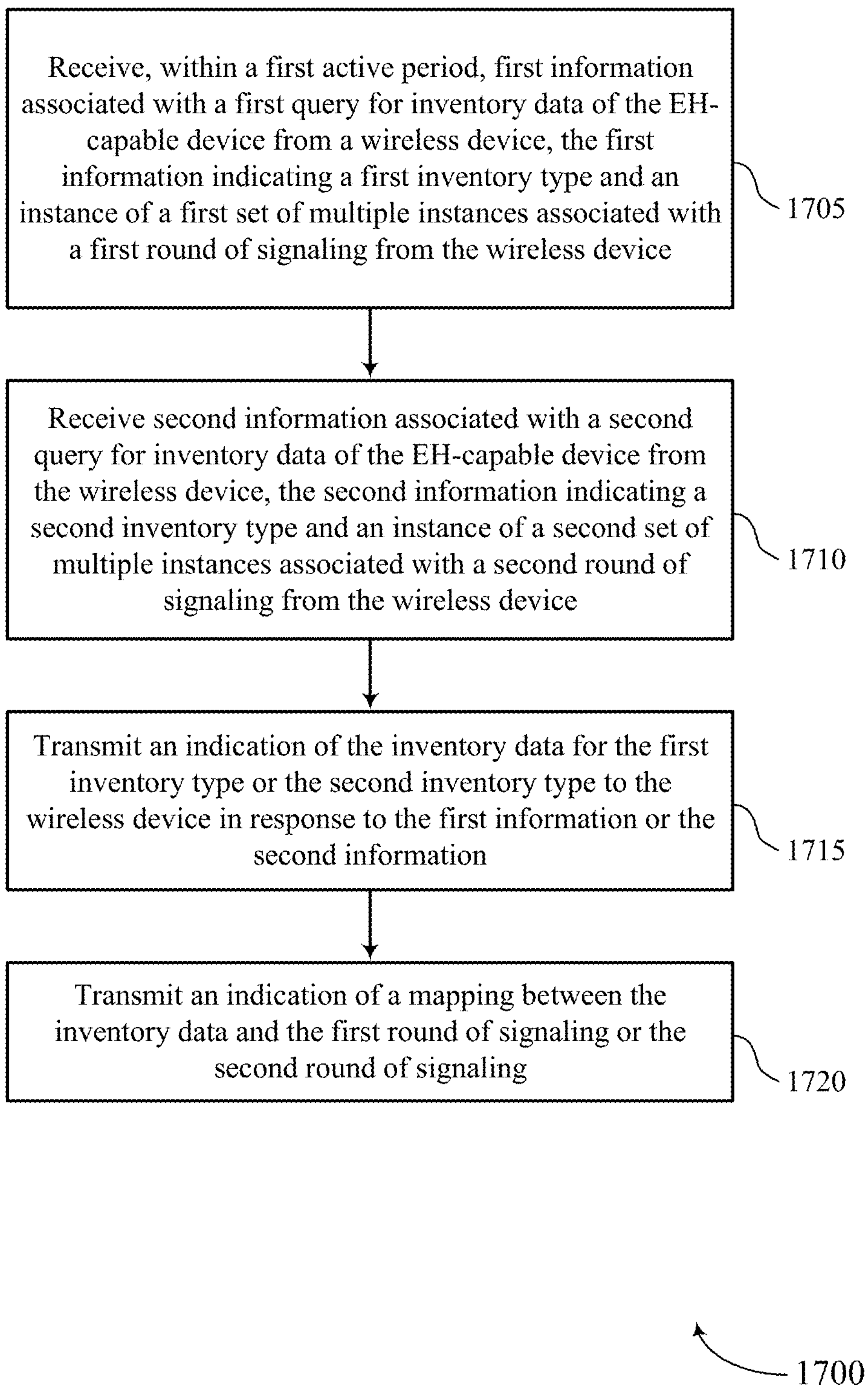

Receive, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device
1705
Receive second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device
1710
Transmit an indication of the inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information
1715
Transmit an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling
1720
1700

FIG. 17

SIGNAL ROUNDS FOR ENERGY HARVESTING-CAPABLE DEVICES

CROSS REFERENCE

[0001] The present Application for Patent claims the benefit of Provisional Patent Application No. 63/553,327 by GUPTA et al., entitled "SIGNAL ROUNDS FOR AMBIENT INTERNET OF THINGS DEVICES," filed Feb. 14, 2024, which is assigned to the assignee hereof and is expressly incorporated by reference herein.

TECHNICAL FIELD

[0002] The following relates to wireless communications, including signal rounds for energy harvesting-capable devices.

BACKGROUND

[0003] Wireless communications systems are widely deployed to provide various types of communication content such as voice, video, packet data, messaging, broadcast, and so on. These systems may be capable of supporting communication with multiple users by sharing the available system resources (e.g., time, frequency, and power). Examples of such multiple-access systems include fourth generation (4G) systems such as Long Term Evolution (LTE) systems, LTE-Advanced (LTE-A) systems, or LTE-A Pro systems, and fifth generation (5G) systems which may be referred to as New Radio (NR) systems. These systems may employ technologies such as code division multiple access (CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal FDMA (OFDMA), or discrete Fourier transform spread orthogonal frequency division multiplexing (DFT-S-OFDM). A wireless multiple-access communications system may include one or more base stations, each supporting wireless communication for communication devices, which may be known as user equipment (UE).

SUMMARY

[0004] In some of the approaches described herein, unsynchronized duty cycle-based operations at energy harvesting (EH)-capable devices (e.g., ambient Internet of Things (IoT) devices) and multiple queries in a round from a wireless device (e.g., reader) may be utilized. Some of the techniques described herein may provide approaches for efficiently multiplexing multiple queries from different inventory rounds. For example, an inventory round may include multiple signaling instances to query one or more EH-capable devices. In some approaches, rounds may be sequenced, where a second round occurs after a first round. In other approaches, queries from different rounds may be interspersed. Some approaches may include combining inventory rounds.

[0005] A method by a wireless device is described. The method may include outputting, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device, outputting second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device, and obtaining an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

[0006] A wireless device is described. The wireless device may include one or more memories storing processor executable code, and one or more processors coupled (e.g., operatively, communicatively, functionally, electronically, or electrically) with the one or more memories. The one or more processors (e.g., directly, indirectly, after pre-processing, without pre-processing) may individually or collectively be operable to execute the code to cause the wireless device to output, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device, output second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device, and obtain an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

[0007] Another wireless device is described. The wireless device may include means for outputting, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device, means for outputting second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device, and means for obtaining an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

[0008] A non-transitory computer-readable medium storing code for wireless communications at a wireless device is described. The code may include instructions executable by at least one processor (e.g., directly, indirectly, after pre-processing, without pre-processing) to output, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device, output second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device, and obtain an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

[0009] Some examples of the method, wireless devices, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for outputting the second set of multiple instances associated with the second round of signaling subsequent to the first set of multiple instances associated with the first round of signaling.

[0010] In some examples of the method, wireless devices, and non-transitory computer-readable medium described herein, outputting the second information may include operations, features, means, or instructions for outputting the second information within a second active period subsequent to the first active period and a first inactive period of the EH-capable device.

[0011] In some examples of the method, wireless devices, and non-transitory computer-readable medium described herein, outputting the second information may include operations, features, means, or instructions for outputting, between two instances of the first set of multiple instances, the second information for the instance of the second set of multiple instances.

[0012] In some examples of the method, wireless devices, and non-transitory computer-readable medium described herein, outputting the second information may include operations, features, means, or instructions for outputting the second information within the first active period and prior to a first inactive period.

[0013] In some examples of the method, wireless devices, and non-transitory computer-readable medium described herein, outputting the second information may include operations, features, means, or instructions for outputting the second information for the instance of the second set of multiple instances with the first information for the instance of the first set of multiple instances, where at least one of the second set of multiple instances may be indicated with at least one of the first set of multiple instances.

[0014] In some examples of the method, wireless devices, and non-transitory computer-readable medium described herein, at least one of the second set of multiple instances may be separate from at least one of the first set of multiple instances.

[0015] In some examples of the method, wireless devices, and non-transitory computer-readable medium described herein, the first information and the second information implicitly indicate a quantity of rounds of signaling for the first inventory type and the second inventory type.

[0016] In some examples of the method, wireless devices, and non-transitory computer-readable medium described herein, the instance of the first set of multiple instances may be indicated as an offset relative to a previous instance of the first set of multiple instances or the instance of the second set of multiple instances may be indicated as an offset relative to the first set of multiple instances.

[0017] Some examples of the method, wireless devices, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for obtaining an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling.

[0018] A method by an EH-capable device is described. The method may include receiving, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device, receiving second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device, and transmitting an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information.

[0019] An EH-capable device is described. The EH-capable device may include one or more memories storing processor executable code, and one or more processors coupled (e.g., operatively, communicatively, functionally, electronically, or electrically) with the one or more memories. The one or more processors (e.g., directly, indirectly, after pre-processing, without pre-processing) may individually or collectively be operable to execute the code to cause the EH-capable device to receive, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device, receive second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device, and transmit an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information.

[0020] Another EH-capable device is described. The EH-capable device may include means for receiving, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device, means for receiving second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device, and means for transmitting an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information.

[0021] A non-transitory computer-readable medium storing code for wireless communications at an EH-capable device is described. The code may include instructions executable by at least one processor (e.g., directly, indirectly, after pre-processing, without pre-processing) to receive, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device, receive second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device, and transmit an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information.

[0022] In some examples of the method, EH-capable devices, and non-transitory computer-readable medium described herein, receiving the second information may include operations, features, means, or instructions for receiving the second information for the instance of the second set of multiple instances, where the second set of multiple instances associated with the second round of signaling occurs subsequent to the first set of multiple instances associated with the first round of signaling.

[0023] In some examples of the method, EH-capable devices, and non-transitory computer-readable medium described herein, receiving the second information may include operations, features, means, or instructions for receiving the second information within a second active period subsequent to the first active period and a first inactive period of the EH-capable device.

[0024] In some examples of the method, EH-capable devices, and non-transitory computer-readable medium described herein, receiving the second information may include operations, features, means, or instructions for receiving, between two instances of the first set of multiple instances, the second information for the instance of the second set of multiple instances.

[0025] In some examples of the method, EH-capable devices, and non-transitory computer-readable medium described herein, receiving the second information may include operations, features, means, or instructions for receiving the second information for the instance of the second set of multiple instances with the first information for the instance of the first set of multiple instances, where at least one of the second set of multiple instances may be indicated with at least one of the first set of multiple instances.

[0026] In some examples of the method, EH-capable devices, and non-transitory computer-readable medium described herein, at least one of the second set of multiple instances may be separate from at least one of the first set of multiple instances.

[0027] In some examples of the method, EH-capable devices, and non-transitory computer-readable medium described herein, the first information and the second information implicitly indicate a quantity of rounds of signaling for the first inventory type and the second inventory type.

[0028] In some examples of the method, EH-capable devices, and non-transitory computer-readable medium described herein, the instance of the first set of multiple instances may be indicated as an offset relative to a previous instance of the first set of multiple instances or the instance of the second set of multiple instances may be indicated as an offset relative to the first set of multiple instances.

[0029] Some examples of the method, EH-capable devices, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for transmitting an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] FIG. **1** shows an example of a wireless communications system that supports signal rounds for energy harvesting (EH)-capable devices in accordance with one or more aspects of the present disclosure.

[0031] FIG. **2** shows an example of a wireless communications system that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

[0032] FIG. **3** shows an example of a wireless communications system that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

[0033] FIG. **4** shows examples of timing diagrams that support signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

[0034] FIG. **5** shows an example of a process flow that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

[0035] FIGS. **6** and **7** show block diagrams of devices that support signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

[0036] FIG. **8** shows a block diagram of a communications manager that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

[0037] FIG. **9** shows a diagram of a system including a device that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

[0038] FIGS. **10** and **11** show block diagrams of devices that support signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

[0039] FIG. **12** shows a block diagram of a communications manager that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

[0040] FIG. **13** shows a diagram of a system including a device that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

[0041] FIGS. **14** through **17** show flowcharts illustrating methods that support signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure.

DETAILED DESCRIPTION

[0042] Some wireless communications systems may support deployment of ambient Internet of Things (IoT) devices, which may include relatively low power or low complexity devices that are capable of harvesting energy from different sources, including radio frequency (RF) waves, solar energy, heat, or other ambient sources. Energy harvesting (EH)-capable devices such as ambient IoT devices may be used for applications such as inventory tracking, sensing, positioning, or command systems. For example, for command systems, EH-capable devices may be used for such applications as control of irrigations systems, dispensing medicine, or providing alerts.

[0043] Ambient IoT devices may be deployed for inventory reading or tracking. In some approaches, inventory tracking may be modeled as reading a quantity of tags per second. In an automobile factory, for example, a reader may read approximately 100 tags/s, with 1300 readers deployed to cover 600,000 square miles and approximately 800,000 tags in total. Inventory reading may be performed periodically or on-demand. For instance, in a retail set-up, inventory goods may be read every 15 minutes, or when initiated on-demand. In addition, a latency threshold may be demanded in completing an inventory round. For instance, an inventory reading may be completed within a quantity of seconds (e.g., one second in automated warehousing).

[0044] An ambient IoT device may be able to receive a reader's inventory query and respond within a specified latency constraint (e.g., X s). To conserve energy, an ambient IoT device may be in sleep mode often. Unlike some approaches for radio frequency identification (RFID), an energy harvesting rate at longer range may be demanded for ambient IoT devices (e.g., 30+ meters, which may be insufficient to sustain query decoding). In some cases, an ambient IoT device may rely on stored energy. Asynchronous operation or continuous monitoring for receiving queries at the ambient IoT device may drain stored energy. One current challenge is to specify operations for an ambient IoT tag and a reader and signaling to satisfy the inventory latency constraints and maintain energy efficiency for prolonged operation.

[0045] In some of the approaches described herein, unsynchronized duty cycle-based operations at ambient IoT devices or multiple queries in a round from a reader may be utilized. For example, some of the techniques described herein may provide approaches for efficiently multiplexing multiple queries from different inventory rounds. For example, an inventory round may include multiple signaling instances to query one or more ambient IoT devices. In some approaches, rounds may be sequenced, where a second round occurs after a first round. In other approaches, queries from different rounds may be interspersed. Some approaches may include combining inventory rounds. Some examples of the techniques described herein may be implemented or applied in contexts (e.g., a warehouse context, among other examples) where a significant quantity of devices may be utilized, or where latency and contention issues may occur.

[0046] Aspects of the disclosure are initially described in the context of wireless communications systems. Aspects of the disclosure are further illustrated by and described with reference to timing diagrams and a process flow that relate to signal rounds for EH-capable devices. Aspects of the disclosure are further illustrated by and described with reference to apparatus diagrams, system diagrams, and flowcharts that relate to signal rounds for EH-capable devices.

[0047] FIG. **1** shows an example of a wireless communications system **100** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The wireless communications system **100** may include one or more devices, such as one or more network devices (e.g., network entities **105**), one or more user equipments (UEs) **115**, and a core network **130**. In some examples, the wireless communications system **100** may be a Long Term Evolution (LTE) network, an LTE-Advanced (LTE-A) network, an LTE-A Pro network, a New Radio (NR) network, or a network operating in accordance with other systems and radio technologies, including future systems and radio technologies not explicitly mentioned herein.

[0048] The network entities **105** may be dispersed throughout a geographic area to form the wireless communications system **100** and may include devices in different forms or having different capabilities. In various examples, a network entity **105** may be referred to as a network element, a mobility element, a radio access network (RAN) node, or network equipment, among other nomenclature. In some examples, network entities **105** and UEs **115** may wirelessly communicate via communication link(s) **125** (e.g., a radio frequency (RF) access link). For example, a network entity **105** may support a coverage area **110** (e.g., a geographic coverage area) over which the UEs **115** and the network entity **105** may establish the communication link(s) **125**. The coverage area **110** may be an example of a geographic area over which a network entity **105** and a UE **115** may support the communication of signals according to one or more radio access technologies (RATs).

[0049] The UEs **115** may be dispersed throughout a coverage area **110** of the wireless communications system **100**, and each UE **115** may be stationary, or mobile, or both at different times. The UEs **115** may be devices in different forms or having different capabilities. Some example UEs **115** are illustrated in FIG. **1**. The UEs **115** described herein may be capable of supporting communications with various types of devices in the wireless communications system **100** (e.g., other wireless communication devices, including UEs **115** or network entities **105**), as shown in FIG. **1**.

[0050] As described herein, a node of the wireless communications system **100**, which may be referred to as a network node, or a wireless node, may be a network entity **105** (e.g., any network entity described herein), a UE **115** (e.g., any UE described herein), a network controller, an apparatus, a device, a computing system, one or more components, or another suitable processing entity configured to perform any of the techniques described herein. For example, a node may be a UE **115**. As another example, a node may be a network entity **105**. As another example, a first node may be configured to communicate with a second node or a third node. In one aspect of this example, the first node may be a UE **115**, the second node may be a network entity **105**, and the third node may be a UE **115**. In another aspect of this example, the first node may be a UE **115**, the second node may be a network entity **105**, and the third node may be a network entity **105**. In yet other aspects of this example, the first, second, and third nodes may be different relative to these examples. Similarly, reference to a UE **115**, network entity **105**, apparatus, device, computing system, or the like may include disclosure of the UE **115**, network entity **105**, apparatus, device, computing system, or the like being a node. For example, disclosure that a UE **115** is configured to receive information from a network entity **105** also discloses that a first node is configured to receive information from a second node.

[0051] In some examples, network entities **105** may communicate with a core network **130**, or with one another, or both. For example, network entities **105** may communicate with the core network **130** via backhaul communication link(s) **120** (e.g., in accordance with an S1, N2, N3, or other interface protocol). In some examples, network entities **105** may communicate with one another via backhaul communication link(s) **120** (e.g., in accordance with an X2, Xn, or other interface protocol) either directly (e.g., directly between network entities **105**) or indirectly (e.g., via the core network **130**). In some examples, network entities **105** may communicate with one another via a midhaul communication link **162** (e.g., in accordance with a midhaul interface protocol) or a fronthaul communication link **168** (e.g., in accordance with a fronthaul interface protocol), or any combination thereof. The backhaul communication link(s) **120**, midhaul communication links **162**, or fronthaul communication links **168** may be or include one or more wired links (e.g., an electrical link, an optical fiber link) or one or more wireless links (e.g., a radio link, a wireless optical link), among other examples or various combinations thereof. A UE **115** may communicate with the core network **130** via a communication link **155**.

[0052] One or more of the network entities **105** or network equipment described herein may include or may be referred to as a base station **140** (e.g., a base transceiver station, a radio base station, an NR base station, an access point, a radio transceiver, a NodeB, an eNodeB (eNB), a next-generation NodeB or giga-NodeB (either of which may be referred to as a gNB), a 5G NB, a next-generation eNB (ng-eNB), a Home NodeB, a Home eNodeB, or other suitable terminology). In some examples, a network entity **105** (e.g., a base station **140**) may be implemented in an aggregated (e.g., monolithic, standalone) base station architecture, which may be configured to utilize a protocol stack that is physically or logically integrated within one network entity (e.g., a network entity **105** or a single RAN node, such as a base station **140**).

[0053] In some examples, a network entity **105** may be implemented in a disaggregated architecture (e.g., a disaggregated base station architecture, a disaggregated RAN architecture), which may be configured to utilize a protocol stack that is physically or logically distributed among multiple network entities (e.g., network entities **105**), such as an integrated access and 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 **105** may include one or more of a central unit (CU), such as a CU **160**, a distributed unit (DU), such as a DU **165**, a radio unit (RU), such as an RU **170**, a RAN Intelligent Controller (RIC), such as an RIC **175** (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, such as an SMO system **180**, or any combination thereof. An RU **170** 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 **105** in a disaggregated RAN architecture may be co-located, or one or more components of the network entities **105** may be located in distributed locations (e.g., separate physical locations). In some examples, one or more of the network entities **105** 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)).

[0054] The split of functionality between a CU **160**, a DU **165**, and an RU **170** is flexible and may support different functionalities depending on which functions (e.g., network layer functions, protocol layer functions, baseband functions, RF functions, or any combinations thereof) are performed at a CU **160**, a DU **165**, or an RU **170**. For example, a functional split of a protocol stack may be employed between a CU **160** and a DU **165** such that the CU **160** may support one or more layers of the protocol stack and the DU **165** may support one or more different layers of the protocol stack. In some examples, the CU **160** may host upper protocol layer (e.g., layer 3 (L3), layer 2 (L2)) functionality and signaling (e.g., Radio Resource Control (RRC), service data adaption protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU **160** (e.g., one or more CUs) may be connected to a DU **165** (e.g., one or more DUs) or an RU **170** (e.g., one or more RUs), or some combination thereof, and the DUs **165**, RUs **170**, or both may host lower protocol layers, such as layer 1 (L1) (e.g., physical (PHY) layer) or 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**. Additionally, or alternatively, a functional split of the protocol stack may be employed between a DU **165** and an RU **170** such that the DU **165** may support one or more layers of the protocol stack and the RU **170** may support one or more different layers of the protocol stack. The DU **165** may support one or multiple different cells (e.g., via one or multiple different RUs, such as an RU **170**). In some cases, a functional split between a CU **160** and a DU **165** or between a DU **165** and an RU **170** may be within a protocol layer (e.g., some functions for a protocol layer may be performed by one of a CU **160**, a DU **165**, or an RU **170**, while other functions of the protocol layer are performed by a different one of the CU **160**, the DU **165**, or the RU **170**). A CU **160** may be functionally split further into CU control plane (CU-CP) and CU user plane (CU-UP) functions. A CU **160** may be connected to a DU **165** via a midhaul communication link **162** (e.g., F1, F1-c, F1-u), and a DU **165** may be connected to an RU **170** via a fronthaul communication link **168** (e.g., open fronthaul (FH) interface). In some examples, a midhaul communication link **162** or a fronthaul communication link **168** may be implemented in accordance with an interface (e.g., a channel) between layers of a protocol stack supported by respective network entities (e.g., one or more of the network entities **105**) that are in communication via such communication links.

[0055] In some wireless communications systems (e.g., the wireless communications system **100**), infrastructure and spectral resources for radio access may support wireless backhaul link capabilities to supplement wired backhaul connections, providing an IAB network architecture (e.g., to a core network **130**). In some cases, in an IAB network, one or more of the network entities **105** (e.g., network entities **105** or IAB node(s) **104**) may be partially controlled by each other. The IAB node(s) **104** may be referred to as a donor entity or an IAB donor. A DU **165** or an RU **170** may be partially controlled by a CU **160** associated with a network entity **105** or base station **140** (such as a donor network entity or a donor base station). The one or more donor entities (e.g., IAB donors) may be in communication with one or more additional devices (e.g., IAB node(s) **104**) via supported access and backhaul links (e.g., backhaul communication link(s) **120**). IAB node(s) **104** may include an IAB mobile termination (IAB-MT) controlled (e.g., scheduled) by one or more DUs (e.g., DUs **165**) of a coupled IAB donor. An IAB-MT may be equipped with an independent set of antennas for relay of communications with UEs **115** or may share the same antennas (e.g., of an RU **170**) of IAB node(s) **104** used for access via the DU **165** of the IAB node(s) **104** (e.g., referred to as virtual IAB-MT (vIAB-MT)). In some examples, the IAB node(s) **104** may include one or more DUs (e.g., DUs **165**) that support communication links with additional entities (e.g., IAB node(s) **104**, UEs **115**) within the relay chain or configuration of the access network (e.g., downstream). In such cases, one or more components of the disaggregated RAN architecture (e.g., the IAB node(s) **104** or components of the IAB node(s) **104**) may be configured to operate according to the techniques described herein.

[0056] For instance, an access network (AN) or RAN may include communications between access nodes (e.g., an IAB donor), IAB node(s) **104**, and one or more UEs **115**. The IAB donor may facilitate connection between the core network **130** and the AN (e.g., via a wired or wireless connection to the core network **130**). That is, an IAB donor may refer to a RAN node with a wired or wireless connection to the core network **130**. The IAB donor may include one or more of a CU **160**, a DU **165**, and an RU **170**, in which case the CU **160** may communicate with the core network **130** via an interface (e.g., a backhaul link). The IAB donor and IAB node(s) **104** may communicate via an F1 interface according to a protocol that defines signaling messages (e.g., an F1 AP protocol). Additionally, or alternatively, the CU **160** may communicate with the core network **130** via an interface, which may be an example of a portion of a backhaul link, and may communicate with other CUs (e.g., including a CU **160** associated with an alternative IAB donor) via an Xn-C interface, which may be an example of another portion of a backhaul link.

[0057] IAB node(s) **104** may refer to RAN nodes that provide IAB functionality (e.g., access for UEs **115**, wireless self-backhauling capabilities). A DU **165** may act as a distributed scheduling node towards child nodes associated with the IAB node(s) **104**, and the IAB-MT may act as a scheduled node towards parent nodes associated with IAB node(s) **104**. That is, an IAB donor may be referred to as a parent node in communication with one or more child nodes (e.g., an IAB donor may relay transmissions for UEs through other IAB node(s) **104**). Additionally, or alternatively, IAB node(s) **104** may also be referred to as parent nodes or child nodes to other IAB node(s) **104**, depending on the relay chain or configuration of the AN. The IAB-MT entity of IAB node(s) **104** may provide a Uu interface for a child IAB node (e.g., the IAB node(s) **104**) to receive signaling from a parent IAB node (e.g., the IAB node(s) **104**), and a DU interface (e.g., a DU **165**) may provide a Uu interface for a parent IAB node to signal to a child IAB node or UE **115**.

[0058] For example, IAB node(s) **104** may be referred to as parent nodes that support communications for child IAB nodes, or may be referred to as child IAB nodes associated with IAB donors, or both. An IAB donor may include a CU **160** with a wired or wireless connection (e.g., backhaul communication link(s) **120**) to the core network **130** and may act as a parent node to IAB node(s) **104**. For example, the DU **165** of an IAB donor may relay transmissions to UEs **115** through IAB node(s) **104**, or may directly signal transmissions to a UE **115**, or both. The CU **160** of the IAB donor may signal communication link establishment via an F1 interface to IAB node(s) **104**, and the IAB node(s) **104** may schedule transmissions (e.g., transmissions to the UEs **115** relayed from the IAB donor) through one or more DUs (e.g., DUs **165**). That is, data may be relayed to and from IAB node(s) **104** via signaling via an NR Uu interface to MT of IAB node(s) **104** (e.g., other IAB node(s)). Communications with IAB node(s) **104** may be scheduled by a DU **165** of the IAB donor or of IAB node(s) **104**.

[0059] In the case of the techniques described herein applied in the context of a disaggregated RAN architecture, one or more components of the disaggregated RAN architecture may be configured to support test as described herein. For example, some operations described as being performed by a UE **115** or a network entity **105** (e.g., a base station **140**) may additionally, or alternatively, be performed by one or more components of the disaggregated RAN architecture (e.g., components such as an IAB node, a DU **165**, a CU **160**, an RU **170**, an RIC **175**, an SMO system **180**).

[0060] A UE **115** may include or may be referred to as a mobile device, a wireless device, a remote device, a handheld device, or a subscriber device, or some other suitable terminology, where the "device" may also be referred to as a unit, a station, a terminal, or a client, among other examples. A UE **115** may also include or may be referred to as a personal electronic device such as a cellular phone, a personal digital assistant (PDA), a multimedia/entertainment device (e.g., a radio, a MP3 player, or a video device), a camera, a gaming device, a navigation/positioning device (e.g., GNSS (global navigation satellite system) devices based on, for example, GPS (global positioning system), Beidou, GLONASS, or Galileo, or a terrestrial-based device), a tablet computer, a laptop computer, a netbook, a smartbook, a personal computer, a smart device, a wearable device (e.g., a smart watch, smart clothing, smart glasses, virtual reality goggles, a smart wristband, smart jewelry (e.g., a smart ring, a smart bracelet)), a drone, a robot/robotic device, a vehicle, a vehicular device, a meter (e.g., parking meter, electric meter, gas meter, water meter), a monitor, a gas pump, an appliance (e.g., kitchen appliance, washing machine, dryer), a location tag, a medical/healthcare device, an implant, a sensor/actuator, a display, or any other suitable device configured to communicate via a wireless or wired medium. In some examples, a UE **115** may include or be referred to as a wireless local loop (WLL) station, an IoT device, an Internet of Everything (IoE) device, or a machine type communications (MTC) device, among other examples, which may be implemented in various objects such as appliances, vehicles, or meters, among other examples.

[0061] The UEs **115** described herein may be able to communicate with various types of devices, such as UEs **115** that may sometimes operate as relays, as well as the network entities **105** and the network equipment including macro eNBs or gNBs, small cell eNBs or gNBs, or relay base stations, among other examples, as shown in FIG. **1**.

[0062] The UEs **115** and the network entities **105** may wirelessly communicate with one another via the communication link(s) **125** (e.g., one or more access links) using resources associated with one or more carriers. The term "carrier" may refer to a set of RF spectrum resources having a defined PHY layer structure for supporting the communication link(s) **125**. For example, a carrier used for the communication link(s) **125** may include a portion of an RF spectrum band (e.g., a bandwidth part (BWP)) that is operated according to one or more PHY layer channels for a given RAT (e.g., LTE, LTE-A, LTE-A Pro, NR). Each PHY layer channel may carry acquisition signaling (e.g., synchronization signals, system information), control signaling that coordinates operation for the carrier, user data, or other signaling. The wireless communications system **100** may support communication with a UE **115** using carrier aggregation or multi-carrier operation. A UE **115** may be configured with multiple downlink component carriers and one or more uplink component carriers according to a carrier aggregation configuration. Carrier aggregation may be used with both frequency division duplexing (FDD) and time division duplexing (TDD) component carriers. Communication between a network entity **105** and other devices may refer to communication between the devices and any portion (e.g., entity, sub-entity) of a network entity **105**. For example, the terms "transmitting," "receiving," or "communicating," when referring to a network entity **105**, may refer to any portion of a network entity **105** (e.g., a base station **140**, a CU **160**, a DU **165**, a RU **170**) of a RAN communicating with another device (e.g., directly or via one or more other network entities, such as one or more of the network entities **105**).

[0063] In some examples, such as in a carrier aggregation configuration, a carrier may have acquisition signaling or control signaling that coordinates operations for other carriers. A carrier may be associated with a frequency channel (e.g., an evolved universal mobile telecommunication system terrestrial radio access (E-UTRA) absolute RF channel number (EARFCN)) and may be identified according to a channel raster for discovery by the UEs **115**. A carrier may be operated in a standalone mode, in which case initial acquisition and connection may be conducted by the UEs **115** via the carrier, or the carrier may be operated in a non-standalone mode, in which case a connection is anchored using a different carrier (e.g., of the same or a different RAT).

[0064] The communication link(s) **125** of the wireless communications system **100** may include downlink transmissions (e.g., forward link transmissions) from a network entity **105** to a UE **115**, uplink transmissions (e.g., return link transmissions) from a UE **115** to a network entity **105**, or both, among other configurations of transmissions. Carriers may carry downlink or uplink communications (e.g., in an FDD mode) or may be configured to carry downlink and uplink communications (e.g., in a TDD mode).

[0065] A carrier may be associated with a particular bandwidth of the RF spectrum and, in some examples, the carrier bandwidth may be referred to as a "system bandwidth" of the carrier or the wireless communications system **100**. For example, the carrier bandwidth may be one of a set of bandwidths for carriers of a particular RAT (e.g., 1.4, 3, 5, 10, 15, 20, 40, or 80 megahertz (MHZ)). Devices of the wireless communications system **100** (e.g., the network entities **105**, the UEs **115**, or both) may have hardware configurations that support communications using a particular carrier bandwidth or may be configurable to support communications using one of a set of carrier bandwidths. In some examples, the wireless communications system **100** may include network entities **105** or UEs **115** that support concurrent communications using carriers associated with multiple carrier bandwidths. In some examples, each served UE **115** may be configured for operating using portions (e.g., a sub-band, a BWP) or all of a carrier bandwidth.

[0066] Signal waveforms transmitted via a carrier may be made up of multiple subcarriers (e.g., using multi-carrier modulation (MCM) techniques such as orthogonal frequency division multiplexing (OFDM) or discrete Fourier transform spread OFDM (DFT-S-OFDM)). In a system employing MCM techniques, a resource element may refer to resources of one symbol period (e.g., a duration of one modulation symbol) and one subcarrier, in which case the symbol period and subcarrier spacing may be inversely related. The quantity of bits carried by each resource element may depend on the modulation scheme (e.g., the order of the modulation scheme, the coding rate of the modulation scheme, or both), such that a relatively higher quantity of resource elements (e.g., in a transmission duration) and a relatively higher order of a modulation scheme may correspond to a relatively higher rate of communication. A wireless communications resource may refer to a combination of an RF spectrum resource, a time resource, and a spatial resource (e.g., a spatial layer, a beam), and the use of multiple spatial resources may increase the data rate or data integrity for communications with a UE **115**.

[0067] One or more numerologies for a carrier may be supported, and a numerology may include a subcarrier spacing (Δf) and a cyclic prefix. A carrier may be divided into one or more BWPs having the same or different numerologies. In some examples, a UE **115** may be configured with multiple BWPs. In some examples, a single BWP for a carrier may be active at a given time and communications for the UE **115** may be restricted to one or more active BWPs.

[0068] The time intervals for the network entities **105** or the UEs **115** may be expressed in multiples of a basic time unit which may, for example, refer to a sampling period of $T_s=1/(\Delta f_{max}\cdot N_f)$ seconds, for which Δf_{max} may represent a supported subcarrier spacing, and N_f may represent a supported discrete Fourier transform (DFT) size. Time intervals of a communications resource may be organized according to radio frames each having a specified duration (e.g., 10 milliseconds (ms)). Each radio frame may be identified by a system frame number (SFN) (e.g., ranging from 0 to 1023).

[0069] Each frame may include multiple consecutively-numbered subframes or slots, and each subframe or slot may have the same duration. In some examples, a frame may be divided (e.g., in the time domain) into subframes, and each subframe may be further divided into a quantity of slots. Alternatively, each frame may include a variable quantity of slots, and the quantity of slots may depend on subcarrier spacing. Each slot may include a quantity of symbol periods (e.g., depending on the length of the cyclic prefix prepended to each symbol period). In some wireless communications systems, such as the wireless communications system **100**, a slot may further be divided into multiple mini-slots associated with one or more symbols. Excluding the cyclic prefix, each symbol period may be associated with one or more (e.g., N_f) sampling periods. The duration of a symbol period may depend on the subcarrier spacing or frequency band of operation.

[0070] A subframe, a slot, a mini-slot, or a symbol may be the smallest scheduling unit (e.g., in the time domain) of the wireless communications system **100** and may be referred to as a transmission time interval (TTI). In some examples, the TTI duration (e.g., a quantity of symbol periods in a TTI) may be variable. Additionally, or alternatively, the smallest scheduling unit of the wireless communications system **100** may be dynamically selected (e.g., in bursts of shortened TTIs (STTIs)).

[0071] Physical channels may be multiplexed for communication using a carrier according to various techniques. A physical control channel and a physical data channel may be multiplexed for signaling via a downlink carrier, for example, using one or more of time division multiplexing (TDM) techniques, frequency division multiplexing (FDM) techniques, or hybrid TDM-FDM techniques. A control region (e.g., a control resource set (CORESET)) for a physical control channel may be defined by a set of symbol periods and may extend across the system bandwidth or a subset of the system bandwidth of the carrier. One or more control regions (e.g., CORESETs) may be configured for a set of the UEs **115**. For example, one or more of the UEs **115** may monitor or search control regions for control information according to one or more search space sets, and each search space set may include one or multiple control channel candidates in one or more aggregation levels arranged in a cascaded manner. An aggregation level for a control channel candidate may refer to an amount of control channel resources (e.g., control channel elements (CCEs)) associated with encoded information for a control information format having a given payload size. Search space sets may include common search space sets configured for sending control information to UEs **115** (e.g., one or more UEs) or may include UE-specific search space sets for sending control information to a UE **115** (e.g., a specific UE).

[0072] A network entity **105** may provide communication coverage via one or more cells, for example a macro cell, a small cell, a hot spot, or other types of cells, or any combination thereof. The term "cell" may refer to a logical communication entity used for communication with a network entity **105** (e.g., using a carrier) and may be associated with an identifier for distinguishing neighboring cells (e.g., a physical cell identifier (PCID), a virtual cell identifier (VCID)). In some examples, a cell also may refer to a coverage area **110** or a portion of a coverage area **110** (e.g., a sector) over which the logical communication entity operates. Such cells may range from smaller areas (e.g., a structure, a subset of structure) to larger areas depending on various factors such as the capabilities of the network entity **105**. For example, a cell may be or include a building, a subset of a building, or exterior spaces between or overlapping with coverage areas **110**, among other examples.

[0073] A macro cell generally covers a relatively large geographic area (e.g., several kilometers in radius) and may allow unrestricted access by the UEs **115** with service subscriptions with the network provider supporting the macro cell. A small cell may be associated with a network entity **105** operating with lower power (e.g., a base station **140** operating with lower power) relative to a macro cell, and a small cell may operate using the same or different (e.g., licensed, unlicensed) frequency bands as macro cells. Small cells may provide unrestricted access to the UEs **115** with service subscriptions with the network provider or may provide restricted access to the UEs **115** having an association with the small cell (e.g., the UEs **115** in a closed subscriber group (CSG), the UEs **115** associated with users in a home or office). A network entity **105** may support one or more cells and may also support communications via the one or more cells using one or multiple component carriers.

[0074] In some examples, a carrier may support multiple cells, and different cells may be configured according to different protocol types (e.g., MTC, narrowband IoT (NB-IoT), enhanced mobile broadband (eMBB)) that may provide access for different types of devices.

[0075] In some examples, a network entity **105** (e.g., a base station **140**, an RU **170**) may be movable and therefore provide communication coverage for a moving coverage area, such as the coverage area **110**. In some examples, coverage areas **110** (e.g., different coverage areas) associated with different technologies may overlap, but the coverage areas **110** (e.g., different coverage areas) may be supported by the same network entity (e.g., a network entity **105**). In some other examples, overlapping coverage areas, such as a coverage area **110**, associated with different technologies may be supported by different network entities (e.g., the network entities **105**). The wireless communications system **100** may include, for example, a heterogeneous network in which different types of the network entities **105** support communications for coverage areas **110** (e.g., different coverage areas) using the same or different RATs.

[0076] The wireless communications system **100** may support synchronous or asynchronous operation. For synchronous operation, network entities **105** (e.g., base stations **140**) may have similar frame timings, and transmissions from different network entities (e.g., different ones of the network entities **105**) may be approximately aligned in time. For asynchronous operation, network entities **105** may have different frame timings, and transmissions from different network entities (e.g., different ones of network entities **105**) may, in some examples, not be aligned in time. The techniques described herein may be used for either synchronous or asynchronous operations.

[0077] Some UEs **115**, such as MTC or IoT devices, may be low cost or low complexity devices, and may provide for automated communication between machines (e.g., via Machine-to-Machine (M2M) communication). M2M communication or MTC may refer to data communication technologies that allow devices to communicate with one another or a network entity **105** without human intervention. In some examples, M2M communication or MTC may include communications from devices that integrate sensors or meters to measure or capture information and relay that information to a central server or application program that can make use of the information or present the information to humans interacting with the program or application. Some UEs **115** may be designed to collect information or enable automated behavior of machines. Examples of applications for MTC devices include smart metering, inventory monitoring, water level monitoring, equipment monitoring, healthcare monitoring, wildlife monitoring, weather and geological event monitoring, fleet management and tracking, remote security sensing, physical access control, and transaction-based business charging. In an aspect, techniques disclosed herein may be applicable to MTC or IoT UEs. MTC or IoT UEs may include MTC/enhanced MTC (eMTC, also referred to as CAT-M, Cat M1) UEs, NB-IoT (also referred to as CAT NB1) UEs, as well as other types of UEs. eMTC and NB-IoT may refer to future technologies that may evolve from or may be based on these technologies. For example, eMTC may include FeMTC (further eMTC), eFeMTC (enhanced further eMTC), and mMTC (massive MTC), and NB-IoT may include eNB-IoT (enhanced NB-IoT), and FeNB-IoT (further enhanced NB-IoT).

[0078] Wireless communications systems are widely deployed to provide various types of communication content such as voice, video, packet data, messaging, broadcast, and so on. These systems may be multiple-access systems capable of supporting communication with multiple users by sharing the available system resources (e.g., time, frequency, and power). A wireless network, for example a wireless local area network (WLAN), such as a Wi-Fi (e.g., Institute of Electrical and Electronics Engineers (IEEE) 802.11) network may include an access point (AP) that may communicate with one or more wireless or mobile devices. The AP may be coupled to a network, such as the Internet, and may enable a mobile device to communicate via the network (or communicate with other devices coupled to the access point). A wireless device may communicate with a network device bi-directionally. For example, in a WLAN, a device may communicate with an associated AP via downlink (e.g., the communication link from the AP to the device) and uplink (e.g., the communication link from the device to the AP). A wireless personal area network (PAN), which may include a Bluetooth connection, may provide for short range wireless connections between two or more paired wireless devices. For example, wireless devices such as cellular phones may utilize wireless PAN communications to exchange information such as audio signals with wireless headsets. Components within a wireless communication system may be coupled (for example, operatively, communicatively, functionally, electronically, and/or electrically) to each other.

[0079] Some UEs **115** may be configured to employ operating modes that reduce power consumption, such as half-duplex communications (e.g., a mode that supports one-way communication via transmission or reception, but not transmission and reception concurrently). In some examples, half-duplex communications may be performed at a reduced peak rate. Other power conservation techniques for the UEs **115** may include entering a power saving deep sleep mode when not engaging in active communications, operating using a limited bandwidth (e.g., according to narrowband communications), or a combination of these techniques. For example, some UEs **115** may be configured for operation using a narrowband protocol type that is associated with a defined portion or range (e.g., set of subcarriers or resource blocks (RBs)) within a carrier, within a guard-band of a carrier, or outside of a carrier.

[0080] The wireless communications system **100** may be configured to support ultra-reliable communications or low-latency communications, or various combinations thereof. For example, the wireless communications system **100** may be configured to support ultra-reliable low-latency communications (URLLC). The UEs **115** may be designed to support ultra-reliable, low-latency, or critical functions. Ultra-reliable communications may include private communication or group communication and may be supported by one or more services such as push-to-talk, video, or data. Support for ultra-reliable, low-latency functions may include prioritization of services, and such services may be used for public safety or general commercial applications. The terms ultra-reliable, low-latency, and ultra-reliable low-latency may be used interchangeably herein.

[0081] In some examples, a UE **115** may be configured to support communicating directly with other UEs (e.g., one or more of the UEs **115**) via a device-to-device (D2D) communication link, such as a D2D communication link **135** (e.g., in accordance with a peer-to-peer (P2P), D2D, or sidelink protocol). In some examples, one or more UEs **115** of a group that are performing D2D communications may be within the coverage area **110** of a network entity **105** (e.g., a base station **140**, an RU **170**), which may support aspects of such D2D communications being configured by (e.g., scheduled by) the network entity **105**. In some examples, one or more UEs **115** of such a group may be outside the coverage area **110** of a network entity **105** or may be otherwise unable to or not configured to receive transmissions from a network entity **105**. In some examples, groups of the UEs **115** communicating via D2D communications may support a one-to-many (1:M) system in which each UE **115** transmits to one or more of the UEs **115** in the group. In some examples, a network entity **105** may facilitate the scheduling of resources for D2D communications. In some other examples, D2D communications may be carried out between the UEs **115** without an involvement of a network entity **105**.

[0082] In some systems, a D2D communication link **135** may be an example of a communication channel, such as a sidelink communication channel, between vehicles (e.g., UEs **115**). In some examples, vehicles may communicate using vehicle-to-everything (V2X) communications, vehicle-to-vehicle (V2V) communications, or some combination of these. A vehicle may signal information related to traffic conditions, signal scheduling, weather, safety, emergencies, or any other information relevant to a V2X system. In some examples, vehicles in a V2X system may communicate with roadside infrastructure, such as roadside units, or with the network via one or more network nodes (e.g., network entities **105**, base stations **140**, RUs **170**) using vehicle-to-network (V2N) communications, or with both.

[0083] The core network **130** may provide user authentication, access authorization, tracking, Internet Protocol (IP) connectivity, and other access, routing, or mobility functions. The core network **130** may be an evolved packet core (EPC) or 5G core (5GC), which may include at least one control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management function (AMF)) and at least one 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)). The control plane entity may manage non-access stratum (NAS) functions such as mobility, authentication, and bearer management for the UEs **115** served by the network entities **105** (e.g., base stations **140**) associated with the core network **130**. User IP packets may be transferred through the user plane entity, which may provide IP address allocation as well as other functions. The user plane entity may be connected to IP services **150** for one or more network operators. The IP services **150** may include access to the Internet, Intranet(s), an IP Multimedia Subsystem (IMS), or a Packet-Switched Streaming Service.

[0084] The wireless communications system **100** may operate using one or more frequency bands, which may be in the range of 300 megahertz (MHz) to 300 gigahertz (GHz). Generally, the region from 300 MHz to 3 GHz is known as the ultra-high frequency (UHF) region or decimeter band because the wavelengths range from approximately one decimeter to one meter in length. UHF waves may be blocked or redirected by buildings and environmental features, which may be referred to as clusters, but the waves may penetrate structures sufficiently for a macro cell to provide service to the UEs **115** located indoors. Communications using UHF waves may be associated with smaller antennas and shorter ranges (e.g., less than one hundred kilometers) compared to communications using the smaller frequencies and longer waves of the high frequency (HF) or very high frequency (VHF) portion of the spectrum below 300 MHz.

[0085] The wireless communications system **100** may also operate using a super high frequency (SHF) region, which may be in the range of 3 GHz to 30 GHz, also known as the centimeter band, or using an extremely high frequency (EHF) region of the spectrum (e.g., from 30 GHz to 300 GHz), also known as the millimeter band. In some examples, the wireless communications system **100** may support millimeter wave (mmW) communications between the UEs **115**

and the network entities **105** (e.g., base stations **140**, RUs **170**), and EHF antennas of the respective devices may be smaller and more closely spaced than UHF antennas. In some examples, such techniques may facilitate using antenna arrays within a device. The propagation of EHF transmissions, however, may be subject to even greater attenuation and shorter range than SHF or UHF transmissions. The techniques disclosed herein may be employed across transmissions that use one or more different frequency regions, and designated use of bands across these frequency regions may differ by country or regulating body.

[0086] The wireless communications system **100** may utilize both licensed and unlicensed RF spectrum bands. For example, the wireless communications system **100** may employ License Assisted Access (LAA), LTE-Unlicensed (LTE-U) RAT, or NR technology using an unlicensed band such as the 5 GHz industrial, scientific, and medical (ISM) band. While operating using unlicensed RF spectrum bands, devices such as the network entities **105** and the UEs **115** may employ carrier sensing for collision detection and avoidance. In some examples, operations using unlicensed bands may be based on a carrier aggregation configuration in conjunction with component carriers operating using a licensed band (e.g., LAA). Operations using unlicensed spectrum may include downlink transmissions, uplink transmissions, P2P transmissions, or D2D transmissions, among other examples.

[0087] A network entity **105** (e.g., a base station **140**, an RU **170**) or a UE **115** may be equipped with multiple antennas, which may be used to employ techniques such as transmit diversity, receive diversity, multiple-input multiple-output (MIMO) communications, or beamforming. The antennas of a network entity **105** or a UE **115** may be located within one or more antenna arrays or antenna panels, which may support MIMO operations or transmit or receive beamforming. For example, one or more base station antennas or antenna arrays may be co-located at an antenna assembly, such as an antenna tower. In some examples, antennas or antenna arrays associated with a network entity **105** may be located at diverse geographic locations. A network entity **105** may include an antenna array with a set of rows and columns of antenna ports that the network entity **105** may use to support beamforming of communications with a UE **115**. Likewise, a UE **115** may include one or more antenna arrays that may support various MIMO or beamforming operations. Additionally, or alternatively, an antenna panel may support RF beamforming for a signal transmitted via an antenna port.

[0088] The network entities **105** or the UEs **115** may use MIMO communications to exploit multipath signal propagation and increase spectral efficiency by transmitting or receiving multiple signals via different spatial layers. Such techniques may be referred to as spatial multiplexing. The multiple signals may, for example, be transmitted by the transmitting device via different antennas or different combinations of antennas. Likewise, the multiple signals may be received by the receiving device via different antennas or different combinations of antennas. Each of the multiple signals may be referred to as a separate spatial stream and may carry information associated with the same data stream (e.g., the same codeword) or different data streams (e.g., different codewords). Different spatial layers may be associated with different antenna ports used for channel measurement and reporting. MIMO techniques include single-user MIMO (SU-MIMO), for which multiple spatial layers are transmitted to the same receiving device, and multiple-user MIMO (MU-MIMO), for which multiple spatial layers are transmitted to multiple devices.

[0089] Beamforming, which may also be referred to as spatial filtering, directional transmission, or directional reception, is a signal processing technique that may be used at a transmitting device or a receiving device (e.g., a network entity **105**, a UE **115**) to shape or steer an antenna beam (e.g., a transmit beam, a receive beam) along a spatial path between the transmitting device and the receiving device. Beamforming may be achieved by combining the signals communicated via antenna elements of an antenna array such that some signals propagating along particular orientations with respect to an antenna array experience constructive interference while others experience destructive interference. The adjustment of signals communicated via the antenna elements may include a transmitting device or a receiving device applying amplitude offsets, phase offsets, or both to signals carried via the antenna elements associated with the device. The adjustments associated with each of the antenna elements may be defined by a beamforming weight set associated with a particular orientation (e.g., with respect to the antenna array of the transmitting device or receiving device, or with respect to some other orientation).

[0090] A network entity **105** or a UE **115** may use beam sweeping techniques as part of beamforming operations. For example, a network entity **105** (e.g., a base station **140**, an RU **170**) may use multiple antennas or antenna arrays (e.g., antenna panels) to conduct beamforming operations for directional communications with a UE **115**. Some signals (e.g., synchronization signals, reference signals, beam selection signals, or other control signals) may be transmitted by a network entity **105** multiple times along different directions. For example, the network entity **105** may transmit a signal according to different beamforming weight sets associated with different directions of transmission. Transmissions along different beam directions may be used to identify (e.g., by a transmitting device, such as a network entity **105**, or by a receiving device, such as a UE **115**) a beam direction for later transmission or reception by the network entity **105**.

[0091] Some signals, such as data signals associated with a particular receiving device, may be transmitted by a transmitting device (e.g., a network entity **105** or a UE **115**) along a single beam direction (e.g., a direction associated with the receiving device, such as another network entity **105** or UE **115**). In some examples, the beam direction associated with transmissions along a single beam direction may be determined based on a signal that was transmitted along one or more beam directions. For example, a UE **115** may receive one or more of the signals transmitted by the network entity **105** along different directions and may report to the network entity **105** an indication of the signal that the UE **115** received with a highest signal quality or an otherwise acceptable signal quality.

[0092] In some examples, transmissions by a device (e.g., by a network entity **105** or a UE **115**) may be performed using multiple beam directions, and the device may use a combination of digital precoding or beamforming to generate a combined beam for transmission (e.g., from a network entity **105** to a UE **115**). The UE **115** may report feedback that indicates precoding weights for one or more beam directions, and the feedback may correspond to a configured set of beams across a system bandwidth or one or more sub-bands. The network entity **105** may transmit a reference signal (e.g., a cell-specific reference signal (CRS), a channel state information reference signal (CSI-RS)), which may be precoded or unprecoded. The UE **115** may provide feedback for beam selection, which may be a precoding matrix indicator (PMI) or codebook-based feedback (e.g., a multi-panel type codebook, a linear combination type codebook, a port selection type codebook). Although these techniques are described with reference to signals transmitted along one or more directions by a network entity **105** (e.g., a base station **140**, an RU **170**), a UE **115** may employ similar techniques for transmitting signals multiple times along different directions (e.g., for identifying a beam direction for subsequent transmission or reception by the UE **115**) or for transmitting a signal along a single direction (e.g., for transmitting data to a receiving device).

[0093] A receiving device (e.g., a UE **115**) may perform reception operations in accordance with multiple receive configurations (e.g., directional listening) when receiving various signals from a transmitting device (e.g., a network entity **105**), such as synchronization signals, reference signals, beam selection signals, or other control signals. For example, a receiving device may perform reception in accordance with multiple receive directions by receiving via different antenna subarrays, by processing received signals according to different antenna subarrays, by receiving according to different receive beamforming weight sets (e.g., different directional listening weight sets) applied to signals received at multiple antenna elements of an antenna array, or by processing received signals according to different receive beamforming weight sets applied to signals received at multiple antenna elements of an antenna array, any of which may be referred to as "listening" according to different receive configurations or receive directions. In some examples, a receiving device may use a single receive configuration to receive along a single beam direction (e.g., when receiving a data signal). The single receive configuration may be aligned along a beam direction determined based on listening according to different receive configuration directions (e.g., a beam direction determined to have a highest signal strength, highest signal-to-noise ratio (SNR), or otherwise acceptable signal quality based on listening according to multiple beam directions).

[0094] The wireless communications system **100** may be a packet-based network that operates according to a layered protocol stack. In the user plane, communications at the bearer or PDCP layer may be IP-based. An RLC layer may perform packet segmentation and reassembly to communicate via logical channels. A MAC layer may perform priority handling and multiplexing of logical channels into transport channels. The MAC layer also may implement error detection techniques, error correction techniques, or both to support retransmissions to improve link efficiency. In the control plane, an RRC layer may provide establishment, configuration, and maintenance of an RRC connection between a UE **115** and a network entity **105** or a core network **130** supporting radio bearers for user plane data. A PHY layer may map transport channels to physical channels.

[0095] The UEs **115** and the network entities **105** may support retransmissions of data to increase the likelihood that data is received successfully. Hybrid automatic repeat request (HARQ) feedback is one technique for increasing the likelihood that data is received correctly via a communication link (e.g., the communication link(s) **125**, a D2D communication link **135**). HARQ may include a combination of error detection (e.g., using a cyclic redundancy check (CRC)), forward error correction (FEC), and retransmission (e.g., automatic repeat request (ARQ)). HARQ may improve throughput at the MAC layer in relatively poor radio conditions (e.g., low signal-to-noise conditions). In some examples, a device may support same-slot HARQ feedback, in which case the device may provide HARQ feedback in a specific slot for data received via a previous symbol in the slot. In some other examples, the device may provide HARQ feedback in a subsequent slot, or according to some other time interval.

[0096] Some wireless communications systems may support deployment of ambient IoT devices, which may include relatively low power or low complexity devices that are capable of harvesting energy from different sources, including RF waves, solar energy, heat, or other ambient sources. EH-capable devices such as ambient IoT devices may be used for applications such as inventory tracking, sensing, positioning, or command systems. For example, for command systems, EH-capable devices may be used for such applications as control of irrigations systems, dispensing medicine, or providing alerts. In some aspects, one or more UEs **115** may be EH-capable devices.

[0097] Ambient IoT devices may be deployed for inventory reading or tracking. In some approaches, inventory tracking may be modeled as reading a quantity of tags per second. In an automobile factory, for example, a reader (e.g., a network entity **105** or a UE **115**) may read approximately 100 tags/s, with 1300 readers deployed to cover 600,000 square miles and approximately 800,000 tags in total. Inventory reading may be performed periodically or on-demand. For instance, in a retail set-up, inventory goods may be read every 15 minutes, or when initiated on-demand. In addition, a latency threshold may be demanded in completing an inventory round. For instance, an inventory reading may be completed within a quantity of seconds (e.g., one second in automated warehousing).

[0098] An ambient IoT device may be able to receive a reader's inventory query and respond within a specified latency constraint (e.g., X s). To conserve energy, an ambient IoT device may be in sleep mode often. Unlike some approaches for RFID, an energy harvesting rate at longer range may be demanded for ambient IoT devices (e.g., 30+ meters, which may be insufficient to sustain query decoding). In some cases, an ambient IoT device may rely on stored energy. Asynchronous operation or continuous monitoring for receiving queries at the ambient IoT device may drain stored energy. One current challenge is to specify operations for an ambient IoT tag and a reader and signaling to satisfy the inventory latency constraints and maintain energy efficiency for prolonged operation.

[0099] In some of the approaches described herein, unsynchronized duty cycle-based operations at ambient IoT devices or multiple queries in a round from a reader (e.g., network entity **105** or UE **115**) may be utilized. For example, some of the techniques described herein may provide approaches for efficiently multiplexing multiple queries from different inventory rounds. For example, an inventory round may include multiple signaling instances to query one or more ambient IoT devices. In some approaches, rounds may be sequenced, where a second round occurs after a first round. In other approaches, queries from different rounds may be interspersed. Some approaches may include combining inventory rounds. Some examples of the techniques described herein may be implemented or applied in contexts (e.g., a warehouse context, among other examples) where a significant quantity of devices may be utilized, or where latency and contention issues may occur.

[0100] FIG. **2** shows an example of a wireless communications system **200** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The wireless communications system **200** may implement aspects of the wireless communications system **100**.

[0101] The wireless communications system **200** may include a wireless device **205**. In some approaches, the wireless device **205** may be an example of a UE **115** or a network entity **105** as described herein. The wireless device **205** may be referred to as a wireless communication device. In some aspects, the wireless device **205** may be an example of an energy transfer device or an RFID reader. The wireless communications system **200** may include an EH-capable device **210**. In some examples, the EH-capable device **210** may be a UE **115** as described herein. The EH-capable device **210** may be capable of performing backscattering based communication. In some examples, the EH-capable device **210** may be an example of an IoT device, an ambient IoT device, an RFID tag, or any combination thereof. EH-capable devices may harvest energy over the air (e.g., via reception of an interrogating signal **215**). In response to the interrogating signal **215** (e.g., using the energy of the interrogating signal **215**), power transmission/reception circuitry **225** may transmit a responsive signal **220**. Responsive signals **220** transmitted by RFID devices may be backscatter modulated (e.g., referred to as backscatter responses). In some examples, RFID devices may be semi-passive or active and may include an energy storage device (e.g., a battery). In some examples, a wireless communications system may support a bistatic structure, where one network device (e.g., the wireless device **205**) transmits an energy transfer signal (e.g., the interrogating signal **215**) to the EH-capable device **210** and another network device may receive the responsive signal **220** (e.g., may communicate with the EH-capable device).

[0102] EH-capable devices may be passive, semi-passive, or active. Table 1 below shows characteristics of passive, semi-passive, and active EH-capable devices. Example applications for passive EH-capable devices include access or proximity cards. Example applications for semi-passive EH-capable devices include electronic tolls or pallet tracking. Example applications for active EH-capable devices include large asset tracking or livestock tracking.

TABLE 1

EH-Capable Device Type	Passive	Semi-Passive	Active
Power Source	Harvesting energy (e.g., RF energy, solar, heat)	Harvesting energy (e.g., RF energy, solar, heat), battery	Harvesting energy (e.g., RF energy, solar, heat), battery
Communication type	Response only	Response only	Respond or initiate
Approximate Maximum Range	10M	>100M	>100M
Relative Cost	Least expensive	More expensive	Most expensive

[0103] Passive EH-capable devices may have short range capability (e.g., less than 10 meters) due to insufficient link budget issues and poor communication reliability. For example, the maximum transmit power by the wireless device **205** may be limited for the transmission band. For example, the effective isotropic radiated power (EIRP) for the network device may be 36 decibel-milliwatts (dBm). As another example, weak reflected backscatter signal by passive EH-capable devices may limit the range of the passive EH-capable devices. As passive EH-capable devices are power limited, the reflected signal power strength is approximately inversely proportional to the fourth power of the distance

$$\frac{1}{d^4}.$$

Another issue affecting the range of passive EH-capable devices may be interference from other reader devices, other tags, or other communications systems. CRC may be used for error detection for signals involving passive EH-capable devices.

[0104] As described herein, ambient IoT devices such as the EH-capable device **210** may be used for inventory use cases in indoor or outdoor environments. For example, Table 2 shows different example use cases for indoor ambient IoT devices and parameters associated with the use cases. Table 3 shows different example use cases for outdoor ambient IoT devices and parameters associated with the use cases. Table 2 or Table 3 illustrate examples of use cases, message size (in bits), report data, a reporting period (for Table 2), latency (in seconds), positioning accuracy (in meters at 90%), device density (/100 meters squared), and moving speed (in kilometers (km) per hour (hr)). For convenience, the term "management" is abbreviated as "mgmt." in Table 2 and Table 3.

TABLE 2

Use Case	Size (bits)	Report Data	Report period (min)	Latency (s)	Position Accuracy (m at 90%)	Device Density (/100 m^2)	Speed (km/hr)
Automated warehousing	96/128	Device ID or position	—	1	2-3	—	5-10
Medical instruments inventory mgmt. and positioning	176		—	Several seconds	3-5	≥0.1	<6
Non-Public Network for logistics	—		—	—	—	—	—
Automobile manufacturing	96		—	>0.1 (>100 tags/s)	3	<150	—
Airport terminal/ shipping port	256		—	1-10	Cell level	0.01	3-10
Smart laundry	<800		—	>10	—	20	<6
Automated supply chain distribution	<800		—	>10	Indoor: 3 Outdoor: cell level	<150	—
Fresh food supply chain	<100		15	>60	—	150	3.6
End-to-end logistics	—		—	—	—	—	—
Flower auction	96		—	10	—	<130	—
Electronic shelf label	96						

TABLE 3

Use Case	Message Size (bits)	Report Data	Latency (s)	Position Accuracy (m at 90%)	Device Density (/100 m^2)	Moving speed (km/hr)
Medical instruments inventory mgmt. and positioning	176	Device ID/ position	Several seconds	3-5	≥0.1	<6
Non-Public Network for logistics	—		—	—	—	—

TABLE 3-continued

Use Case	Message Size (bits)	Report Data	Latency (s)	Position Accuracy (m at 90%)	Device Density (/100 m^2)	Moving speed (km/hr)
Airport terminal/ shipping port	256		1-10	Cell level	0.01	3-10
Automated supply chain distribution	<800		>10	Indoor: 3 Outdoor: cell level	—	—

[0105] In some examples, the wireless device **205** may be implemented with one or more of the structures, or may be implemented to perform one or more of the operations described with reference to FIG. **3**, FIG. **4**, or FIG. **5**. Additionally, or alternatively, the EH-capable device **210** may be implemented with one or more of the structures, or may be implemented to perform one or more of the operations described with reference to FIG. **3**, FIG. **4**, or FIG. **5**.

[0106] FIG. **3** shows an example of a wireless communications system **300** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The wireless communications system **300** may implement aspects of the wireless communications system **100** or the wireless communications system **200**. For example, the wireless communications system **300** includes a wireless device **205**-*a*, which may be an example of a wireless device **205** as described herein. In some cases, the wireless device **205**-*a* may be referred to as a reader or reader device. As another example, the wireless communications system **300** includes at least one EH-capable device **210**-*a*, which may be an example of an EH-capable device **210** as described herein. An electronic tag may be one example of the EH-capable device **210**-*a*.

[0107] Some examples of the techniques described herein may provide one or more inventory or command operations for one or more EH-capable devices **320** (e.g., ambient IoT device(s)). In some aspects, one or more of the EH-capable devices **320** may operate in accordance with an active period and an inactive period. For instance, an EH-capable device **210**-*a* may operate in accordance with a duty cycle, where the EH-capable device **210**-*a* is active (e.g., activated for one or more communications or one or more other operations) for a portion of the duty cycle or is inactive (e.g., deactivated from communicating or performing one or more other operations). For example, an EH-capable device may wake up periodically to communicate or perform one or more operations. In some approaches, the EH-capable device **210**-*a* may activate periodically (e.g., may wake up every X seconds) and may remain active during the active period (e.g., for Y seconds of the X seconds). In some examples, X=1 s and Y=25 ms. Other values may be utilized in some examples. The periodic operation of the EH-capable device **210**-*a* may help to reduce latency (e.g., satisfy latency targets) or enhance energy efficiency.

[0108] In some cases, an active period or an inactive period may differ between two or more of the EH-capable devices **320**. For example, the duty cycle may not be synchronized across the EH-capable devices **320**. To address the lack of synchronized active periods of the EH-capable device **320** (e.g., due to relatively large clock drifts), the wireless device **205**-*a* (e.g., reader) may output (e.g., transmit or send) multiple queries. A query may be a signal that requests, instructs, or commands a response. For instance, a query may be a signal that requests inventory data or commands an operation for an EH-capable device **210**-*a*. As used herein, a "round" may denote a set of queries or a period for communicating a set of queries.

[0109] In some examples, queries may be communicated (e.g., transmitted or received) periodically. For instance, queries may be communicated with a period of Z seconds (e.g., Z=10 ms) within a round. In some aspects, a query may be communicated within a portion (e.g., a subset) of the period of Z seconds. In some approaches, $X \geq Y \geq Z$ or another relationship may exist between X, Y, or Z. A quantity of n (e.g., n=100) queries may be communicated within a round. In some aspects, the wireless device **205**-*a* (e.g., reader) may transmit the n queries (e.g., Qi, where $1 \leq i \leq n$) in a round (e.g., in an inventory or command round). Some of the techniques described herein may provide signaling, procedures, or multiplexing for one or more queries.

[0110] In some examples, multiple rounds (e.g., inventory rounds) may be multiplexed. For instance, the wireless device **205**-*a* may output queries for multiple inventory rounds (e.g., one round for milk cartons, one round for egg cartons, or one round for dairy goods, among other examples). Multiplexing the multiple rounds may be performed in one or more approaches. In some approaches, multiple rounds may be signaled sequentially (e.g., a first inventory round followed by a second inventory round and so on), with interleaving (e.g., queries from rounds may be interspersed), or with combining (e.g., queries from different inventory types may be combined).

[0111] As used herein, ordinal terms (e.g., "first," "second," or "third," among other examples) may not necessarily indicate an order or sequence in time. In some cases, ordinal terms (e.g., "first," "second," or "third," among other examples) may indicate an order or sequence in time. While some examples are given herein in terms of "first" and "second" elements, some of the techniques described herein may be applied to more or fewer elements.

[0112] The wireless device **205**-*a* may output (e.g., transmit), within a first active period of the EH-capable device **210**-*a*, first information **305** associated with a first query for inventory data of the EH-capable device **210**-*a*. One or more of the EH-capable devices **320** (e.g., the EH-capable device **210**-*a*) may receive the first information **305**. The first information **305** may indicate a first inventory type and an instance of a first set of instances associated with a first round of signaling from the wireless device **205**-*a*. For example, the first information **305** may include a value(s), code(s), bit(s), or indicator(s) of the first inventory type. The first inventory type may be associated with (e.g., may indicate) a product, item, or category of items (e.g., milk, eggs, broccoli, hygiene products, medicines, towels, shoes, vehicle make and model, electronic components, manufacturing components, gift cards, luggage, clothing, appliances, or tools, among other examples).

[0113] The instance of the first round may be associated with a query of the first round. For example, the first information **305** may include a value(s), code(s), bit(s), or indicator(s) of the instance. In some aspects, the instance of the first round may be an indicator of a count, order, sequence, or identifier of a query in a set of queries of the first round. For example, the instance may be a quantity (e.g., 1, 2, 3, 4, . . . , n) corresponding to a query of the first round. In some aspects, the instance may indicate, to the EH-capable device **210**-*a*, which query is being signaled in a set of queries of the first round. For example, if the EH-capable device **210**-*a* enters an active state and receives the first information **305** with an instance of 19 with a product type indicating milk, the instance may indicate to the EH-capable device **210**-*a* that previous queries with instances of 1-18 were not received or that subsequent queries with instances of 20-100 will be signaled. In some approaches, the instance may enable the EH-capable device **210**-*a* to disregard later instances of queries of the first round if the EH-capable device **210**-*a* has already responded to a query of the first round or to determine the timing for an end (or beginning) of a round (e.g., of the first round or of another round).

[0114] The wireless device **205**-*a* may output (e.g., transmit) second information **310** associated with a second query for inventory data of the EH-capable device **320**. One or more of the EH-capable devices **320** (e.g., the EH-capable device **210**-*a*) may receive the second information **310**. The second information **310** may indicate a second inventory type and an instance of a second set of instances associated with a second round of signaling from the wireless device **205**-*a*. For example, the first information **305** may include a value(s), code(s), bit(s), or indicator(s) of the second inventory type. The second inventory type may be different from the first inventory type. For example, the second inventory type may be associated with (e.g., may indicate) a product, item, or category of items that is different from the first inventory type.

[0115] The instance of the second round may be associated with a query of the second round. For example, the second information **310** may include a value(s), code(s), bit(s), or indicator(s) of the instance. In some aspects, the instance of the second round may be an indicator of a count, order, sequence, or identifier of a query in a set of queries of the second round. For example, the instance may be a quantity (e.g., 1, 2, 3, 4, . . . , n) corresponding to a query of the second round. In some aspects, the instance may indicate, to the EH-capable device **210**-*a*, which query is being signaled in a set of queries of the second round. In some approaches, the instance of the second round may enable the EH-capable device **210**-*a* to disregard later instances of queries of the second round if the EH-capable device **210**-*a* has already responded to a query of the second round or to determine the timing for an end (or beginning) of a round (e.g., of the second round or of another round).

[0116] The EH-capable device **210**-*a* may transmit an indication **325** of inventory data for the first inventory type or the second inventory type to the wireless device **205**-*a* in response to the first information **305** or the second information **310**. The wireless device **205**-*a* may obtain the indication **325** from the EH-capable device **210**-*a* in response to the first information **305** or the second information **310**. For example, the EH-capable device **210**-*a* may respond to the first information **305** or to the second information **310** in a case that the EH-capable device **210**-*a* has inventory data corresponding to the inventory type indicated by the first information **305** or the second information **310** (e.g., first inventory data corresponding to a first inventory type indicated by the first information **305**, or second inventory data corresponding to a second inventory type indicated by the second information **310**).

[0117] In an example, if the EH-capable device **210**-*a* is a tag with a type (e.g., penicillin) included in (or matching) the inventory type (e.g., antibiotics) indicated by the first information **305**, but has a type (e.g., penicillin) that does not correspond to the inventory type (e.g., dairy products) indicated by the second information **310**, the EH-capable device **210**-*a* may transmit the indication **325** of the inventory data in response to the first information **305**, and may not respond to the second information **310**. In some approaches, the EH-capable device **210**-*a* may disregard or ignore one or more further instances of queries of the second round. Additionally, or alternatively, the EH-capable device **210**-*a* may disregard or ignore one or more further instances of queries of the first round after a threshold quantity of responses (e.g., 1, 2, 3, 5, 10, or 20, among other examples).

[0118] In some aspects, the wireless device **205**-*a* may multiplex the first information **305** and the second information **310**. Multiplexing the first information **305** and the second information **310** may enable reduced latency or greater communication throughput for multiple rounds (e.g., inventory types) while allowing power savings via the duty cycle of one or more of the EH-capable devices **320**.

[0119] In some aspects, the first information **305** and the second information **310** may be multiplexed sequentially. The wireless device **205**-*a* may output (e.g., transmit) the second set of instances associated with the second round of signaling subsequent to the first set of instances associated with the first round of signaling. The EH-capable device **210**-*a* may receive the second set of instances (e.g., the second round) subsequent to the first set of instances (e.g., the first round). For example, the wireless device **205**-*a* may transmit a first set of instances of a first round for milk cartons, followed by a second set of instances of a second round for eggs. While two rounds are provided in accordance with some of the examples herein, two or more rounds of signaling (e.g., two or more sets of instances) may be communicated.

[0120] In some approaches, the wireless device **205**-*a* may output (e.g., transmit) the second information **310** within a second active period subsequent to the first active period and a first inactive period of the EH-capable device **210**-*a*. For example, the first information **305** may be transmitted and received during the first active period of the EH-capable device **210**-*a*. The EH-capable device **210**-*a* may then enter a first inactive period (e.g., a sleep period). After the first active period and the first inactive period, the wireless device **205**-*a* may transmit the second information **310**, and the EH-capable device **210**-*a* may receive the second information **310**, within the second active period. In some cases, the second active period may occur at any time subsequent to the first active period and the first inactive period (e.g., 1, 2, 5, 10, or any quantity of cycles after the first inactive period). For example, the second active period (and the communication of the second information **310** for the second round) may occur after a 10th instance of the first round. In some examples, a delay in starting the second round may be any quantity of time depending on an initiation of the second round from a higher layer (e.g., the application layer).

[0121] In some cases, sequential multiplexing may allow lower complexity signaling or processing at the EH-capable devices **320** (e.g., tags) because the EH-capable devices may not concurrently track multiple rounds. Sequential multiplexing may not be feasible for some use cases due to latency constraints. An example of sequential multiplexing of instances of queries corresponding to different rounds is given with reference to FIG. **4**.

[0122] In some approaches, the wireless device **205**-*a* may employ interleaving or interspersion (e.g., TDM) for instances of queries of different rounds. For example, queries between (e.g., from different) rounds may be interspersed. The wireless device **205**-*a* may output (e.g., transmit), between two instances of the first set of instances, the second information **310** for the instance of the second set of instances. The EH-capable device **210**-*a* may receive the second information **310** for the instance of the second set of instances (e.g., a query of the second round) between two instances of the first set of instances. In multiplexing using interleaving or interspersion, the EH-capable device **210**-*a* may track multiple rounds concurrently. An example of interleaving or interspersing instances of queries corresponding to different rounds is given with reference to FIG. **4**.

[0123] In some cases, the wireless device **205**-*a* may initiate rounds when an application-level request is received (e.g., received at a lower level than the application level, such as at the MAC level or PHY level). Interspersing queries from different rounds may allow the initiation of a new round of queries within an ongoing round.

[0124] In some examples, the wireless device **205**-*a* may output the second information **310** within the first active period and prior to a first inactive period. For instance, the first information **305** and the second information **310** (or information for one or more additional rounds) may be signaled in the same active period, which may help satisfy latency constraints for multiple (e.g., all) rounds. The same active period of the EH-capable device **210**-*a* (e.g., tag) may allow instances of queries corresponding to multiple (e.g., two or more) rounds.

[0125] The wireless device **205**-*a* may multiplex the first information **305** and the second information **310** by combining rounds in some approaches. The wireless device **205**-*a* may output (e.g., transmit) the second information **310** for the instance of the second set of instances with the first information **305** for the instance of the first set of instances. One or more of the second set of instances may be one or more of the first set of instances. The EH-capable device **210**-*a* may receive the second information **310** with the first information **305**. In multiplexing by combining rounds, the EH-capable device **210**-*a* may track multiple rounds concurrently.

[0126] With combined inventory rounds, a query may include information for multiple inventory types (e.g., both milk and egg cartons). In some cases, both rounds may start together. For example, an initial query for milk can be communicated in the same instance at an initial query for egg cartons. An example of interleaving or interspersing instances of queries corresponding to different rounds is given with reference to FIG. **4**.

[0127] In some examples, combined inventory rounds may be performed asynchronously. For example, one or more of the second set of instances may overlap with one or more of the first set of instances, and one or more of the second set of instances may be separate from one or more of the first set of instances. For example, if each round lasts X seconds and the queries contain compatible information, the information from different rounds may be combined. In some approaches, one or more of the EH-capable devices **320** (e.g., tags) may determine whether to respond further after one or more responses to preceding queries in a current active period (e.g., wake-up duration). For instance, if the EH-capable device **210**-*a* has already responded to a threshold quantity of queries in the current active period, the EH-capable device **210**-*a* may not respond to further queries for the same inventory type in the current active period.

[0128] An example of a format for combined inventory rounds is given in Table 4.

TABLE 4

Quantity of Rounds = L	
Round 1	Query # of 1
Round 2	Query # of 2
.	.
.	.
.	.
Round L	Query # of L

Each instance of a combined query may indicate a round identifier and query quantity (e.g., index or number) corresponding to the round in some approaches.

[0129] In some aspects, one or more compression techniques may be utilized. For example, the round identifier may be omitted or may be indicated implicitly. The first information **305** and the second information **310** may implicitly indicate a quantity of rounds of signaling for the first inventory type and the second inventory type. For example, a quantity of query fields (e.g., query indices or numbers) in a query may implicitly indicate a quantity of rounds.

[0130] In some aspects, a query quantity (e.g., query index or number) may be relative to an offset (rather than being absolute). For example, the instance of the first set of instances may be indicated as an offset relative to a previous instance of the first set of instances. Additionally, or alternatively, the instance of the second plurality of instances may be indicated as an offset relative to the first plurality of instances. For example, an offset may be relative among rounds. If an instance of one round differs from an instance of another round by a quantity, the instance of the other round may be indicated as an offset of the quantity relative to the one round. Utilizing an offset may utilize smaller quantities (or avoid repeating relatively large quantities) by indicating instances of one round with absolute quantities and instances of one or more other rounds with offsets relative to the one round. Relatively smaller quantities may be represented with fewer bits.

[0131] In some cases, combining inventory rounds may incur a relatively small additional delay (e.g., <Z seconds, or

10 ms). Combining inventory rounds may reduce query overhead and energy consumption of the EH-capable device **210**-*a* (e.g., tag). For example, a quantity of queries may be reduced (e.g., from 2n to (n+1) for overlapping instances except **1**) due to queries being combined in overlapping instances.

[0132] In some approaches, the EH-capable device **210**-*a* may transmit an indication of a mapping between the inventory data and the signaling round (e.g., the first round of signaling or the second round of signaling). The wireless device **205**-*a* may obtain (e.g., receive) the indication of the mapping. For example, the EH-capable device **210**-*a* (e.g., tag) may transmit include an explicit mapping to one or more inventory rounds with the inventory data. In some use cases where an identifier of the EH-capable device **210**-*a* is signaled for the inventory data, combining the inventory rounds may reduce transmitted data by avoiding repetition of the identifier for multiple inventory types.

[0133] FIG. **4** shows examples of timing diagrams **400** that support signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The timing diagrams **400** may implement aspects of the wireless communications system **100**, the wireless communications system **200**, or the wireless communications system **300**. In FIG. **4**, Q1-Qn may correspond to a round of signaling (e.g., queries of a round), or E1-En may correspond to another round of signaling (e.g., queries of another round).

[0134] The first timing diagram **405** illustrates an example of sequential query multiplexing. The first timing diagram **405** illustrates a first round **420**-*a* of signaling and a second round **420**-*b* of signaling. The first round **420**-*a* of signaling may include queries **410**-*a* to **410**-*n* corresponding to a first inventory type. The second round **420**-*b* of signaling may include queries **415**-*a* to **415**-*n* corresponding to a second inventory type. In this example, three queries **410**-*a*, **410**-*b*, and **410**-*c* of the first round **420**-*a* for the first inventory type occur during a first active period **412**-*a* of an EH-capable device (e.g., EH-capable device **210**-*a*). Three queries **415**-*a*, **415**-*b*, and **415**-*c* of the second round **420**-*b* for the second inventory type occur during a second active period **412**-*b* of an EH-capable device (e.g., EH-capable device **210**-*a*). Sequential multiplexing may allow relative lower signaling or processing complexity at an EH-capable device, as the EH-capable device may not tracking multiple rounds concurrently.

[0135] The second timing diagram **425** illustrates an example of multiplexing using interleaving or interspersion. The second timing diagram **425** illustrates a first round of signaling and a second round of signaling. The first round of signaling may include queries **430**-*a* to **430**-*n* corresponding to a first inventory type. The second round of signaling may include queries **435**-*a* to **435**-*n* corresponding to a second inventory type. In this example, three queries **430**-*a*, **430**-*b*, and **430**-*c* of the first round for the first inventory type and three queries **435**-*a*, **435**-*b*, and **435**-*c* of the second round for the second inventory type occur during an active period **432** of an EH-capable device (e.g., EH-capable device **210**-*a*). Multiplexing using interleaving or interspersion may reduce latency between rounds, which may enable meeting latency constraints for multiple inventory types or rounds.

[0136] The third timing diagram **450** illustrates an example of multiplexing by combining rounds. The third timing diagram **450** illustrates a first round of signaling and a second round of signaling. The first round of signaling may include queries **460**-*a* to **460**-*n* corresponding to a first inventory type. The second round of signaling may include queries **460**-*b* to **460**-*o* corresponding to a second inventory type. In this example, three queries **460**-*a*, **460**-*b*, and **460**-*c* of the first round for the first inventory type and two queries **460**-*b* and **460**-*c* of the second round for the second inventory type occur during an active period **462** of an EH-capable device (e.g., EH-capable device **210**-*a*). Multiplexing using interleaving or interspersion may reduce latency between rounds, may reduce signaling for multiple inventory types, or may allow for one or more types of compression or implicitly signaling.

[0137] FIG. **5** shows an example of a process flow **500** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The process flow **500** may include a wireless device **205**-*b*, which may be an example of a wireless device **205** (e.g., wireless device **205**-*a*) as described herein. The process flow **500** includes a first EH-capable device **210**-*b*, a second EH-capable device **210**-*c*, and a third EH-capable device **210**-*d*, which may examples of an EH-capable device **210** (e.g., EH-capable device **210**-*a*) as described herein. In the following description of the process flow **500**, the operations between the wireless device **205**-*b* and the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d* may be transmitted in a different order than the example order shown, or the operations performed by the wireless device **205**-*b* and the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d* may be performed in different orders or at different times. Some operations may also be omitted from the process flow **500**, or other operations may be added to the process flow **500**.

[0138] At **505**-*a*, the wireless device **205**-*b* may output, to the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d*, a first instance of a first query of a first round of signaling. The first round of signaling may include queries at (e.g., instances) **505**-*a* and **505**-*b* to **505**-*n*. In the example of FIG. **5**, the first EH-capable device **210**-*b* may be within a first active period **535**-*b* when the first query is communicated (e.g., transmitted or received).

[0139] At **510**, the first EH-capable device **210**-*b* may transmit first inventory data. For example, the first query may have an inventory type corresponding to the first EH-capable device **210**-*b* and may be received within the first active period **535**-*b* of the first EH-capable device **210**-*b*. Accordingly, the first EH-capable device **210**-*b* may respond by transmitting the first inventory data. Because the second EH-capable device **210**-*c* and the third EH-capable device **210**-*d* are not active when the first query is transmitted, the second EH-capable device **210**-*c* and the third EH-capable device **210**-*d* may not respond.

[0140] At **515**-*a*, the wireless device **205**-*b* may output, to the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d*, a first instance of a second query of a second round of signaling. The second round of signaling may include queries at (e.g., instances) **515**-*a* and **515**-*b* to **515**-*n*. In the example of FIG. **5**, the second EH-capable device **210**-*c* may be within a second active period **535**-*c* when the second query is communicated (e.g., transmitted or received).

[0141] At **520**, the second EH-capable device **210**-*c* may transmit second inventory data. For example, the second query may have an inventory type corresponding to the second EH-capable device **210**-*c* and may be received within the second active period **535**-*c* of the second EH-capable device **210**-*c*. Accordingly, the second EH-capable device **210**-*c* may respond by transmitting the second inventory data. In the example of FIG. **5**, the first EH-capable device **210**-*b* may be within a first active period **535**-*b* when the second query at **515**-*a* is communicated (e.g., transmitted or received). The second inventory type may not correspond to the first EH-capable device **210**-*b*. Accordingly, the first EH-capable device **210**-*b* may not respond to the first instance of the second query.

[0142] At **525**-*a*, the wireless device **205**-*b* may output, to the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d*, a first instance of a third query of a third round of signaling. The third round of signaling may include queries at (e.g., instances) **525**-*a* and **525**-*b* to **525**-*n*. In the example of FIG. **5**, the third EH-capable device **210**-*d* may not be within a third active period **535**-*d* when the third query is transmitted. In the example of FIG. **5**, the first EH-capable device **210**-*b* may be within the first active period **535**-*b* and the second EH-capable device **210**-*c* may be within the second active period **535**-*c* when the first instance of the third query at **525**-*a* is communicated (e.g., transmitted or received). The third inventory type may not correspond to the first EH-capable device **210**-*b* or to the second EH-capable device. Accordingly, the first EH-capable device **210**-*b* and the second EH-capable device may not respond to the first instance of the third query.

[0143] At **505**-*b*, the wireless device **205**-*b* may output, to the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d*, a second instance of the first query of the first round of signaling. The first EH-capable device **210**-*b* has already responded to the first instance of the first query. Accordingly, the first EH-capable device **210**-*b* does not respond to the second instance of the first query during the first active period **535**-*b*. The second EH-capable device **210**-*c* and the third EH-capable device **210**-*d* may be inactive (e.g., within inactive periods) when the second instance of the first query is communicated (e.g., transmitted or received). Accordingly, the second EH-capable device **210**-*c* and the third EH-capable device **210**-*d* may not respond to the second instance of the first query.

[0144] At **515**-*b*, the wireless device **205**-*b* may output, to the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d*, a second instance of the second query of the second round of signaling. The first EH-capable device **210**-*b*, the second EH-capable device **210**-*c*, and the third EH-capable device **210**-*d* may be inactive (e.g., within inactive periods) when the second instance of the second query is communicated (e.g., transmitted or received). Accordingly, the first EH-capable device **210**-*b*, the second EH-capable device **210**-*c*, and the third EH-capable device **210**-*d* may not respond to the second instance of the second query.

[0145] At **525**-*b*, the wireless device **205**-*b* may output, to the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d*, a second instance of a third query of a third round of signaling. In the example of FIG. **5**, the third EH-capable device **210**-*d* is within a third active period **535**-*d* when the second instance of the third query is transmitted.

[0146] At **530**, the third EH-capable device **210**-*d* may transmit third inventory data. For example, the second instance of the third query may have an inventory type corresponding to the third EH-capable device **210**-*d* and may be received within the third active period **535**-*d* of the third EH-capable device **210**-*d*. Accordingly, the third EH-capable device **210**-*d* may respond by transmitting the third inventory data. In the example of FIG. **5**, the first EH-capable device **210**-*b* and the second EH-capable device **210**-*c* may be inactive when the second instance of the third query at **525**-*b* is communicated (e.g., transmitted or received). Accordingly, the first EH-capable device **210**-*b* and the second EH-capable device may not respond to the second instance of the third query.

[0147] At **505**-*n*, the wireless device **205**-*b* may output, to the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d*, a last (e.g., n-th) instance of the first query of the first round of signaling. At **515**-*n*, the wireless device **205**-*b* may output, to the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d*, a last (e.g., n-th) instance of the second query of the second round of signaling. At **525**-*n*, the wireless device **205**-*b* may output, to the EH-capable devices **210**-*b*, **210**-*c*, **210**-*d*, a last instance (e.g., n-th) of a third query of a third round of signaling. In the example of FIG. **5**, the first EH-capable device **210**-*b*, the second EH-capable device **210**-*c*, and the third EH-capable device **210**-*d* are inactive when the last instances of the first query, the second query, and the third query are transmitted. Accordingly, the first EH-capable device **210**-*b*, the second EH-capable device **210**-*c*, and the third EH-capable device **210**-*d* may not respond to the last instances of the first query, the second query, and the third query.

[0148] FIG. **6** shows a block diagram **600** of a device **605** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The device **605** may be an example of aspects of a wireless device (e.g., network entity **105** or UE **115**) as described herein. The device **605** may include a receiver **610**, a transmitter **615**, and a communications manager **620**. The device **605**, or one or more components of the device **605** (e.g., the receiver **610**, the transmitter **615**, the communications manager **620**), may include at least one processor, which may be coupled with at least one memory, to, individually or collectively, support or enable the described techniques. Each of these components may be in communication with one another (e.g., via one or more buses).

[0149] The receiver **610** may provide a means for obtaining (e.g., receiving, determining, identifying) information such as user data, control information, or any combination thereof (e.g., I/Q samples, symbols, packets, protocol data units, service data units) associated with various channels (e.g., control channels, data channels, information channels, channels associated with a protocol stack). Information may be passed on to other components of the device **605**. In some examples, the receiver **610** may support obtaining information by receiving signals via one or more antennas. Additionally, or alternatively, the receiver **610** may support obtaining information by receiving signals via one or more wired (e.g., electrical, fiber optic) interfaces, wireless interfaces, or any combination thereof.

[0150] The transmitter **615** may provide a means for outputting (e.g., transmitting, providing, conveying, sending) information generated by other components of the device **605**. For example, the transmitter **615** may output information such as user data, control information, or any combination thereof (e.g., I/Q samples, symbols, packets, protocol data units, service data units) associated with various channels (e.g., control channels, data channels, information channels, channels associated with a protocol stack). In some examples, the transmitter **615** may support outputting information by transmitting signals via one or more antennas. Additionally, or alternatively, the transmitter

615 may support outputting information by transmitting signals via one or more wired (e.g., electrical, fiber optic) interfaces, wireless interfaces, or any combination thereof. In some examples, the transmitter **615** and the receiver **610** may be co-located in a transceiver, which may include or be coupled with a modem.

[0151] The communications manager **620**, the receiver **610**, the transmitter **615**, or various combinations or components thereof may be examples of means for performing various aspects of signal rounds for EH-capable devices as described herein. For example, the communications manager **620**, the receiver **610**, the transmitter **615**, or various combinations or components thereof may be capable of performing one or more of the functions described herein.

[0152] In some examples, the communications manager **620**, the receiver **610**, the transmitter **615**, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include at least one of a processor, a DSP, a CPU, an ASIC, an FPGA or other programmable logic device, a microcontroller, discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting, individually or collectively, a means for performing the functions described in the present disclosure. In some examples, at least one processor and at least one memory coupled with the at least one processor may be configured to perform one or more of the functions described herein (e.g., by one or more processors, individually or collectively, executing instructions stored in the at least one memory).

[0153] Additionally, or alternatively, the communications manager **620**, the receiver **610**, the transmitter **615**, or various combinations or components thereof may be implemented in code (e.g., as communications management software) executed by at least one processor (e.g., referred to as a processor-executable code). If implemented in code executed by at least one processor, the functions of the communications manager **620**, the receiver **610**, the transmitter **615**, or various combinations or components thereof may be performed by a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, a microcontroller, or any combination of these or other programmable logic devices (e.g., configured as or otherwise supporting, individually or collectively, a means for performing the functions described in the present disclosure).

[0154] In some examples, the communications manager **620** may be configured to perform various operations (e.g., receiving, obtaining, monitoring, outputting, transmitting) using or otherwise in cooperation with the receiver **610**, the transmitter **615**, or both. For example, the communications manager **620** may receive information from the receiver **610**, send information to the transmitter **615**, or be integrated in combination with the receiver **610**, the transmitter **615**, or both to obtain information, output information, or perform various other operations as described herein.

[0155] For example, the communications manager **620** is capable of, configured to, or operable to support a means for outputting, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. The communications manager **620** is capable of, configured to, or operable to support a means for outputting second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The communications manager **620** is capable of, configured to, or operable to support a means for obtaining an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

[0156] By including or configuring the communications manager **620** in accordance with examples as described herein, the device **605** (e.g., at least one processor controlling or otherwise coupled with the receiver **610**, the transmitter **615**, the communications manager **620**, or a combination thereof) may support techniques for reduced processing, reduced power consumption, or more efficient utilization of communication resources.

[0157] FIG. **7** shows a block diagram **700** of a device **705** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The device **705** may be an example of aspects of a device **605** or a wireless device **205** as described herein. The device **705** may include a receiver **710**, a transmitter **715**, and a communications manager **720**. The device **705**, or one or more components of the device **705** (e.g., the receiver **710**, the transmitter **715**, the communications manager **720**), may include at least one processor, which may be coupled with at least one memory, to support the described techniques. Each of these components may be in communication with one another (e.g., via one or more buses).

[0158] The receiver **710** may provide a means for obtaining (e.g., receiving, determining, identifying) information such as user data, control information, or any combination thereof (e.g., I/Q samples, symbols, packets, protocol data units, service data units) associated with various channels (e.g., control channels, data channels, information channels, channels associated with a protocol stack). Information may be passed on to other components of the device **705**. In some examples, the receiver **710** may support obtaining information by receiving signals via one or more antennas. Additionally, or alternatively, the receiver **710** may support obtaining information by receiving signals via one or more wired (e.g., electrical, fiber optic) interfaces, wireless interfaces, or any combination thereof.

[0159] The transmitter **715** may provide a means for outputting (e.g., transmitting, providing, conveying, sending) information generated by other components of the device **705**. For example, the transmitter **715** may output information such as user data, control information, or any combination thereof (e.g., I/Q samples, symbols, packets, protocol data units, service data units) associated with various channels (e.g., control channels, data channels, information channels, channels associated with a protocol stack). In some examples, the transmitter **715** may support outputting information by transmitting signals via one or more antennas. Additionally, or alternatively, the transmitter **715** may support outputting information by transmitting signals via one or more wired (e.g., electrical, fiber optic) interfaces, wireless interfaces, or any combination thereof. In some examples, the transmitter **715** and the receiver **710** may be co-located in a transceiver, which may include or be coupled with a modem.

[0160] The device **705**, or various components thereof, may be an example of means for performing various aspects of signal rounds for EH-capable devices as described herein. For example, the communications manager **720** may include a query manager **725** a data manager **730**, or any combination thereof. The communications manager **720** may be an example of aspects of a communications manager **620** as described herein. In some examples, the communications manager **720**, or various components thereof, may be configured to perform various operations (e.g., receiving, obtaining, monitoring, outputting, transmitting) using or otherwise in cooperation with the receiver **710**, the transmitter **715**, or both. For example, the communications manager **720** may receive information from the receiver **710**, send information to the transmitter **715**, or be integrated in combination with the receiver **710**, the transmitter **715**, or both to obtain information, output information, or perform various other operations as described herein.

[0161] The query manager **725** is capable of, configured to, or operable to support a means for outputting, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. The query manager **725** is capable of, configured to, or operable to support a means for outputting second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The data manager **730** is capable of, configured to, or operable to support a means for obtaining an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

[0162] FIG. **8** shows a block diagram **800** of a communications manager **820** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The communications manager **820** may be an example of aspects of a communications manager **620**, a communications manager **720**, or both, as described herein. The communications manager **820**, or various components thereof, may be an example of means for performing various aspects of signal rounds for EH-capable devices as described herein. For example, the communications manager **820** may include a query manager **825**, a data manager **830**, a mapping manager **835**, or any combination thereof. Each of these components, or components or subcomponents thereof (e.g., one or more processors, one or more memories), may communicate, directly or indirectly, with one another (e.g., via one or more buses).

[0163] The query manager **825** is capable of, configured to, or operable to support a means for outputting, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. In some examples, the query manager **825** is capable of, configured to, or operable to support a means for outputting second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The data manager **830** is capable of, configured to, or operable to support a means for obtaining an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

[0164] In some examples, the query manager **825** is capable of, configured to, or operable to support a means for outputting the second set of multiple instances associated with the second round of signaling subsequent to the first set of multiple instances associated with the first round of signaling.

[0165] In some examples, to support outputting the second information, the query manager **825** is capable of, configured to, or operable to support a means for outputting the second information within a second active period subsequent to the first active period and a first inactive period of the EH-capable device.

[0166] In some examples, to support outputting the second information, the query manager **825** is capable of, configured to, or operable to support a means for outputting, between two instances of the first set of multiple instances, the second information for the instance of the second set of multiple instances.

[0167] In some examples, to support outputting the second information, the query manager **825** is capable of, configured to, or operable to support a means for outputting the second information within the first active period and prior to a first inactive period.

[0168] In some examples, to support outputting the second information, the query manager **825** is capable of, configured to, or operable to support a means for outputting the second information for the instance of the second set of multiple instances with the first information for the instance of the first set of multiple instances, where at least one of the second set of multiple instances is indicated with at least one of the first set of multiple instances.

[0169] In some examples, at least one of the second set of multiple instances is separate from at least one of the first set of multiple instances.

[0170] In some examples, the first information and the second information implicitly indicate a quantity of rounds of signaling for the first inventory type and the second inventory type.

[0171] In some examples, the instance of the first set of multiple instances is indicated as an offset relative to a previous instance of the first set of multiple instances or the instance of the second set of multiple instances is indicated as an offset relative to the first set of multiple instances.

[0172] In some examples, the mapping manager **835** is capable of, configured to, or operable to support a means for obtaining an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling.

[0173] FIG. **9** shows a diagram of a system **900** including a device **905** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The device **905** may be an example of or include components of a device **605**, a device **705**, or a wireless device as described herein. The device **905** may include components for bi-directional voice and data communications including components for transmitting and receiving communications, such as a communications manager **920**, a transceiver **910**, one or more antennas **915**, at least one memory **925**, code **930**, and at least one processor **935**. These components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more buses (e.g., a bus **940**).

[0174] In some examples, the device **905** may include an I/O controller. The I/O controller may manage input and output signals for the device **905**. The I/O controller may also manage peripherals not integrated into the device **905**. In some cases, the I/O controller may represent a physical connection or port to an external peripheral. In some cases, the I/O controller may utilize an operating system such as iOS®, ANDROID®, MS-DOS®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. Additionally, or alternatively, the I/O controller may represent or interact with a modem, a keyboard, a mouse, a touchscreen, or a similar device. In some cases, the I/O controller may be implemented as part of one or more processors, such as the at least one processor **935**. In some cases, a user may interact with the device **905** via the I/O controller or via hardware components controlled by the I/O controller.

[0175] The transceiver **910** may support bi-directional communications via wired links, wireless links, or both as described herein. In some examples, the transceiver **910** may include a wired transceiver and may communicate bi-directionally with another wired transceiver. Additionally, or alternatively, in some examples, the transceiver **910** may include a wireless transceiver and may communicate bi-directionally with another wireless transceiver. In some examples, the device **905** may include one or more antennas **915**, which may be capable of transmitting or receiving wireless transmissions (e.g., concurrently). The transceiver **910** may also include a modem to modulate signals, to provide the modulated signals for transmission (e.g., by one or more antennas **915**, by a wired transmitter), to receive modulated signals (e.g., from one or more antennas **915**, from a wired receiver), and to demodulate signals. In some implementations, the transceiver **910** may include one or more interfaces, such as one or more interfaces coupled with the one or more antennas **915** that are configured to support various receiving or obtaining operations, or one or more interfaces coupled with the one or more antennas **915** that are configured to support various transmitting or outputting operations, or a combination thereof. In some implementations, the transceiver **910** may include or be configured for coupling with one or more processors or one or more memory components that are operable to perform or support operations based on received or obtained information or signals, or to generate information or other signals for transmission or other outputting, or any combination thereof. In some implementations, the transceiver **910**, or the transceiver **910** and the one or more antennas **915**, or the transceiver **910** and the one or more antennas **915** and one or more processors or one or more memory components (e.g., the at least one processor **935**, the at least one memory **925**, or both), may be included in a chip or chip assembly that is installed in the device **905**. In some examples, the transceiver **910** may be operable to support communications via one or more communications links (e.g., communication link(s) **125**, backhaul communication link(s) **120**, a midhaul communication link **162**, a fronthaul communication link **168**).

[0176] The at least one memory **925** may include RAM, ROM, or any combination thereof. The at least one memory **925** may store computer-readable, computer-executable, or processor-executable code, such as the code **930**. The code **930** may include instructions that, when executed by one or more of the at least one processor **935**, cause the device **905** to perform various functions described herein. The code **930** may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some cases, the code **930** may not be directly executable by a processor of the at least one processor **935** but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some cases, the at least one memory **925** may include, among other things, a BIOS which may control basic hardware or software operation such as the interaction with peripheral components or devices. In some examples, the at least one processor **935** may include multiple processors and the at least one memory **925** 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 (for example, as part of a processing system).

[0177] The at least one processor **935** may include one or more intelligent hardware devices (e.g., one or more general-purpose processors, one or more DSPs, one or more central processing units (CPUs), one or more graphics processing units (GPUs), one or more neural processing units (NPUs) (also referred to as neural network processors or deep learning processors (DLPs)), one or more microcontrollers, one or more ASICs, one or more FPGAs, one or more programmable logic devices, discrete gate or transistor logic, one or more discrete hardware components, or any combination thereof). In some cases, the at least one processor **935** may be configured to operate a memory array using a memory controller. In some other cases, a memory controller may be integrated into one or more of the at least one processor **935**. The at least one processor **935** may be configured to execute computer-readable instructions stored in a memory (e.g., one or more of the at least one memory **925**) to cause the device **905** to perform various functions (e.g., functions or tasks supporting signal rounds for EH-capable devices). For example, the device **905** or a component of the device **905** may include at least one processor **935** and at least one memory **925** coupled with one or more of the at least one processor **935**, the at least one processor **935** and the at least one memory **925** configured to perform various functions described herein. The at least one processor **935** may be an example of a cloud-computing platform (e.g., one or more physical nodes and supporting software such as operating systems, virtual machines, or container instances) that may host the functions (e.g., by executing code **930**) to perform the functions of the device **905**. The at least one processor **935** may be any one or more suitable processors capable of executing scripts or instructions of one or more software programs stored in the device **905** (such as within one or more of the at least one memory **925**). In some examples, the at least one processor **935** may include multiple processors and the at least one memory **925** 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. In some examples, the at least one processor **935** may be a component of a processing system, which may refer to a system (such as a series) of machines, circuitry (including, for example, one or both of processor circuitry (which may include the at least one processor **935**) and memory circuitry (which may include the at least one memory **925**)), or components, that receives or obtains inputs and processes the inputs to produce, generate, or obtain a set of outputs. The processing system may be configured to perform one or more of the functions described herein. For example, the at least one processor **935** or a processing system including the at least one processor **935** may be configured to, configurable to, or operable to cause the device **905** to perform one or more of the functions described herein. Further, as described herein, being "configured to," being "configurable to," and being "operable to" may be used interchangeably and may be associated with a capability, when executing code stored in the at least one memory **925** or otherwise, to perform one or more of the functions described herein.

[0178] In some examples, a bus **940** may support communications of (e.g., within) a protocol layer of a protocol stack. In some examples, a bus **940** may support communications associated with a logical channel of a protocol stack (e.g., between protocol layers of a protocol stack), which may include communications performed within a component of the device **905**, or between different components of the device **905** that may be co-located or located in different locations (e.g., where the device **905** may refer to a system in which one or more of the communications manager **920**, the transceiver **910**, the at least one memory **925**, the code **930**, and the at least one processor **935** may be located in one of the different components or divided between different components).

[0179] In some examples, the communications manager **920** may manage aspects of communications with a core network **130** (e.g., via one or more wired or wireless backhaul links). For example, the communications manager **920** may manage the transfer of data communications for client devices, such as one or more UEs **115**. In some examples, the communications manager **920** may manage communications with one or more other network entities **105**, and may include a controller or scheduler for controlling communications with UEs **115** (e.g., in cooperation with the one or more other network devices). In some examples, the communications manager **920** may support an X2 interface within an LTE/LTE-A wireless communications network technology to provide communication between network entities **105**.

[0180] In some examples, the communications manager **920** or I/O controller may manage aspects of communications with one or more devices (e.g., via one or more wired or wireless links). For example, the communications manager **920** or I/O controller may manage the transfer of data communications associated with one or more devices, such as one or more EH-capable devices, UEs **115**, or network entities **105**. In some examples, the communications manager **920** may include a controller or scheduler for controlling communications with one or more devices, such as EH-capable devices, UEs **115**, or network entities **105** (e.g., in cooperation with one or more other EH-capable devices, UEs **115**, or network entities **105**). In some examples, the communications manager **920** or I/O controller may support backscattering based communication (e.g., one or more interrogating signals or responsive signals) for communication with an EH-capable device or other device.

[0181] For example, the communications manager **920** is capable of, configured to, or operable to support a means for outputting, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. The communications manager **920** is capable of, configured to, or operable to support a means for outputting second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The communications manager **920** is capable of, configured to, or operable to support a means for obtaining an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

[0182] By including or configuring the communications manager **920** in accordance with examples as described herein, the device **905** may support techniques for improved communication reliability, reduced latency, reduced power consumption, more efficient utilization of communication resources, improved coordination between devices, longer battery life, or improved utilization of processing capability.

[0183] In some examples, the communications manager **920** may be configured to perform various operations (e.g., receiving, obtaining, monitoring, outputting, transmitting) using or otherwise in cooperation with the transceiver **910**, the one or more antennas **915** (e.g., where applicable), or any combination thereof. Although the communications manager **920** is illustrated as a separate component, in some examples, one or more functions described with reference to the communications manager **920** may be supported by or performed by the transceiver **910**, one or more of the at least one processor **935**, one or more of the at least one memory **925**, the code **930**, or any combination thereof (for example, by a processing system including at least a portion of the at least one processor **935**, the at least one memory **925**, the code **930**, or any combination thereof). For example, the code **930** may include instructions executable by one or more of the at least one processor **935** to cause the device **905** to perform various aspects of signal rounds for EH-capable devices as described herein, or the at least one processor **935** and the at least one memory **925** may be otherwise configured to, individually or collectively, perform or support such operations.

[0184] FIG. **10** shows a block diagram **1000** of a device **1005** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The device **1005** may be an example of aspects of an EH-capable device (e.g., EH-capable device **210**, EH-capable device **210**-*a*, EH-capable device **210**-*b*, EH-capable device **210**-*c*, or EH-capable device **210**-*d*) as described herein. The device **1005** may include a receiver **1010**, a transmitter **1015**, and a communications manager **1020**. The device **1005**, or one or more components of the device **1005** (e.g., the receiver **1010**, the transmitter **1015**, the communications manager **1020**), may include at least one processor, which may be coupled with at least one memory, to, individually or collectively, support or enable the described techniques. Each of these components may be in communication with one another (e.g., via one or more buses).

[0185] The receiver **1010** may provide a means for receiving information such as packets, user data, control information, or any combination thereof associated with various information channels (e.g., control channels, data channels, information channels related to signal rounds for EH-capable devices). Information may be passed on to other components of the device **1005**. The receiver **1010** may utilize a single antenna or a set of multiple antennas.

[0186] The transmitter **1015** may provide a means for transmitting signals generated by other components of the device **1005**. For example, the transmitter **1015** may transmit information such as packets, user data, control information, or any combination thereof associated with various information channels (e.g., control channels, data channels, information channels related to signal rounds for EH-capable devices). In some examples, the transmitter **1015** may be co-located with a receiver **1010** in a transceiver module. The transmitter **1015** may utilize a single antenna or a set of multiple antennas.

[0187] The communications manager **1020**, the receiver **1010**, the transmitter **1015**, or various combinations or components thereof may be examples of means for performing various aspects of signal rounds for EH-capable devices as described herein. For example, the communications manager **1020**, the receiver **1010**, the transmitter **1015**, or various combinations or components thereof may be capable of performing one or more of the functions described herein.

[0188] In some examples, the communications manager **1020**, the receiver **1010**, the transmitter **1015**, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include at least one of a processor, a DSP, a CPU, an ASIC, an FPGA or other programmable logic device, a microcontroller, discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting, individually or collectively, a means for performing the functions described in the present disclosure. In some examples, at least one processor and at least one memory coupled with the at least one processor may be configured to perform one or more of the functions described herein (e.g., by one or more processors, individually or collectively, executing instructions stored in the at least one memory).

[0189] Additionally, or alternatively, the communications manager **1020**, the receiver **1010**, the transmitter **1015**, or various combinations or components thereof may be implemented in code (e.g., as communications management software) executed by at least one processor (e.g., referred to as a processor-executable code). If implemented in code executed by at least one processor, the functions of the communications manager **1020**, the receiver **1010**, the transmitter **1015**, or various combinations or components thereof may be performed by a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, a microcontroller, or any combination of these or other programmable logic devices (e.g., configured as or otherwise supporting, individually or collectively, a means for performing the functions described in the present disclosure).

[0190] In some examples, the communications manager **1020** may be configured to perform various operations (e.g., receiving, obtaining, monitoring, outputting, transmitting) using or otherwise in cooperation with the receiver **1010**, the transmitter **1015**, or both. For example, the communications manager **1020** may receive information from the receiver **1010**, send information to the transmitter **1015**, or be integrated in combination with the receiver **1010**, the transmitter **1015**, or both to obtain information, output information, or perform various other operations as described herein.

[0191] For example, the communications manager **1020** is capable of, configured to, or operable to support a means for receiving, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. The communications manager **1020** is capable of, configured to, or operable to support a means for receiving second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The communications manager **1020** is capable of, configured to, or operable to support a means for transmitting an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information.

[0192] By including or configuring the communications manager **1020** in accordance with examples as described herein, the device **1005** (e.g., at least one processor controlling or otherwise coupled with the receiver **1010**, the transmitter **1015**, the communications manager **1020**, or a combination thereof) may support techniques for reduced processing, reduced power consumption, or more efficient utilization of communication resources.

[0193] FIG. **11** shows a block diagram **1100** of a device **1105** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The device **1105** may be an example of aspects of a device **1005** or an EH-capable device **210** as described herein. The device **1105** may include a receiver **1110**, a transmitter **1115**, and a communications manager **1120**. The device **1105**, or one or more components of the device **1105** (e.g., the receiver **1110**, the transmitter **1115**, the communications manager **1120**), may include at least one processor, which may be coupled with at least one memory, to support the described techniques. Each of these components may be in communication with one another (e.g., via one or more buses).

[0194] The receiver **1110** may provide a means for receiving information such as packets, user data, control information, or any combination thereof associated with various information channels (e.g., control channels, data channels, information channels related to signal rounds for EH-capable devices). Information may be passed on to other components of the device **1105**. The receiver **1110** may utilize a single antenna or a set of multiple antennas.

[0195] The transmitter **1115** may provide a means for transmitting signals generated by other components of the device **1105**. For example, the transmitter **1115** may transmit information such as packets, user data, control information, or any combination thereof associated with various information channels (e.g., control channels, data channels, information channels related to signal rounds for EH-capable devices). In some examples, the transmitter **1115** may be co-located with a receiver **1110** in a transceiver module. The transmitter **1115** may utilize a single antenna or a set of multiple antennas.

[0196] The device **1105**, or various components thereof, may be an example of means for performing various aspects of signal rounds for EH-capable devices as described herein. For example, the communications manager **1120** may include a query component **1125** a data component **1130**, or any combination thereof. The communications manager **1120** may be an example of aspects of a communications manager **1020** as described herein. In some examples, the communications manager **1120**, or various components thereof, may be configured to perform various operations (e.g., receiving, obtaining, monitoring, outputting, transmitting) using or otherwise in cooperation with the receiver **1110**, the transmitter **1115**, or both. For example, the communications manager **1120** may receive information from the receiver **1110**, send information to the transmitter **1115**, or be integrated in combination with the receiver **1110**, the transmitter **1115**, or both to obtain information, output information, or perform various other operations as described herein.

[0197] The query component **1125** is capable of, configured to, or operable to support a means for receiving, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. The query component **1125** is capable of, configured to, or operable to support a means for receiving second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The data component **1130** is capable of, configured to, or operable to support a means for transmitting an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information.

[0198] FIG. **12** shows a block diagram **1200** of a communications manager **1220** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The communications manager **1220** may be an example of aspects of a communications manager **1020**, a communications manager **1120**, or both, as described herein. The communications manager **1220**, or various components thereof, may be an example of means for performing various aspects of signal rounds for EH-capable devices as described herein. For example, the communications manager **1220** may include a query component **1225**, a data component **1230**, a mapping component **1235**, or any combination thereof. Each of these components, or components or subcomponents thereof (e.g., one or more processors, one or more memories), may communicate, directly or indirectly, with one another (e.g., via one or more buses).

[0199] The query component **1225** is capable of, configured to, or operable to support a means for receiving, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. In some examples, the query component **1225** is capable of, configured to, or operable to support a means for receiving second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The data component **1230** is capable of, configured to, or operable to support a means for transmitting an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information.

[0200] In some examples, to support receiving the second information, the query component **1225** is capable of, configured to, or operable to support a means for receiving the second information for the instance of the second set of multiple instances, where the second set of multiple instances associated with the second round of signaling occurs subsequent to the first set of multiple instances associated with the first round of signaling.

[0201] In some examples, to support receiving the second information, the query component **1225** is capable of, configured to, or operable to support a means for receiving the second information within a second active period subsequent to the first active period and a first inactive period of the EH-capable device.

[0202] In some examples, to support receiving the second information, the query component **1225** is capable of, configured to, or operable to support a means for receiving, between two instances of the first set of multiple instances, the second information for the instance of the second set of multiple instances.

[0203] In some examples, to support receiving the second information, the query component **1225** is capable of, configured to, or operable to support a means for receiving the second information for the instance of the second set of multiple instances with the first information for the instance of the first set of multiple instances, where at least one of the second set of multiple instances is indicated with at least one of the first set of multiple instances.

[0204] In some examples, at least one of the second set of multiple instances is separate from at least one of the first set of multiple instances.

[0205] In some examples, the first information and the second information implicitly indicate a quantity of rounds of signaling for the first inventory type and the second inventory type.

[0206] In some examples, the instance of the first set of multiple instances is indicated as an offset relative to a previous instance of the first set of multiple instances or the instance of the second set of multiple instances is indicated as an offset relative to the first set of multiple instances.

[0207] In some examples, the mapping component **1235** is capable of, configured to, or operable to support a means for transmitting an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling.

[0208] FIG. **13** shows a diagram of a system **1300** including a device **1305** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The device **1305** may be an example of or include components of a device **1005**, a device **1105**, or an EH-capable device as described herein. The device **1305** may include components for bi-directional voice and data communications including components for transmitting and receiving communications, such as a communications manager **1320**, an I/O controller, such as an I/O controller **1310**, a transceiver **1315**, one or more antennas **1325**, at least one memory **1330**, code **1335**, and at least one processor **1340**. These components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more buses (e.g., a bus **1345**).

[0209] The I/O controller **1310** may manage input and output signals for the device **1305**. The I/O controller **1310** may also manage peripherals not integrated into the device **1305**. In some cases, the I/O controller **1310** may represent a physical connection or port to an external peripheral. In some cases, the I/O controller **1310** may utilize an operating system such as iOS®, ANDROID®, MS-DOS®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. Additionally, or alternatively, the I/O controller **1310** may represent or interact with a modem, a keyboard, a mouse, a touchscreen, or a similar device. In some cases, the I/O controller **1310** may be implemented as part of one or more processors, such as the at least one processor **1340**. In some cases, a user may interact with the device **1305** via the I/O controller **1310** or via hardware components controlled by the I/O controller **1310**.

[0210] In some cases, the device **1305** may include a single antenna. However, in some other cases, the device **1305** may have more than one antenna, which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver **1315** may communicate bi-directionally via the one or more antennas **1325** using wired or wireless links as described herein. For example, the transceiver **1315** may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver **1315** may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas **1325** for transmission, and to demodulate packets received from the one or more antennas **1325**. The transceiver **1315**, or the transceiver **1315** and one or more antennas **1325**, may be an example of a transmitter **1015**, a transmitter **1115**, a receiver **1010**, a receiver **1110**, or any combination thereof or component thereof, as described herein.

[0211] The at least one memory **1330** may include RAM and ROM. The at least one memory **1330** may store computer-readable, computer-executable, or processor-executable code, such as the code **1335**. The code **1335** may include instructions that, when executed by the at least one processor **1340**, cause the device **1305** to perform various functions described herein. The code **1335** may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some cases, the code **1335** may not be directly executable by the at least one processor **1340** but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some cases, the at least one memory **1330** may include, among other things, a BIOS which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0212] The at least one processor **1340** may include one or more intelligent hardware devices (e.g., one or more general-purpose processors, one or more DSPs, one or more CPUs, one or more GPUs, one or more NPUs (also referred to as neural network processors or DLPs), one or more microcontrollers, one or more ASICs, one or more FPGAs, one or more programmable logic devices, discrete gate or transistor logic, one or more discrete hardware components, or any combination thereof). In some cases, the at least one processor **1340** may be configured to operate a memory array using a memory controller. In some other cases, a memory controller may be integrated into the at least one processor **1340**. The at least one processor **1340** may be configured to execute computer-readable instructions stored in a memory (e.g., the at least one memory **1330**) to cause the device **1305** to perform various functions (e.g., functions or tasks supporting signal rounds for EH-capable devices). For example, the device **1305** or a component of the device **1305** may include at least one processor **1340** and at least one memory **1330** coupled with or to the at least one processor **1340**, the at least one processor **1340** and the at least one memory **1330** configured to perform various functions described herein. In some examples, the at least one processor **1340** may include multiple processors and the at least one memory **1330** 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 described herein. In some examples, the at least one processor **1340** may be a component of a processing system, which may refer to a system (such as a series) of machines, circuitry (including, for example, one or both of processor circuitry (which may include the at least one processor **1340**) and memory circuitry (which may include the at least one memory **1330**)), or components, that receives or obtains inputs and processes the inputs to produce, generate, or obtain a set of outputs. The processing system may be configured to perform one or more of the functions described herein. For example, the at least one processor **1340** or a processing system including the at least one processor **1340** may be configured to, configurable to, or operable to cause the device **1305** to perform one or more of the functions described herein. Further, as described herein, being "configured to," being "configurable to," and being "operable to" may be used interchangeably and may be associated with a capability, when executing code **1335** (e.g., processor-executable code) stored in the at least one memory **1330** or otherwise, to perform one or more of the functions described herein.

[0213] In some examples, the communications manager **1320** or I/O controller **1310** may manage aspects of communications with one or more devices (e.g., via one or more wired or wireless links). For example, the communications manager **1320** or I/O controller **1310** may manage the transfer of data communications associated with one or more devices, such as one or more wireless devices (e.g., one or more UEs **115** or network entities **105**). In some examples, the communications manager **1320** may include a controller or scheduler for controlling communications with one or more wireless devices, such as UEs **115** or network entities **105** (e.g., in cooperation with one or more other EH-capable devices, UEs **115**, or network entities **105**). In some examples, the communications manager **1320** or I/O controller **1310** may support backscattering based communication (e.g., one or more interrogating signals or responsive signals) for communication with a wireless device or other device.

[0214] For example, the communications manager **1320** is capable of, configured to, or operable to support a means for receiving, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. The communications manager **1320** is capable of, configured to, or operable to support a means for receiving second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The communications manager **1320** is capable of, configured to, or operable to support a means for transmitting an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information.

[0215] By including or configuring the communications manager **1320** in accordance with examples as described herein, the device **1305** may support techniques for improved communication reliability, reduced latency, reduced power consumption, more efficient utilization of communication resources, improved coordination between devices, longer battery life, or improved utilization of processing capability.

[0216] In some examples, the communications manager **1320** may be configured to perform various operations (e.g., receiving, monitoring, transmitting) using or otherwise in cooperation with the transceiver **1315**, the one or more antennas **1325**, or any combination thereof. Although the communications manager **1320** is illustrated as a separate component, in some examples, one or more functions described with reference to the communications manager **1320** may be supported by or performed by the at least one processor **1340**, the at least one memory **1330**, the code **1335**, or any combination thereof. For example, the code **1335** may include instructions executable by the at least one processor **1340** to cause the device **1305** to perform various aspects of signal rounds for EH-capable devices as described herein, or the at least one processor **1340** and the at least one memory **1330** may be otherwise configured to, individually or collectively, perform or support such operations.

[0217] FIG. **14** shows a flowchart illustrating a method **1400** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The operations of the method **1400** may be implemented by a wireless device or its components as described herein. For example, the operations of the method **1400** may be performed by a wireless device as described with reference to FIGS. **1** through **9**. In some examples, a wireless device may execute a set of instructions to control the functional elements of the wireless device to perform the described functions. Additionally, or alternatively, the wireless device may perform aspects of the described functions using special-purpose hardware.

[0218] At **1405**, the method may include outputting, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. The operations of **1405** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1405** may be performed by a query manager **825** as described with reference to FIG. **8**.

[0219] At **1410**, the method may include outputting second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The operations of **1410** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1410** may be performed by a query manager **825** as described with reference to FIG. **8**.

[0220] At **1415**, the method may include obtaining an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information. The operations of **1415** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1415** may be performed by a data manager **830** as described with reference to FIG. **8**.

[0221] FIG. **15** shows a flowchart illustrating a method **1500** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The operations of the method **1500** may be implemented by a wireless device or its components as described herein. For example, the operations of the method **1500** may be performed by a wireless device as described with reference to FIGS. **1** through **9**. In some examples, a wireless device may execute a set of instructions to control the functional elements of the wireless device to perform the described functions. Additionally, or alternatively, the wireless device may perform aspects of the described functions using special-purpose hardware.

[0222] At **1505**, the method may include outputting, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. The operations of **1505** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1505** may be performed by a query manager **825** as described with reference to FIG. **8**.

[0223] At **1510**, the method may include outputting second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The operations of **1510** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1510** may be performed by a query manager **825** as described with reference to FIG. **8**.

[0224] At **1515**, the method may include obtaining an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

The operations of **1515** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1515** may be performed by a data manager **830** as described with reference to FIG. **8**.

[0225] At **1520**, the method may include obtaining an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling. The operations of **1520** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1520** may be performed by a mapping manager **835** as described with reference to FIG. **8**.

[0226] FIG. **16** shows a flowchart illustrating a method **1600** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The operations of the method **1600** may be implemented by an EH-capable device or its components as described herein. For example, the operations of the method **1600** may be performed by an EH-capable device as described with reference to FIGS. **1** through **5** and **10** through **13**. In some examples, an EH-capable device may execute a set of instructions to control the functional elements of the EH-capable device to perform the described functions. Additionally, or alternatively, the EH-capable device may perform aspects of the described functions using special-purpose hardware.

[0227] At **1605**, the method may include receiving, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. The operations of **1605** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1605** may be performed by a query component **1225** as described with reference to FIG. **12**.

[0228] At **1610**, the method may include receiving second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The operations of **1610** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1610** may be performed by a query component **1225** as described with reference to FIG. **12**.

[0229] At **1615**, the method may include transmitting an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information. The operations of **1615** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1615** may be performed by a data component **1230** as described with reference to FIG. **12**.

[0230] FIG. **17** shows a flowchart illustrating a method **1700** that supports signal rounds for EH-capable devices in accordance with one or more aspects of the present disclosure. The operations of the method **1700** may be implemented by an EH-capable device or its components as described herein. For example, the operations of the method **1700** may be performed by an EH-capable device as described with reference to FIGS. **1** through **5** and **10** through **13**. In some examples, an EH-capable device may execute a set of instructions to control the functional elements of the EH-capable device to perform the described functions. Additionally, or alternatively, the EH-capable device may perform aspects of the described functions using special-purpose hardware.

[0231] At **1705**, the method may include receiving, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first set of multiple instances associated with a first round of signaling from the wireless device. The operations of **1705** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1705** may be performed by a query component **1225** as described with reference to FIG. **12**.

[0232] At **1710**, the method may include receiving second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second set of multiple instances associated with a second round of signaling from the wireless device. The operations of **1710** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1710** may be performed by a query component **1225** as described with reference to FIG. **12**.

[0233] At **1715**, the method may include transmitting an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information. The operations of **1715** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1715** may be performed by a data component **1230** as described with reference to FIG. **12**.

[0234] At **1720**, the method may include transmitting an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling. The operations of **1720** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1720** may be performed by a mapping component **1235** as described with reference to FIG. **12**.

[0235] The following provides an overview of aspects of the present disclosure:

[0236] Aspect 1: A method for wireless communications at a wireless device, comprising: outputting, within a first active period of an EH-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first plurality of instances associated with a first round of signaling from the wireless device; outputting second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second plurality of instances associated with a second round of signaling from the wireless device; and obtaining an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

[0237] Aspect 2: The method of aspect 1, further comprising: outputting the second plurality of instances associated with the second round of signaling subsequent to the first plurality of instances associated with the first round of signaling.

[0238] Aspect 3: The method of aspect 2, wherein outputting the second information comprises: outputting the second information within a second active period subsequent to the first active period and a first inactive period of the EH-capable device.

[0239] Aspect 4: The method of aspect 1, wherein outputting the second information comprises: outputting, between two instances of the first plurality of instances, the second information for the instance of the second plurality of instances.

[0240] Aspect 5: The method of aspect 4, wherein outputting the second information comprises: outputting the second information within the first active period and prior to a first inactive period.

[0241] Aspect 6: The method of aspect 1, wherein outputting the second information comprises: outputting the second information for the instance of the second plurality of instances with the first information for the instance of the first plurality of instances, wherein at least one of the second plurality of instances is indicated with at least one of the first plurality of instances.

[0242] Aspect 7: The method of aspect 6, wherein at least one of the second plurality of instances is separate from at least one of the first plurality of instances.

[0243] Aspect 8: The method of any of aspects 6 through 7, wherein the first information and the second information implicitly indicate a quantity of rounds of signaling for the first inventory type and the second inventory type.

[0244] Aspect 9: The method of any of aspects 6 through 8, wherein the instance of the first plurality of instances is indicated as an offset relative to a previous instance of the first plurality of instances or the instance of the second plurality of instances is indicated as an offset relative to the first plurality of instances.

[0245] Aspect 10: The method of any of aspects 1 through 9, further comprising: obtaining an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling.

[0246] Aspect 11: A method for wireless communications at an EH-capable device, comprising: receiving, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first plurality of instances associated with a first round of signaling from the wireless device; receiving second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second plurality of instances associated with a second round of signaling from the wireless device; and transmitting an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information.

[0247] Aspect 12: The method of aspect 11, wherein receiving the second information comprises: receiving the second information for the instance of the second plurality of instances, wherein the second plurality of instances associated with the second round of signaling occurs subsequent to the first plurality of instances associated with the first round of signaling.

[0248] Aspect 13: The method of aspect 12, wherein receiving the second information comprises: receiving the second information within a second active period subsequent to the first active period and a first inactive period of the EH-capable device.

[0249] Aspect 14: The method of aspect 11, wherein receiving the second information comprises: receiving, between two instances of the first plurality of instances, the second information for the instance of the second plurality of instances.

[0250] Aspect 15: The method of aspect 11, wherein receiving the second information comprises: receiving the second information for the instance of the second plurality of instances with the first information for the instance of the first plurality of instances, wherein at least one of the second plurality of instances is indicated with at least one of the first plurality of instances.

[0251] Aspect 16: The method of aspect 15, wherein at least one of the second plurality of instances is separate from at least one of the first plurality of instances.

[0252] Aspect 17: The method of any of aspects 15 through 16, wherein the first information and the second information implicitly indicate a quantity of rounds of signaling for the first inventory type and the second inventory type.

[0253] Aspect 18: The method of any of aspects 15 through 17, wherein the instance of the first plurality of instances is indicated as an offset relative to a previous instance of the first plurality of instances or the instance of the second plurality of instances is indicated as an offset relative to the first plurality of instances.

[0254] Aspect 19: The method of any of aspects 11 through 18, further comprising: transmitting an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling.

[0255] Aspect 20: A wireless device comprising one or more memories storing processor-executable code, and one or more processors coupled (e.g., operatively, communicatively, functionally, electronically, or electrically) with the one or more memories and individually or collectively operable (e.g., directly, indirectly, after pre-processing, without pre-processing) to execute the code to cause the wireless device to perform a method of any of aspects 1 through 10.

[0256] Aspect 21: A wireless device comprising at least one means for performing a method of any of aspects 1 through 10.

[0257] Aspect 22: A non-transitory computer-readable medium storing code for wireless communications at a wireless device, the code comprising instructions executable by at least one processor (e.g., directly, indirectly, after pre-processing, without pre-processing) to perform a method of any of aspects 1 through 10.

[0258] Aspect 23: An EH-capable device comprising one or more memories storing processor-executable code, and one or more processors coupled (e.g., operatively, communicatively, functionally, electronically, or electrically) with the one or more memories and individually or collectively operable (e.g., directly, indirectly, after pre-processing, without pre-processing) to execute the code to cause the EH-capable device to perform a method of any of aspects 11 through 19.

[0259] Aspect 24: An EH-capable device comprising at least one means for performing a method of any of aspects 11 through 19.

[0260] Aspect 25: A non-transitory computer-readable medium storing code for wireless communications at an EH-capable device, the code comprising instructions executable by at least one processor (e.g., directly, indirectly, after pre-processing, without pre-processing) to perform a method of any of aspects 11 through 19.

[0261] It should be noted that the methods described herein describe possible implementations. The operations and the steps may be rearranged or otherwise modified and other implementations are possible. Further, aspects from two or more of the methods may be combined.

[0262] Although aspects of an LTE, LTE-A, LTE-A Pro, or NR system may be described for purposes of example, and LTE, LTE-A, LTE-A Pro, or NR terminology may be used in much of the description, the techniques described herein are applicable beyond LTE, LTE-A, LTE-A Pro, or NR networks. For example, the described techniques may be applicable to various other wireless communications systems such as Ultra Mobile Broadband (UMB), Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDM, as well as other systems and radio technologies, including future systems and radio technologies, not explicitly mentioned herein.

[0263] 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.

[0264] The various illustrative blocks and components described in connection with the disclosure herein may be implemented or performed using a general-purpose processor, a DSP, an ASIC, a CPU, a GPU, an NPU, 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). Any functions or operations described herein as being capable of being performed by a processor may be performed by multiple processors that, individually or collectively, are capable of performing the described functions or operations.

[0265] The functions described herein may be implemented using hardware, software executed by a processor, or any combination thereof. Software shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, or functions, whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. 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 can be implemented using software executed by a processor, hardware, 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.

[0266] 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 location 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, and not limitation, non-transitory computer-readable media may include RAM, ROM, electrically erasable programmable ROM (EEPROM), flash memory, phase change 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. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of computer-readable medium. Disk and disc, as used herein, include CD, laser disc, optical disc, digital versatile disc (DVD), floppy disk, and Blu-ray disc. Disks may reproduce data magnetically, and discs may reproduce data optically using lasers. Combinations of the above are also included within the scope of computer-readable media. Any functions or operations described herein as being capable of being performed by a memory may be performed by multiple memories that, individually or collectively, are capable of performing the described functions or operations.

[0267] As used herein, including in the claims, "or" as used in a list of items (e.g., including a list of items prefaced by a phrase such as "at least one of" or "one or more of") indicates an inclusive list such that, for example, a list of at least one of A, B, or C means, e.g., A or B or C or AB or AC or BC or ABC (e.g., 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." As used herein, the term "and/or," when used in a list of two or more items, means that any one of the listed items can be employed by itself, or any combination of two or more of the listed items can be employed. For example, if a composition is described as containing components A, B, and/or C, the composition can contain A alone; B alone; C alone; A and B in combination; A and C in combination; B and C in combination; or A, B, and C in combination.

[0268] As used herein, including in the claims, the article "a" before a noun is open-ended and understood to refer to "at least one" of those nouns or "one or more" of those nouns. Thus, the terms "a," "at least one," "one or more," and "at least one of one or more" may be interchangeable. For example, if a claim recites "a component" that performs one or more functions, each of the individual functions may be performed by a single component or by any combination of multiple components. Thus, the term "a component" having characteristics or performing functions may refer to "at least one of one or more components" having a particular characteristic or performing a particular function. Subsequent reference to a component introduced with the article "a" using the terms "the" or "said" may refer to any or all of the one or more components. For example, a component introduced with the article "a" may be understood to mean "one or more components," and referring to "the component" subsequently in the claims may be understood to be equivalent to referring to "at least one of the one or more components." Similarly, subsequent reference to a component introduced as "one or more components" using the terms "the" or "said" may refer to any or all of the one or more components. For example, referring to "the one or more components" subsequently in the claims may be understood to be equivalent to referring to "at least one of the one or more components."

[0269] The term "determine" or "determining" or "identify" or "identifying" encompasses a variety of actions and, therefore, "determining" or "identifying" can include calculating, computing, processing, deriving, investigating, looking up (such as via looking up in a table, a database or another data structure), ascertaining and the like. Also, "determining" or "identifying" can include receiving (such as receiving information or signaling, e.g., receiving information or signaling for determining, receiving information or signaling for identifying), accessing (such as accessing data in a memory, or accessing information) and the like. Also, "determining" or "identifying" can include resolving, obtaining, selecting, choosing, establishing and other such similar actions.

[0270] In the appended figures, similar components or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If just the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label or other subsequent reference label.

[0271] The description set forth herein, in connection with the appended drawings, describes example configurations and does not represent all the examples that may be implemented or that are within the scope of the claims. The term "example" used herein means "serving as an example, instance, or illustration" and not "preferred" or "advantageous over other examples." The detailed description includes specific details for the purpose of providing an understanding of the described techniques. These techniques, however, may be practiced without these specific details. In some figures, known structures and devices are shown in block diagram form in order to avoid obscuring the concepts of the described examples.

[0272] 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.

What is claimed is:

1. A wireless device, comprising:

one or more memories storing processor-executable code; and

one or more processors coupled with the one or more memories and individually or collectively operable to execute the code to cause the wireless device to:

output, within a first active period of an energy harvesting (EH)-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first plurality of instances associated with a first round of signaling from the wireless device;

output second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second plurality of instances associated with a second round of signaling from the wireless device; and

obtain an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

2. The wireless device of claim **1**, wherein the one or more processors are individually or collectively further operable to execute the code to cause the wireless device to:

output the second plurality of instances associated with the second round of signaling subsequent to the first plurality of instances associated with the first round of signaling.

3. The wireless device of claim **2**, wherein, to output the second information, the one or more processors are individually or collectively operable to execute the code to cause the wireless device to:

output the second information within a second active period subsequent to the first active period and a first inactive period of the EH-capable device.

4. The wireless device of claim **1**, wherein, to output the second information, the one or more processors are individually or collectively operable to execute the code to cause the wireless device to:

output, between two instances of the first plurality of instances, the second information for the instance of the second plurality of instances.

5. The wireless device of claim **4**, wherein, to output the second information, the one or more processors are individually or collectively operable to execute the code to cause the wireless device to:

output the second information within the first active period and prior to a first inactive period.

6. The wireless device of claim **1**, wherein, to output the second information, the one or more processors are individually or collectively operable to execute the code to cause the wireless device to:

output the second information for the instance of the second plurality of instances with the first information for the instance of the first plurality of instances, wherein at least one of the second plurality of instances is indicated with at least one of the first plurality of instances.

7. The wireless device of claim **6**, wherein at least one of the second plurality of instances is separate from at least one of the first plurality of instances.

8. The wireless device of claim **6**, wherein the first information and the second information implicitly indicate a quantity of rounds of signaling for the first inventory type and the second inventory type.

9. The wireless device of claim **6**, wherein the instance of the first plurality of instances is indicated as an offset relative to a previous instance of the first plurality of instances or the instance of the second plurality of instances is indicated as an offset relative to the first plurality of instances.

10. The wireless device of claim **1**, wherein the one or more processors are individually or collectively further operable to execute the code to cause the wireless device to:

obtain an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling.

11. An energy harvesting (EH)-capable device, comprising:

one or more memories storing processor-executable code; and

one or more processors coupled with the one or more memories and individually or collectively operable to execute the code to cause the EH-capable device to:

receive, within a first active period, first information associated with a first query for inventory data of the EH-capable device from a wireless device, the first information indicating a first inventory type and an instance of a first plurality of instances associated with a first round of signaling from the wireless device;

receive second information associated with a second query for inventory data of the EH-capable device from the wireless device, the second information indicating a second inventory type and an instance of a second plurality of instances associated with a second round of signaling from the wireless device; and

transmit an indication of inventory data for the first inventory type or the second inventory type to the wireless device in response to the first information or the second information.

12. The EH-capable device of claim **11**, wherein, to receive the second information, the one or more processors are individually or collectively operable to execute the code to cause the EH-capable device to:

receive the second information for the instance of the second plurality of instances, wherein the second plurality of instances associated with the second round of signaling occurs subsequent to the first plurality of instances associated with the first round of signaling.

13. The EH-capable device of claim **12**, wherein, to receive the second information, the one or more processors are individually or collectively operable to execute the code to cause the EH-capable device to:

receive the second information within a second active period subsequent to the first active period and a first inactive period of the EH-capable device.

14. The EH-capable device of claim **11**, wherein, to receive the second information, the one or more processors are individually or collectively operable to execute the code to cause the EH-capable device to:

receive, between two instances of the first plurality of instances, the second information for the instance of the second plurality of instances.

15. The EH-capable device of claim **11**, wherein, to receive the second information, the one or more processors are individually or collectively operable to execute the code to cause the EH-capable device to:

receive the second information for the instance of the second plurality of instances with the first information for the instance of the first plurality of instances, wherein at least one of the second plurality of instances is indicated with at least one of the first plurality of instances.

16. The EH-capable device of claim **15**, wherein at least one of the second plurality of instances is separate from at least one of the first plurality of instances.

17. The EH-capable device of claim **15**, wherein the first information and the second information implicitly indicate a quantity of rounds of signaling for the first inventory type and the second inventory type.

18. The EH-capable device of claim **15**, wherein the instance of the first plurality of instances is indicated as an offset relative to a previous instance of the first plurality of instances or the instance of the second plurality of instances is indicated as an offset relative to the first plurality of instances.

19. The EH-capable device of claim **11**, wherein the one or more processors are individually or collectively further operable to execute the code to cause the EH-capable device to:

transmit an indication of a mapping between the inventory data and the first round of signaling or the second round of signaling.

20. A method for wireless communications at a wireless device, comprising:

outputting, within a first active period of an energy harvesting (EH)-capable device, first information associated with a first query for inventory data of the EH-capable device, the first information indicating a first inventory type and an instance of a first plurality of instances associated with a first round of signaling from the wireless device;

outputting second information associated with a second query for inventory data of the EH-capable device, the second information indicating a second inventory type and an instance of a second plurality of instances associated with a second round of signaling from the wireless device; and

obtaining an indication of inventory data for the first inventory type or the second inventory type from the EH-capable device in response to the first information or the second information.

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