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(71) **Applicant: QUALCOMM INCORPORATED** [US/US]; ATTN: International IP Administration, 5775 Morehouse Drive, San Diego, California 92121-1714 (US).

(72) **Inventors; and**
(71) **Applicants** *(for WS only)*: **HUANG, Yi** [CN/US]; 5775 Morehouse Drive, San Diego, California 92121-1714 (US). **SUN, Jing** [US/US]; 5775 Morehouse Drive, San Diego, California 92121-1714 (US). **XU, Changlong** [CN/CN]; 5775 Morehouse Drive, San Diego, California 92121-1714 (US). **KHOSHNEVISAN, Mostafa** [IR/US]; 5775 Morehouse Drive, San Diego, California 92121-1714 (US).

(74) **Agent: NTD PATENT & TRADEMARK AGENCY LTD.**; 10th Floor, Tower C, Beijing Global Trade Center, 36 North Third Ring Road East, Dongcheng District, Beijing 100013 (CN).

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(54) **Title:** MULTIPLEXING CONFIGURED GRANT SIGNALING AND FEEDBACK WITH DIFFERENT PRIORITIES

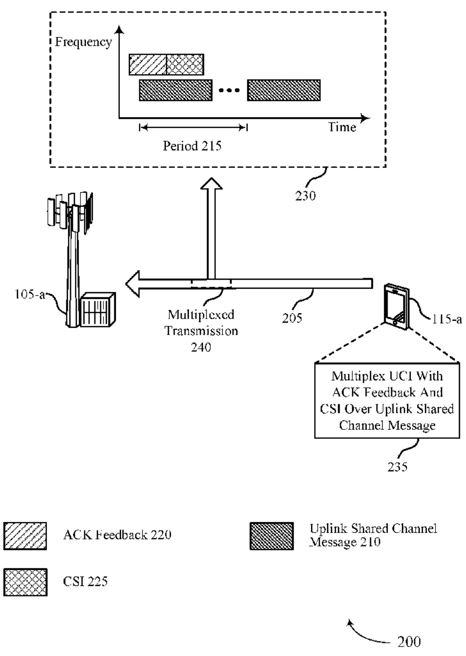

FIG. 2

(57) **Abstract:** Methods, systems, and devices for wireless communications are described. A user equipment (UE) may determine time-frequency resources allocated for an acknowledgement (ACK) feedback and channel state information (CSI) overlap with periodic resource allocation for the uplink shared channel (e.g., a configured grant-physical uplink shared channel (CG-PUSCH)). The UE may multiplex uplink control information (UCI) for the uplink shared channel with at least some of the ACK feedback, the CSI, or both over the uplink shared channel message. For example, the UE may use an encoding chain designated for multiplexing ACK feedback of a priority type of the uplink shared channel message. After the UE multiplexes the ACK feedback, the CSI, or both with the UCI, the UE may transmit the uplink shared channel message.

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MULTIPLEXING CONFIGURED GRANT SIGNALING AND FEEDBACK WITH DIFFERENT PRIORITIES

TECHNICAL FIELD

[0001] The following relates generally to wireless communications, including multiplexing configured grant (CG) signaling and feedback with different priorities.

BACKGROUND

[0002] 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

[0003] The described techniques relate to improved methods, systems, devices, and apparatuses that support multiplexing configured grant signaling and feedback with different priorities. For example, the described techniques provide for a user equipment (UE) to multiplex uplink control information (UCI) with acknowledgement (ACK) feedback and channel state information (CSI) according to a priority type of an uplink shared channel message carrying the UCI. The UE may determine time-frequency resources allocated for the ACK feedback and the CSI overlap with periodic resource allocation for the uplink shared channel (e.g., a configured grant-physical uplink shared channel (CG-PUSCH)). In some cases, the UE may multiplex the UCI with at least

some of the ACK feedback, the CSI, or both over the uplink shared channel message. For example, the UE may use an encoding chain designated for multiplexing ACK feedback of a priority type of the uplink shared channel message. After the UE multiplexes the ACK feedback, the CSI, or both with the UCI, the UE may transmit the uplink shared channel message.

[0004] A method for wireless communications at a UE is described. The method may include determining that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority type, multiplexing the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message, and transmitting, on a configured grant (CG) uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI.

[0005] An apparatus for wireless communications at a UE is described. The apparatus may include a processor, memory coupled with the processor, and instructions stored in the memory. The instructions may be executable by the processor to cause the apparatus to determine that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority type, multiplex the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message, and transmit, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI.

[0006] Another apparatus for wireless communications at a UE is described. The apparatus may include means for determining that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority type, means for multiplexing the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message, and means for transmitting, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI.

[0007] A non-transitory computer-readable medium storing code for wireless communications at a UE is described. The code may include instructions executable by a processor to determine that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority type, multiplex the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message, and transmit, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI.

[0008] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, multiplexing the UCI may include operations, features, means, or instructions for appending the UCI to ACK feedback of the first priority type in an ACK feedback codebook, the ACK feedback of the first priority type being at least a portion of the ACK feedback multiplexed over the uplink shared channel message.

[0009] Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for multiplexing the CSI over the uplink shared channel message using a combination of a second encoding chain and a third encoding chain, where the ACK feedback multiplexed over the uplink shared channel message may be included entirely of the ACK feedback of the first priority type, and where the second encoding chain and the third encoding chain may be each different from the first encoding chain.

[0010] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, multiplexing the CSI may include operations, features, means, or instructions for multiplexing a first part of the CSI using the second encoding chain and multiplexing a second part of the CSI using the third encoding chain.

[0011] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, multiplexing ACK feedback of a second priority type over the uplink shared channel message using a second encoding chain, where the ACK feedback multiplexed over the uplink shared channel message includes the ACK feedback of the first priority type and the ACK feedback of the second priority type and multiplexing a first part of the CSI over the uplink shared channel message using a third encoding chain, where the CSI includes the first part and a second part.

[0012] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the second part of the CSI may be not multiplexed over the uplink shared channel message.

[0013] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first priority type may be of a higher priority type than the second priority type.

[0014] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the second priority type may be of a higher priority type than the first priority type.

[0015] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, multiplexing ACK feedback of a second priority type over the uplink shared channel message using a second encoding chain, where the ACK feedback multiplexed over the uplink shared channel message may be included entirely of the ACK feedback of the second priority type and multiplexing a first part of the CSI over the uplink shared channel message using a third encoding chain, where the CSI includes the first part and a second part.

[0016] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, multiplexing the UCI may include operations, features, means, or instructions for appending the UCI to dummy ACK feedback in an ACK feedback codebook.

[0017] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the second part of the CSI may be not multiplexed over the uplink shared channel message.

[0018] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first priority type may be of a higher priority type than the second priority type.

[0019] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the second priority type may be of a higher priority type than the first priority type.

[0020] Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for multiplexing a first part of the CSI over the uplink shared channel message using a second encoding chain, where the CSI includes the first part and a second part and multiplexing the second part of the CSI over the uplink shared channel message using a third encoding chain, where the UCI may be multiplexed with the CSI but not with the ACK feedback.

[0021] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the UCI includes CG-UCI.

[0022] A method for wireless communications at a network entity is described. The method may include determining that one or more time-frequency resources allocated to a UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority and receiving, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the UCI multiplexed with at least some of the ACK feedback and the CSI.

[0023] An apparatus for wireless communications at a network entity is described. The apparatus may include a processor, memory coupled with the processor, and instructions stored in the memory. The instructions may be executable by the processor to cause the apparatus to determine that one or more time-frequency resources allocated to a UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority and receive, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the UCI multiplexed with at least some of the ACK feedback and the CSI.

[0024] Another apparatus for wireless communications at a network entity is described. The apparatus may include means for determining that one or more time-frequency resources allocated to a UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority and means for receiving, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the UCI multiplexed with at least some of the ACK feedback and the CSI.

[0025] A non-transitory computer-readable medium storing code for wireless communications at a network entity is described. The code may include instructions executable by a processor to determine that one or more time-frequency resources allocated to a UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority and receive, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the UCI multiplexed with at least some of the ACK feedback and the CSI.

[0026] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the UCI may be encoded with at least a portion of the ACK feedback based on the portion of the ACK feedback having a same priority type as the UCI.

[0027] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the UCI includes CG-UCI.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] FIGs. 1 and 2 illustrate examples of wireless communications systems that support multiplexing configured grant (CG) signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure.

[0029] FIGs. 3A through 3C illustrate examples of resource diagrams that support multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure.

[0030] FIG. 4 illustrates an example of a process flow that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure.

[0031] FIGs. 5 and 6 show block diagrams of devices that support multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure.

[0032] FIG. 7 shows a block diagram of a communications manager that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure.

[0033] FIG. 8 shows a diagram of a system including a device that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure.

[0034] FIGs. 9 and 10 show block diagrams of devices that support multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure.

[0035] FIG. 11 shows a block diagram of a communications manager that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure.

[0036] FIG. 12 shows a diagram of a system including a device that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure.

[0037] FIGs. 13 through 16 show flowcharts illustrating methods that support multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure.

DETAILED DESCRIPTION

[0038] In some wireless communications systems, a wireless device, such as a user equipment (UE), may simultaneously transmit multiple channels of information on the same time-frequency resources using a technique referred to as multiplexing. That is, a network entity (e.g., a base station) may schedule multiple uplink transmissions that may conflict in time-frequency resources. The UE may then multiplex the uplink transmissions onto a single channel, in accordance with specified rules. For example, the UE may be scheduled to transmit an uplink shared channel transmission, such as a physical uplink shared channel (PUSCH) transmission, at the same time that the UE is scheduled to transmit a feedback message, such as acknowledgment (ACK) or negative acknowledgment (NACK) information, as well as channel state information (CSI). The ACK and NACK information may be referred to as A/N feedback, ACK feedback, or feedback information. The UE may follow rules for multiplexing the feedback and the CSI onto the PUSCH. The rules may include encoding the different sets of information using different encoding chains. A rule may specify that the ACK feedback is multiplexed onto the PUSCH using a specific encoding chain (one that is associated with ACK feedback encoding). A rule may also specify that the CSI is multiplexed onto the PUSCH using different encoding chains. In some examples, CSI may be divided into two parts, so the rule may specify that CSI part 1 is encoded using a CSI part 1 encoding chain and CSI part 2 is encoded using a CSI part 2 encoding chain. Thus, three encoding chains may be used to multiplex ACK information and CSI onto a PUSCH.

[0039] The UE may be scheduled to transmit a configured grant (CG) transmission, which is a type of periodic uplink transmission. A CG-PUSCH message may have associated CG-uplink control information (CG-UCI), which may also be multiplexed with the CG-PUSCH. However, no rules exist for multiplexing a CG-UCI, ACK feedback, and CSI with a CG-PUSCH.

[0040] As described herein, a UE may multiplex CG-UCI with ACK feedback, or feedback information, and CSI over a CG-PUSCH. For example, the UE may encode the CG-UCI, which may be referred to as UCI, using an encoding chain used for encoding feedback information of a same priority as the UCI. For example, the feedback information may include feedback bits of either high priority or low priority. The UCI may also be of either high priority or low priority. Thus, the UCI may be appended to the feedback codebook and encoded with the feedback information that matches the priority of the UCI. The UE may reuse the three encoding chains described above. The highest priority encoding chain may be the feedback encoding chain. The next encoding chain may be the CSI part 1 encoding chain. A third encoding chain may be the CSI part 2 encoding chain. If the feedback information includes both high priority feedback and low priority feedback, then the high priority feedback information may be encoded using the feedback encoding chain and the low priority feedback information may be encoded using the CSI part 1 encoding chain. That means that the CSI part 1 information may be shifted and encoded using the CSI part 2 encoding chain, and the CSI part 2 information may be dropped. In this scheme, the UE may encode the UCI using either the feedback encoding chain or the CSI part 1 encoding chain, as if the UCI were feedback information of the same priority.

[0041] Aspects of the disclosure are initially described in the context of wireless communications systems. Aspects of the disclosure are further described in the context of resource diagrams and process flows. Aspects of the disclosure are further illustrated by and described with reference to apparatus diagrams, system diagrams, and flowcharts that relate to multiplexing CG signaling and feedback with different priorities.

[0042] **FIG. 1** illustrates an example of a wireless communications system 100 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The wireless communications system 100 may include one or more network entities 105, one or more 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.

[0043] 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 one or more communication links 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 one or more communication links 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).

[0044] 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 able to communicate with various types of devices, such as other UEs 115 or network entities 105, as shown in FIG. 1.

[0045] 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, or computing system may include disclosure of the UE 115, network entity 105, apparatus, device, or computing system 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.

[0046] In some examples, network entities 105 may communicate with the core network 130, or with one another, or both. For example, network entities 105 may communicate with the core network 130 via one or more backhaul communication links 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 over a backhaul communication link 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 a 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 links 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), 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 through a communication link 155.

[0047] One or more of the network entities 105 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 a 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 a single network entity 105 (e.g., a single RAN node, such as a base station 140).

[0048] 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 two or more network entities 105, such as an integrated access backhaul (IAB) network, an open RAN (O-RAN) (e.g., a network configuration sponsored by the O-RAN Alliance), or a virtualized RAN (vRAN) (e.g., a cloud RAN (C-RAN)). For example, a network entity 105 may include one or more of a central unit (CU) 160, a distributed unit (DU) 165, a radio unit (RU) 170, a RAN Intelligent Controller (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) 180 system, 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 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)).

[0049] The split of functionality between a CU 160, a DU 165, and an RU 175 is flexible and may support different functionalities depending upon which functions (e.g., network layer functions, protocol layer functions, baseband functions, RF functions, and any combinations thereof) are performed at a CU 160, a DU 165, or an RU 175. 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 may be connected to one or more DUs 165 or RUs 170, and the one or more DUs 165 or RUs 170 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 more RUs 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 one or more DUs 165 via a midhaul communication link 162 (e.g., F1, F1-c, F1-u), and a DU 165 may be connected to one or more RUs 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 105 that are in communication over such communication links.

[0050] In wireless communications systems (e.g., 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 network entities 105 (e.g., IAB nodes 104) may be partially controlled by each other. One or more IAB nodes 104 may be referred to as a donor entity or an IAB donor. One or more DUs 165 or one or more RUs 170 may be partially controlled by one or more CUs 160 associated with a donor network entity 105 (e.g., a donor base station 140). The one or more donor network entities 105 (e.g., IAB donors) may be in communication with one or more additional network entities 105 (e.g., IAB nodes 104) via supported access and backhaul links (e.g., backhaul communication links 120). IAB nodes 104 may include an IAB mobile termination (IAB-MT) controlled (e.g., scheduled) by DUs 165 of a coupled IAB donor. An IAB-MT may include 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 an IAB node 104 used for access via the DU 165 of the IAB node 104 (e.g., referred to as virtual IAB-MT (vIAB-MT)). In some examples, the IAB nodes 104 may include DUs 165 that support communication links with additional entities (e.g., IAB nodes 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., one or more IAB nodes 104 or components of IAB nodes 104) may be configured to operate according to the techniques described herein.

[0051] For instance, an access network (AN) or RAN may include communications between access nodes (e.g., an IAB donor), IAB nodes 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 core network 130. The IAB donor may include a CU 160 and at least one DU 165 (e.g., and RU 170), in which case the CU 160 may communicate with the core network 130 over an interface (e.g., a backhaul link). IAB donor and IAB nodes 104 may communicate over 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 over an interface, which may be an example of a portion of backhaul link, and may communicate with other CUs 160 (e.g., a CU 160 associated with an alternative IAB donor) over an Xn-C interface, which may be an example of a portion of a backhaul link.

[0052] An IAB node 104 may refer to a RAN node that provides 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 104, and the IAB-MT may act as a scheduled node towards parent nodes associated with the IAB node 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 one or more other IAB nodes 104). Additionally, or alternatively, an IAB node 104 may also be referred to as a parent node or a child node to other IAB nodes 104, depending on the relay chain or configuration of the AN. Therefore, the IAB-MT entity of IAB nodes 104 may provide a Uu interface for a child IAB node 104 to receive signaling from a parent IAB node 104, and the DU interface (e.g., DUs 165) may provide a Uu interface for a parent IAB node 104 to signal to a child IAB node 104 or UE 115.

[0053] For example, IAB node 104 may be referred to as a parent node that supports communications for a child IAB node, and referred to as a child IAB node associated with an IAB donor. The IAB donor may include a CU 160 with a wired or wireless connection (e.g., a backhaul communication link 120) to the core network 130 and may act as parent node to IAB nodes 104. For example, the DU 165 of IAB donor may relay transmissions to UEs 115 through IAB nodes 104, and may directly signal transmissions to a UE 115. The CU 160 of IAB donor may signal communication link establishment via an F1 interface to IAB nodes 104, and the IAB nodes 104 may schedule transmissions (e.g., transmissions to the UEs 115 relayed from the IAB donor) through the DUs 165. That is, data may be relayed to and from IAB nodes 104 via signaling over an NR Uu interface to MT of the IAB node 104. Communications with IAB node 104 may be scheduled by a DU 165 of IAB donor and communications with IAB node 104 may be scheduled by DU 165 of IAB node 104.

[0054] 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 multiplexing CG signaling and feedback with different priorities 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., IAB nodes 104, DUs 165, CUs 160, RUs 170, RIC 175, SMO 180).

[0055] 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, or a personal computer. In some examples, a UE 115 may include or be referred to as a wireless local loop (WLL) station, an Internet of Things (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, or vehicles, meters,, 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, among other examples.

[0056] The UEs 115 described herein may be able to communicate with various types of devices, such as other UEs 115 that may sometimes act 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.

[0057] The UEs 115 and the network entities 105 may wirelessly communicate with one another via one or more communication links 125 (e.g., an access link) over one or more carriers. The term “carrier” may refer to a set of RF spectrum resources having a defined physical layer structure for supporting the communication links 125. For example, a carrier used for a communication link 125 may include a portion of a RF spectrum band (e.g., a bandwidth part (BWP)) that is operated according to one or more physical layer channels for a given radio access technology (e.g., LTE, LTE-A, LTE-A Pro, NR). Each physical 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 105).

[0058] In some examples, such as in a carrier aggregation configuration, a carrier may also 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 positioned 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 radio access technology).

[0059] The communication links 125 shown in 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).

[0060] 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 radio access technology (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 over a particular carrier bandwidth or may be configurable to support communications over 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 via carriers associated with multiple carrier bandwidths. In some examples, each served UE

115 may be configured for operating over portions (e.g., a sub-band, a BWP) or all of a carrier bandwidth.

[0061] Signal waveforms transmitted over 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 the more resource elements that a device receives and the higher the order of the modulation scheme, the higher the data rate may be for the device. 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.

[0062] One or more numerologies for a carrier may be supported, where 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.

[0063] 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, where Δf_{max} may represent the maximum supported subcarrier spacing, and N_f may represent the maximum 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).

[0064] 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 100, a slot may further be divided into multiple mini-slots containing one or more symbols. Excluding the cyclic prefix, each symbol period may contain 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.

[0065] 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)).

[0066] Physical channels may be multiplexed on a carrier according to various techniques. A physical control channel and a physical data channel may be multiplexed on 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 multiple UEs 115 and UE-specific search space sets for sending control information to a specific UE 115.

[0067] 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., over 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), or others). In some examples, a cell may also 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.

[0068] 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 lower-powered network entity 105 (e.g., a lower-powered base station 140), as compared with a macro cell, and a small cell may operate in 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 multiple cells and may also support communications over the one or more cells using one or multiple component carriers.

[0069] 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.

[0070] 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 110. In some examples, different coverage areas 110 associated with different technologies may overlap, but the different coverage areas 110 may be supported by the same network entity 105. In some other examples, the overlapping coverage areas 110 associated with different technologies may be supported by different network entities 105. The wireless communications system 100 may include, for example, a heterogeneous network in which different types of the network entities 105 provide coverage for various coverage areas 110 using the same or different radio access technologies.

[0071] 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 105 may be approximately aligned in time. For asynchronous operation, network entities 105 may have different frame timings, and transmissions from different 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.

[0072] 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 (e.g., a base station 140) 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 such information to a central server or application program that makes use of the information or presents the information to humans interacting with the application program. Some UEs 115 may be designed to collect information or enable automated behavior of machines or other devices. 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).

[0073] 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 include entering a power saving deep sleep mode when not engaging in active communications, operating over 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.

[0074] 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.

[0075] In some examples, a UE 115 may be able to communicate directly with other UEs 115 over a device-to-device (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 or scheduled by the network entity 105. In some examples, one or more UEs 115 in 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 each of the other 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 the involvement of a network entity 105.

[0076] 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.

[0077] 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.

[0078] 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. The 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. The transmission of UHF waves may be associated with smaller antennas and shorter ranges (e.g., less than 100 kilometers) compared to transmission using the smaller frequencies and longer waves of the high frequency (HF) or very high frequency (VHF) portion of the spectrum below 300 MHz.

[0079] The wireless communications system 100 may also operate in a super high frequency (SHF) region using frequency bands from 3 GHz to 30 GHz, also known as the centimeter band, or in 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, this may facilitate use of antenna arrays within a device. The propagation of EHF transmissions, however, may be subject to even greater atmospheric 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.

[0080] 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) radio access technology, or NR technology in an unlicensed band such as the 5 GHz industrial, scientific, and medical (ISM) band. While operating in 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 in unlicensed bands may be based on a carrier aggregation configuration in conjunction with component carriers operating in a licensed band (e.g., LAA). Operations in unlicensed spectrum may include downlink transmissions, uplink transmissions, P2P transmissions, or D2D transmissions, among other examples.

[0081] 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 in diverse geographic locations. A network entity 105 may have 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 have 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.

[0082] The network entities 105 or the UEs 115 may use MIMO communications to exploit multipath signal propagation and increase the 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), where multiple spatial layers are transmitted to the same receiving device, and multiple-user MIMO (MU-MIMO), where multiple spatial layers are transmitted to multiple devices.

[0083] 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 at 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).

[0084] 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.

[0085] Some signals, such as data signals associated with a particular receiving device, may be transmitted by transmitting device (e.g., a transmitting network entity 105, a transmitting UE 115) along a single beam direction (e.g., a direction associated with the receiving device, such as a receiving network entity 105 or a receiving 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.

[0086] 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 CSI 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).

[0087] 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 receiving 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).

[0088] 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 over logical channels. A MAC layer may perform priority handling and multiplexing of logical channels into transport channels. The MAC layer may also use error detection techniques, error correction techniques, or both to support retransmissions at the MAC layer to improve link efficiency. In the control plane, the RRC protocol 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. At the PHY layer, transport channels may be mapped to physical channels.

[0089] 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 over a communication link (e.g., a communication link 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 poor radio conditions (e.g., low signal-to-noise conditions). In some examples, a device may support same-slot HARQ feedback, where the device may provide HARQ feedback in a specific slot for data received in 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.

[0090] As described herein, a UE 115 may multiplex UCI with ACK feedback, or feedback information, and CSI over a periodic uplink shared channel (e.g., CG-PUSCH). For example, the UE 115 may encode the UCI using an encoding chain used for encoding ACK feedback of a same priority as the UCI. For example, the ACK feedback may include feedback bits of high priority, low priority, or both. The UCI may be of either high priority or low priority. Thus, the UCI may be appended to the feedback codebook and encoded with the ACK feedback that matches the priority of the UCI. The UE may reuse the three encoding chains described above. The highest priority encoding chain may be the feedback encoding chain. The next encoding chain may be the CSI part 1 encoding chain. A third encoding chain may be the CSI part 2 encoding chain. If the ACK feedback includes both high priority feedback and low priority feedback, then the high priority ACK feedback may be encoded using the feedback encoding chain and the low priority ACK feedback may be encoded using the CSI part 1 encoding chain. That means that the CSI part 1 information may be shifted and encoded using the CSI part 2 encoding chain, and the CSI part 2 information may be dropped. In this scheme, the UE may encode the UCI using either the feedback encoding chain or the CSI part 1 encoding chain, as if the UCI were feedback information of the same priority.

[0091] **FIG. 2** illustrates an example of a wireless communications system 200 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The wireless communications system 200 may implement or be implemented to realize aspects of the wireless communications system 100. For example, the wireless communications system 200 illustrates communication between one or more UEs and network entities, such as a UE 115-a and a network entity 105-a, which may be examples of corresponding devices described herein, including with reference to FIG. 1. The wireless communications system 200 may support signaling from a UE 115-a that may be multiplexed using an encoding chain based on priorities of UCI and feedback in an uplink shared channel.

[0092] In some cases, the UE 115-a may be in communication with the network entity 105-a. For example, the UE 115-a may transmit control information, data or both to the network entity 105-a via an uplink communication link 205. The UE 115-a may support simultaneous transmission of multiple channels of information on same time-frequency resources using a technique referred to as multiplexing. For example, the network entity 105-a may schedule uplink transmissions at the UE 115-a that may conflict in time-frequency resources, such as in an unlicensed frequency band. In some cases, the network entity 105-a may periodically, or semi-persistently, schedule one or more of the uplink transmissions, such as via RRC signaling or a MAC-CE. The periodic uplink transmissions may be periodic uplink shared channel transmissions, such as CG-PUSCH transmissions, which may include CG-UCI.

[0093] In some examples, the periodic uplink transmission (e.g., a CG uplink transmission) may be a first type (Type 1) or a second type (Type 2) of periodic uplink transmission. For a Type 1 periodic uplink transmission, a network entity 105-a may transmit RRC signaling configuring time-frequency domain resource allocations including a periodicity of CG resources, offset of the uplink transmission, a start symbol, and a length of an uplink shared channel for the uplink transmission. For a Type 2 periodic uplink transmission, a network entity 105-a may transmit RRC signaling configuring a periodicity and a number of repetitions of the uplink transmission. Then, the network entity 105-a may transmit an activation downlink control information (DCI) message to initiate the uplink transmissions. In some cases, the network entity 105-a may configure the Type 1 and the Type 2 periodic uplink transmissions with a number of allocated slots (e.g., a starting slot and a slot offset in a slot period) a number of consecutive uplink shared channels in a slot, or both to support flexible time domain resource allocation, where a slot may be a dynamic scheduling unit in the time domain.

[0094] In some examples, the UE 115-a may report UCI to the network entity 105-a with the uplink shared channel (e.g., the PUSCH). The UCI may include a HARQ process identifier (ID), a redundancy version ID (RVID), a new data indicator (NDI), channel occupancy time (COT) sharing information, or any combination thereof. In some cases, the network entity 105-a may configure the UE 115-a to use the resources for the periodic uplink transmission for retransmission of a prior transmission. In some examples, the network entity may include downlink feedback information (DFI) to a DCI message to the UE 115-a to provide feedback (e.g., a HARQ A/N) for an uplink shared channel.

[0095] In some examples, the network entity 105-a may schedule the UE 115-a to transmit a periodic uplink transmission (e.g., a CG transmission), such as an uplink shared channel message 210. The uplink shared channel message 210 may be a CG-PUSCH message with associated CG-UCI, which may also be multiplexed with the CG-PUSCH. The network entity 105-a may configure the uplink shared channel message 210, such that the UE 115-a may transmit the uplink shared channel message 210 once every period 215. The uplink shared channel message 210 may overlap with one or more time-frequency resources of an ACK feedback 220, CSI 225, or both, as illustrated in the resource diagram 230. The CSI 225 may include multiple parts of a CSI message, such as a CSI Part 1 and a CSI Part 2. However, the UE 115-a may not know how to multiplex UCI of the uplink shared channel message 210, the ACK feedback 220, and the CSI 225 over the uplink shared channel message 210.

[0096] In some examples, the UE 115-a may use one or more encoding chains to multiplex information over the uplink shared channel message 210. Each encoding chain may include a set of steps for multiplexing the information. For example, a UE 115-a may use a first encoding chain for multiplexing UCI with feedback information, such as the ACK feedback 220. The first encoding chain may include encoding, rate matching or puncturing, and resource element mapping for multiplexing the ACK feedback 220 on the uplink shared channel message 210. Additionally, or alternatively, the UE 115-a may use a second encoding chain or a third encoding chain for multiplexing UCI with the CSI 225, such as the CSI Part 1 and the CSI Part 2, respectively, over the uplink shared channel message 210. The second encoding chain and the third encoding chain may include encoding, rate matching, and resource element mapping of the CSI Part 1 or the CSI Part 2, respectively, over the uplink shared channel message 210.

[0097] In some examples, at 235, the UE 115-a may multiplex the UCI with at least some of the ACK feedback 220, the CSI 225, or both over the uplink shared channel message 210, which is described in further detail with respect to FIGs. 3A through 3C. In some cases, the UE 115-a may use one or more of the three encoding chains in accordance with a priority type of the UCI, the ACK feedback 220, the CSI 225, or any combination thereof. In some examples, the network entity 105-a may transmit the CSI 225 on an uplink control channel (e.g., a physical uplink control channel (PUCCH)). Thus, the UE 115-a may treat the CSI 225 as having a low priority type. When the CSI 225 on the uplink control channel overlaps with the uplink shared channel message 210, the UE 115-a may multiplex the CSI 225 over the uplink shared channel message 210.

[0098] In some examples, the UE 115-a may treat the UCI (e.g., the CG-UCI) of a priority as ACK feedback 220 of a same priority and joint encode the UCI with the ACK feedback 220 (e.g., if the ACK feedback 220 exists) of the same priority. The UE 115-a may joint encode the UCI with the ACK feedback 220 using the first encoding chain or the second encoding chain for the CSI Part 1, which is described in further detail with respect to FIGs. 3A through 3C. If the UCI is a high priority type, the UE 115-a may use the first encoding chain for multiplexing the UCI with the ACK feedback 220 over the uplink shared channel message 210, which is described in further detail with respect to FIG. 3A. If the UCI is a low priority type and there is no high priority type UCI or ACK feedback 220, the UE 115-a may use the second encoding chain, which is described in further detail with respect to FIGs. 3B and 3C. If there is no ACK feedback 220, the UE 115-a may multiplex the UCI with the CSI Part 1 using the second encoding chain.

[0099] In some cases, once the UE 115-a multiplexes the UCI with the ACK feedback 220, the CSI 225, or both, the UE 115-a may transmit the multiplexed transmission 240 to the network entity 105-a. The multiplexed transmission 240 may include the uplink shared channel message 210 with the multiplexed UCI and at least some of the ACK feedback 220 and the CSI 225.

[0100] **FIGs. 3A, 3B, and 3C** illustrate examples of a resource diagram 300-a, a resource diagram 300-b, and a resource diagram 300-c, respectively, that support multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. In some examples, the resource diagram 300-a, the resource diagram 300-b, and the resource diagram 300-c may implement aspects of wireless communications system 100 and wireless communications system

200. For example, the resource diagram 300-a, the resource diagram 300-b, and the resource diagram 300-c may be implemented by a wireless communications system in which a UE may transmit an uplink shared channel message with multiplexed UCI and at least some ACK feedback and CSI to a network entity, where the network entity and UE may be examples of the corresponding devices as described with reference to FIGs. 1 and 2.

[0101] In some examples, a network entity may schedule a UE to transmit a periodic uplink transmission (e.g., a CG transmission), such as an uplink shared channel message. The uplink shared channel message may be a PUSCH message, such as a PUSCH 305-a, a PUSCH 305-b, and a PUSCH 305-c. Each PUSCH may have respective UCI (e.g., UCI 310-a, UCI 310-b, and UCI 310-c, respectively), which may also be multiplexed with the PUSCH. A PUSCH may overlap with one or more time-frequency resources of an ACK feedback, CSI, or both. The CSI 225 may include multiple parts of a CSI message, such as a CSI Part 1 and a CSI Part 2. In some examples, the PUSCH 305-a may overlap with the ACK feedback 315-a, the CSI Part 1 320-a, the CSI Part 2 325-a, or any combination thereof. Similarly, the PUSCH 305-b may overlap with the ACK feedback 315-b, ACK feedback 315-c, the CSI Part 1 320-a, the CSI Part 2 325-a, or any combination thereof and the PUSCH 305-a may overlap with the ACK feedback 315-d, the ACK feedback 315-e, the CSI Part 1 320-a, the CSI Part 2 325-a, or any combination thereof.

[0102] In some examples, the UE may use one or more encoding chains to multiplex information over the uplink shared channel message. Each encoding chain may include a set of steps for multiplexing the information. For example, a UE may use an encoding chain 330-a or an encoding chain 330-b for multiplexing UCI with feedback information, such as the ACK feedback. The encoding chain 330-a or the encoding chain 330-b may include encoding, rate matching or puncturing, and resource element mapping for multiplexing the ACK feedback on the uplink shared channel message. Additionally, or alternatively, the UE may use the encoding chain 330-b or an encoding chain 330-c for multiplexing UCI with the CSI, such as the CSI Part 1 and the CSI Part 2, respectively, over the uplink shared channel message. The encoding chain 330-b and the encoding chain 330-c may include encoding, rate matching, and resource element mapping of the CSI Part 1 or the CSI Part 2, respectively, over the uplink shared channel message.

[0103] The UE may multiplex the UCI with at least some of the ACK feedback, the CSI, or both. For example, as illustrated in FIG. 3A, the UE may multiplex the ACK feedback 315-a with the UCI 310-a over the PUSCH 305-a to obtain a multiplexed transmission 335-a. Similarly, as illustrated in FIG. 3B and FIG. 3C, respectively, the UE may multiplex the ACK feedback 315-b with the UCI 310-b over the PUSCH 305-b to obtain a multiplexed transmission 335-b and the UE may multiplex the ACK feedback 315-e with the UCI 310-c over the PUSCH 305-c to obtain a multiplexed transmission 335-c.

[0104] In some examples, the ACK feedback, the UCI, and the CSI may each have a priority type, such as a high priority or a low priority. For example, as illustrated in FIG. 3A, the ACK feedback 315-a may have bits entirely of a priority 340-a, which may be a same priority as the UCI 310-a, while the CSI Part 1 320-a and the CSI Part 2 325-a have a priority 340-b. In some cases, the priority 340-a may be a high priority and the priority 340-b may be a low priority, such that both the UCI 310-a and the ACK feedback 315-a are high priority, and the CSI Part 1 320-a and the CSI Part 2 325-a are low priority. In some other cases, the priority 340-a may be a low priority and the priority 340-b may also be a low priority, such that both the UCI 310-a, the ACK feedback 315-a, the CSI Part 1 320-a, and the CSI Part 2 325-a may be a low priority. In some examples, the UE may treat the UCI 310-a as if the UCI 310-a is the ACK feedback 315-a with a same priority as the UCI 310-a. For example, the UE may append the UCI 310-a at the end of a feedback codebook (e.g., an A/N codebook) and may joint encode the ACK feedback 315-a with the UCI 310-a. The UE may multiplex the encoded bits over the PUSCH 305-a using the encoding chain 330-a, such that the PUSCH 305-a may have a same priority as the multiplexed transmission 335-a (e.g., the priority 340-a, which may be a high priority or a low priority). In some examples, the UE may encode the CSI Part 1 320-a using the encoding chain 330-b and the CSI Part 2 using the encoding chain 330-c.

[0105] In some examples, as illustrated in FIG. 3B, the ACK feedback 315-b may have bits of a priority 340-a, while a different portion of the feedback information, the ACK feedback 315-c, may have a different priority (e.g., a priority 340-b) than the ACK feedback 315-b. The ACK feedback 315-b may have a same priority as the UCI 310-b, while the CSI Part 1 320-b and the CSI Part 2 325-b may have a same priority as the ACK feedback 315-c (e.g., a priority 340-b). The priority 340-a may be a high priority and the priority 340-b may be a low priority, such that both the UCI 310-b and the ACK feedback 315-b are high priority, and the ACK feedback 315-c, the CSI Part 1 320-b, and the CSI Part 2 325-b are low priority. In some examples, the UE may treat the UCI 310-b as if the UCI 310-b is the ACK feedback 315-b with a same priority as the UCI 310-b. For example, the UE may append the UCI 310-b at the end of a feedback codebook (e.g., an A/N codebook) and may joint encode the ACK feedback 315-b with the UCI 310-b. The UE may multiplex the encoded bits over the PUSCH 305-b using the encoding chain 330-a, such that the PUSCH 305-b may have a same priority as the multiplexed transmission 335-b (e.g., the priority 340-a, which may be a high priority). In some examples, the UE may encode the ACK feedback 315-c using the encoding chain 330-b and the CSI Part 1 using the encoding chain 330-c. The UE may drop the CSI Part 2 325-b.

[0106] In some examples, as illustrated in FIG. 3C, the ACK feedback 315-d may have bits of a priority 340-a, while a different portion of the feedback information, the ACK feedback 315-e, may have a different priority (e.g., a priority 340-b) than the ACK feedback 315-d. The ACK feedback 315-e may have a same priority as the UCI 310-c and the CSI Part 1 320-c and the CSI Part 2 325-c (e.g., a priority 340-b). The priority 340-a may be a high priority and the priority 340-b may be a low priority, such that the ACK feedback 315-d are high priority and both the UCI 310-c and the ACK feedback 315-e are low priority. In some examples, the UE may treat the UCI 310-c as if the UCI 310-c is the ACK feedback 315-e with a same priority as the UCI 310-c. For example, the UE may append the UCI 310-c at the end of a feedback codebook (e.g., an A/N codebook) and may joint encode the ACK feedback 315-e with the UCI 310-c. The UE may multiplex the encoded bits over the PUSCH 305-c using the encoding chain 330-b, such that the PUSCH 305-b may have a same priority as the multiplexed transmission 335-c (e.g., the priority 340-b, which may be a low priority). In some examples, the UE may encode the ACK feedback 315-d using the encoding chain 330-a and the CSI Part 1 using the encoding chain 330-c. The UE may drop the CSI Part 2 325-b.

[0107] In some examples, the UE may not be configured to transmit ACK feedback of a same priority type as the UCI. For example, the UE may have high priority ACK feedback and low priority UCI or low priority ACK feedback and high priority UCI. The UE may use one or more dummy bits (e.g., 2 dummy bits) to mimic ACK feedback of a same priority type as the UCI. For example, the ACK feedback 315-b, the ACK feedback 315-e, or both may be dummy bits. The UE may treat the UCI as if the UCI is ACK feedback of a same priority, and may joint encode the UCI with the dummy bits for the ACK feedback (e.g., using the encoding chain 330-a or the encoding chain 330-b). The UE may multiplex the encoded bits over the PUSCH based on the applied encoding chain.

[0108] **FIG. 4** illustrates an example of a process flow 400 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. In some examples, the process flow 400 may implement aspects of wireless communications system 100, wireless communications system 200, resource diagram 300-a, resource diagram 300-b, and resource diagram 300-c. The process flow 400 may illustrate an example of a UE 115-b transmitting an uplink shared channel message with UCI multiplexed with ACK feedback and CSI to a network entity 105-b. The network entity 105-b and the UE 115-b may be examples of a network entity 105 and a UE 115 as described with reference to FIGs. 1 and 2. Alternative examples of the following may be implemented, where some processes are performed in a different order than described or are not performed. In some cases, processes may include additional features not mentioned below, or further processes may be added.

[0109] At 405, the UE 115-b may determine that one or more time-frequency resources allocated to the UE 115-b for reporting of ACK feedback and CSI overlap with a periodic resource allocation for an uplink shared channel message having UCI. The periodic resource allocation may be for one or more CG-PUSCH messages, and the UCI may be CG-UCI. In some cases, the UCI, the ACK feedback, and the CSI may have a defined priority type (e.g., low priority or high priority).

[0110] At 410, the UE 115-b may multiplex the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message. For example, the UE 115-b may use a first encoding chain designated for multiplexing ACK feedback a same priority type as the UCI over the uplink shared channel message. In some cases, the UE 115-b may append the UCI to ACK feedback of a same priority type in an ACK feedback codebook. The ACK feedback may include at least a portion of bits of the same priority type as the UCI, the portion multiplexed over the uplink shared channel message. The UE 115-b may multiplex the CSI over the uplink shared channel message using a combination of a second encoding chain and a third encoding chain. For example, if the ACK feedback multiplexed over the uplink shared channel message includes the acknowledgment feedback of the same priority type as the UCI (e.g., and not other priority types), the UE 115-b may encode both the CSI Part 1 and the CSI Part 2 using the second encoding chain and the third encoding chain, respectively, as described with reference to FIG. 3A. In some cases, the second encoding chain and the third encoding chain may be different from the first encoding chain.

[0111] In some cases, the UE 115-b may multiplex ACK feedback of a different priority type than the UCI over the uplink shared channel message using a second encoding chain. The ACK feedback multiplexed over the uplink shared channel message may include ACK feedback of the same priority type as the UCI and the ACK feedback of the priority type different from the UCI. The UE 115-a may multiplex a CSI Part 1 over the uplink shared channel message using a third encoding chain. In some cases, the UE 115-b may drop the CSI Part 2 based on multiplexing the CSI Part 1 using the third encoding chain. The UCI may have a high priority or a low priority, while the ACK feedback may have the high priority, the low priority, or both.

[0112] In some examples, the UE 115-b may multiplex ACK feedback of a different priority type than the UCI over the uplink shared channel message using a second encoding chain. The ACK feedback may include bits of the different priority type (e.g., and not of a same priority type as the UCI). The UE 115-b may multiplex a CSI Part 1 over the uplink shared channel message using a third encoding chain. In some cases, the UE 115-b may multiplex the ACK feedback with the UCI by appending the UCI to dummy ACK feedback in an ACK feedback codebook. The UE 115-b may drop the CSI Part 2. The UCI may have a high priority or a low priority, while the ACK feedback may have the high priority, the low priority, or both.

[0113] In some cases, the UE 115-b may multiplex CSI Part 1 over the uplink shared channel message using a second encoding chain and CSI Part 2 over the uplink shared channel message using a third encoding chain, where the UCI is multiplexed with the CSI but not with the ACK feedback.

[0114] At 415, the UE 115-b may transmit the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI on a CG uplink shared channel (e.g., a CG-PUSCH).

[0115] **FIG. 5** shows a block diagram 500 of a device 505 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The device 505 may be an example of aspects of a UE 115 as described herein. The device 505 may include a receiver 510, a transmitter 515, and a communications manager 520. The device 505 may also include a processor. Each of these components may be in communication with one another (e.g., via one or more buses).

[0116] The receiver 510 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 multiplexing CG signaling and feedback with different priorities). Information may be passed on to other components of the device 505. The receiver 510 may utilize a single antenna or a set of multiple antennas.

[0117] The transmitter 515 may provide a means for transmitting signals generated by other components of the device 505. For example, the transmitter 515 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 multiplexing CG signaling and feedback with different priorities). In some examples, the transmitter 515 may be co-located with a receiver 510 in a transceiver module. The transmitter 515 may utilize a single antenna or a set of multiple antennas.

[0118] The communications manager 520, the receiver 510, the transmitter 515, or various combinations thereof or various components thereof may be examples of means for performing various aspects of multiplexing CG signaling and feedback with different priorities as described herein. For example, the communications manager 520, the receiver 510, the transmitter 515, or various combinations or components thereof may support a method for performing one or more of the functions described herein.

[0119] In some examples, the communications manager 520, the receiver 510, the transmitter 515, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include a processor, a digital signal processor (DSP), a central processing unit (CPU), a graphics processing unit (GPU) an application-specific integrated circuit (ASIC), a field-programmable gate array (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 a means for performing the functions described in the present disclosure. In some examples, a processor and memory coupled with the processor may be configured to perform one or more of the functions described herein (e.g., by executing, by the processor, instructions stored in the memory).

[0120] Additionally, or alternatively, in some examples, the communications manager 520, the receiver 510, the transmitter 515, or various combinations or components thereof may be implemented in code (e.g., as communications management software) executed by a processor. If implemented in code executed by a processor, the functions of the communications manager 520, the receiver 510, the transmitter 515, or various combinations or components thereof may be performed by a general-purpose processor, a DSP, a CPU, a GPU, an ASIC, an FPGA, a microcontroller, or any combination of these or other programmable logic devices (e.g., configured as or otherwise supporting a means for performing the functions described in the present disclosure).

[0121] In some examples, the communications manager 520 may be configured to perform various operations (e.g., receiving, obtaining, monitoring, outputting, transmitting) using or otherwise in cooperation with the receiver 510, the transmitter 515, or both. For example, the communications manager 520 may receive information from the receiver 510, send information to the transmitter 515, or be integrated in combination with the receiver 510, the transmitter 515, or both to obtain information, output information, or perform various other operations as described herein.

[0122] The communications manager 520 may support wireless communications at a UE in accordance with examples as disclosed herein. For example, the communications manager 520 may be configured as or otherwise support a means for determining that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority type. The communications manager 520 may be configured as or otherwise support a means for multiplexing the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message. The communications manager 520 may be configured as or otherwise support a means for transmitting, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI.

[0123] By including or configuring the communications manager 520 in accordance with examples as described herein, the device 505 (e.g., a processor controlling or otherwise coupled with the receiver 510, the transmitter 515, the communications manager 520, or a combination thereof) may support techniques for a UE to transmit an uplink shared channel message with multiplexed UCI and at least some ACK feedback and CSI to a network entity, which may provide for reduced processing, reduced power consumption, or more efficient utilization of communication resources.

[0124] **FIG. 6** shows a block diagram 600 of a device 605 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The device 605 may be an example of aspects of a device 505 or a UE 115 as described herein. The device 605 may include a receiver 610, a transmitter 615, and a communications manager 620. The device 605 may also include a processor. Each of these components may be in communication with one another (e.g., via one or more buses).

[0125] The receiver 610 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 multiplexing CG signaling and feedback with different priorities).

Information may be passed on to other components of the device 605. The receiver 610 may utilize a single antenna or a set of multiple antennas.

[0126] The transmitter 615 may provide a means for transmitting signals generated by other components of the device 605. For example, the transmitter 615 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 multiplexing CG signaling and feedback with different priorities). In some examples, the transmitter 615 may be co-located with a receiver 610 in a transceiver module. The transmitter 615 may utilize a single antenna or a set of multiple antennas.

[0127] The device 605, or various components thereof, may be an example of means for performing various aspects of multiplexing CG signaling and feedback with different priorities as described herein. For example, the communications manager 620 may include a resource component 625, an encoding component 630, an uplink shared channel component 635, or any combination thereof. The communications manager 620 may be an example of aspects of a communications manager 520 as described herein. In some examples, the communications manager 620, 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 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.

[0128] The communications manager 620 may support wireless communications at a UE in accordance with examples as disclosed herein. The resource component 625 may be configured as or otherwise support a means for determining that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority type. The encoding component 630 may be configured as or otherwise support a means for multiplexing the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the

UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message. The uplink shared channel component 635 may be configured as or otherwise support a means for transmitting, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI.

[0129] **FIG. 7** shows a block diagram 700 of a communications manager 720 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The communications manager 720 may be an example of aspects of a communications manager 520, a communications manager 620, or both, as described herein. The communications manager 720, or various components thereof, may be an example of means for performing various aspects of multiplexing CG signaling and feedback with different priorities as described herein. For example, the communications manager 720 may include a resource component 725, an encoding component 730, an uplink shared channel component 735, an ACK feedback component 740, or any combination thereof. Each of these components may communicate, directly or indirectly, with one another (e.g., via one or more buses).

[0130] The communications manager 720 may support wireless communications at a UE in accordance with examples as disclosed herein. The resource component 725 may be configured as or otherwise support a means for determining that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority type. The encoding component 730 may be configured as or otherwise support a means for multiplexing the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message. The uplink shared channel component 735 may be configured as or otherwise support a means for transmitting, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI.

[0131] In some examples, to support multiplexing the UCI, the ACK feedback component 740 may be configured as or otherwise support a means for appending the UCI to ACK feedback of the first priority type in an ACK feedback codebook, the ACK feedback of the first priority type being at least a portion of the ACK feedback multiplexed over the uplink shared channel message.

[0132] In some examples, the encoding component 730 may be configured as or otherwise support a means for multiplexing the CSI over the uplink shared channel message using a combination of a second encoding chain and a third encoding chain, where the ACK feedback multiplexed over the uplink shared channel message is included entirely of the ACK feedback of the first priority type, and where the second encoding chain and the third encoding chain are each different from the first encoding chain.

[0133] In some examples, to support multiplexing the CSI, the encoding component 730 may be configured as or otherwise support a means for multiplexing a first part of the CSI using the second encoding chain. In some examples, to support multiplexing the CSI, the encoding component 730 may be configured as or otherwise support a means for multiplexing a second part of the CSI using the third encoding chain.

[0134] In some examples, the encoding component 730 may be configured as or otherwise support a means for multiplexing ACK feedback of a second priority type over the uplink shared channel message using a second encoding chain, where the ACK feedback multiplexed over the uplink shared channel message includes the ACK feedback of the first priority type and the ACK feedback of the second priority type. In some examples, the encoding component 730 may be configured as or otherwise support a means for multiplexing a first part of the CSI over the uplink shared channel message using a third encoding chain, where the CSI includes the first part and a second part.

[0135] In some examples, the second part of the CSI is not multiplexed over the uplink shared channel message.

[0136] In some examples, the first priority type is of a higher priority type than the second priority type.

[0137] In some examples, the second priority type is of a higher priority type than the first priority type.

[0138] In some examples, the encoding component 730 may be configured as or otherwise support a means for multiplexing ACK feedback of a second priority type over the uplink shared channel message using a second encoding chain, where the ACK feedback multiplexed over the uplink shared channel message is included entirely of the ACK feedback of the second priority type. In some examples, the encoding component 730 may be configured as or otherwise support a means for multiplexing a first part of the CSI over the uplink shared channel message using a third encoding chain, where the CSI includes the first part and a second part.

[0139] In some examples, to support multiplexing the UCI, the ACK feedback component 740 may be configured as or otherwise support a means for appending the UCI to dummy ACK feedback in an ACK feedback codebook.

[0140] In some examples, the second part of the CSI is not multiplexed over the uplink shared channel message.

[0141] In some examples, the first priority type is of a higher priority type than the second priority type.

[0142] In some examples, the second priority type is of a higher priority type than the first priority type.

[0143] In some examples, the encoding component 730 may be configured as or otherwise support a means for multiplexing a first part of the CSI over the uplink shared channel message using a second encoding chain, where the CSI includes the first part and a second part. In some examples, the encoding component 730 may be configured as or otherwise support a means for multiplexing the second part of the CSI over the uplink shared channel message using a third encoding chain, where the UCI is multiplexed with the CSI but not with the ACK feedback.

[0144] In some examples, the UCI includes CG-UCI.

[0145] **FIG. 8** shows a diagram of a system 800 including a device 805 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The device 805 may be an example of or include the components of a device 505, a device 605, or a UE 115 as described herein. The device 805 may communicate (e.g., wirelessly) with one or more network entities 105, one or more UEs 115, or any combination thereof. The device 805 may include components for bi-directional voice and data communications including components for transmitting and receiving communications, such as a communications manager 820, an input/output (I/O) controller 810, a transceiver 815, an antenna 825, a memory 830, code 835, and a processor 840. 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 845).

[0146] The I/O controller 810 may manage input and output signals for the device 805. The I/O controller 810 may also manage peripherals not integrated into the device 805. In some cases, the I/O controller 810 may represent a physical connection or port to an external peripheral. In some cases, the I/O controller 810 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 810 may represent or interact with a modem, a keyboard, a mouse, a touchscreen, or a similar device. In some cases, the I/O controller 810 may be implemented as part of a processor, such as the processor 840. In some cases, a user may interact with the device 805 via the I/O controller 810 or via hardware components controlled by the I/O controller 810.

[0147] In some cases, the device 805 may include a single antenna 825. However, in some other cases, the device 805 may have more than one antenna 825, which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver 815 may communicate bi-directionally, via the one or more antennas 825, wired, or wireless links as described herein. For example, the transceiver 815 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 815 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 825 for transmission, and to demodulate packets received from the one or more antennas 825. The transceiver 815, or the transceiver 815 and one or more antennas 825, may be an example of a transmitter 515, a transmitter 615, a receiver 510, a receiver 610, or any combination thereof or component thereof, as described herein.

[0148] The memory 830 may include random access memory (RAM) and read-only memory (ROM). The memory 830 may store computer-readable, computer-executable code 835 including instructions that, when executed by the processor 840, cause the device 805 to perform various functions described herein. The code 835 may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some cases, the code 835 may not be directly executable by the processor 840 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some cases, the memory 830 may contain, among other things, a basic I/O system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0149] The processor 840 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, a GPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some cases, the processor 840 may be configured to operate a memory array using a memory controller. In some other cases, a memory controller may be integrated into the processor 840. The processor 840 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 830) to cause the device 805 to perform various functions (e.g., functions or tasks supporting multiplexing CG signaling and feedback with different priorities). For example, the device 805 or a component of the device 805 may include a processor 840 and memory 830 coupled with or to the processor 840, the processor 840 and memory 830 configured to perform various functions described herein.

[0150] The communications manager 820 may support wireless communications at a UE in accordance with examples as disclosed herein. For example, the communications manager 820 may be configured as or otherwise support a means for determining that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority type. The communications manager 820 may be configured as or otherwise support a means for multiplexing the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message. The communications manager 820 may be configured as or otherwise support a means for transmitting, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI.

[0151] By including or configuring the communications manager 820 in accordance with examples as described herein, the device 805 may support techniques for a UE to transmit an uplink shared channel message with multiplexed UCI and at least some ACK feedback and CSI to a network entity, which may provide for improved communication reliability, reduced latency, improved user experience related to reduced processing, reduced power consumption, more efficient utilization of communication resources, improved coordination between devices, longer battery life, or improved utilization of processing capability.

[0152] In some examples, the communications manager 820 may be configured to perform various operations (e.g., receiving, monitoring, transmitting) using or otherwise in cooperation with the transceiver 815, the one or more antennas 825, or any combination thereof. Although the communications manager 820 is illustrated as a separate component, in some examples, one or more functions described with reference to the communications manager 820 may be supported by or performed by the processor 840, the memory 830, the code 835, or any combination thereof. For example, the code 835 may include instructions executable by the processor 840 to cause the device 805 to perform various aspects of multiplexing CG signaling and feedback with different priorities as described herein, or the processor 840 and the memory 830 may be otherwise configured to perform or support such operations.

[0153] **FIG. 9** shows a block diagram 900 of a device 905 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The device 905 may be an example of aspects of a network entity 105 as described herein. The device 905 may include a receiver 910, a transmitter 915, and a communications manager 920. The device 905 may also include a processor. Each of these components may be in communication with one another (e.g., via one or more buses).

[0154] The receiver 910 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 905. In some examples, the receiver 910 may support obtaining information by receiving signals via one or more antennas. Additionally, or alternatively, the receiver 910 may support obtaining information by receiving signals via one or more wired (e.g., electrical, fiber optic) interfaces, wireless interfaces, or any combination thereof.

[0155] The transmitter 915 may provide a means for outputting (e.g., transmitting, providing, conveying, sending) information generated by other components of the device 905. For example, the transmitter 915 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 915 may support outputting information by transmitting signals via one or more antennas. Additionally, or alternatively, the transmitter 915 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 915 and the receiver 910 may be co-located in a transceiver, which may include or be coupled with a modem.

[0156] The communications manager 920, the receiver 910, the transmitter 915, or various combinations thereof or various components thereof may be examples of means for performing various aspects of multiplexing CG signaling and feedback with different priorities as described herein. For example, the communications manager 920, the receiver 910, the transmitter 915, or various combinations or components thereof may support a method for performing one or more of the functions described herein.

[0157] In some examples, the communications manager 920, the receiver 910, the transmitter 915, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include a processor, a DSP, a CPU, a GPU, 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 a means for performing the functions described in the present disclosure. In some examples, a processor and memory coupled with the processor may be configured to perform one or more of the functions described herein (e.g., by executing, by the processor, instructions stored in the memory).

[0158] Additionally, or alternatively, in some examples, the communications manager 920, the receiver 910, the transmitter 915, or various combinations or components thereof may be implemented in code (e.g., as communications management software) executed by a processor. If implemented in code executed by a processor, the functions of the communications manager 920, the receiver 910, the transmitter 915, or various combinations or components thereof may be performed by a general-purpose processor, a DSP, a CPU, a GPU, an ASIC, an FPGA, a microcontroller, or any combination of these or other programmable logic devices (e.g., configured as or otherwise supporting a means for performing the functions described in the present disclosure).

[0159] 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 receiver 910, the transmitter 915, or both. For example, the communications manager 920 may receive information from the receiver 910, send information to the transmitter 915, or be integrated in combination with the receiver 910, the transmitter 915, or both to obtain information, output information, or perform various other operations as described herein.

[0160] The communications manager 920 may support wireless communications at a network entity in accordance with examples as disclosed herein. For example, the communications manager 920 may be configured as or otherwise support a means for determining that one or more time-frequency resources allocated to a UE for reporting of acknowledgement feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority. The communications manager 920 may be configured as or otherwise support a means for receiving, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the UCI multiplexed with at least some of the ACK feedback and the CSI.

[0161] By including or configuring the communications manager 920 in accordance with examples as described herein, the device 905 (e.g., a processor controlling or otherwise coupled with the receiver 910, the transmitter 915, the communications manager 920, or a combination thereof) may support techniques for a UE to transmit an uplink shared channel message with multiplexed UCI and at least some ACK feedback and CSI to a network entity, which may provide for reduced processing, reduced power consumption, or more efficient utilization of communication resources.

[0162] **FIG. 10** shows a block diagram 1000 of a device 1005 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The device 1005 may be an example of aspects of a device 905 or a network entity 105 as described herein. The device 1005 may include a receiver 1010, a transmitter 1015, and a communications manager 1020. The device 1005 may also include a processor. Each of these components may be in communication with one another (e.g., via one or more buses).

[0163] The receiver 1010 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 1005. In some examples, the receiver 1010 may support obtaining information by receiving signals via one or more antennas. Additionally, or alternatively, the receiver 1010 may support obtaining information by receiving signals via one or more wired (e.g., electrical, fiber optic) interfaces, wireless interfaces, or any combination thereof.

[0164] The transmitter 1015 may provide a means for outputting (e.g., transmitting, providing, conveying, sending) information generated by other components of the device 1005. For example, the transmitter 1015 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 1015 may support outputting information by transmitting signals via one or more antennas. Additionally, or alternatively, the transmitter 1015 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 1015 and the receiver 1010 may be co-located in a transceiver, which may include or be coupled with a modem.

[0165] The device 1005, or various components thereof, may be an example of means for performing various aspects of multiplexing CG signaling and feedback with different priorities as described herein. For example, the communications manager 1020 may include a resource manager 1025 an uplink shred channel manager 1030, or any combination thereof. The communications manager 1020 may be an example of aspects of a communications manager 920 as described herein. In some examples, the communications manager 1020, 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 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.

[0166] The communications manager 1020 may support wireless communications at a network entity in accordance with examples as disclosed herein. The resource manager 1025 may be configured as or otherwise support a means for determining that one or more time-frequency resources allocated to a UE for reporting of acknowledgement feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority. The uplink shred channel manager 1030 may be configured as or otherwise support a means for receiving, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the UCI multiplexed with at least some of the ACK feedback and the CSI.

[0167] **FIG. 11** shows a block diagram 1100 of a communications manager 1120 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The communications manager 1120 may be an example of aspects of a communications manager 920, a communications manager 1020, or both, as described herein. The communications manager 1120, or various components thereof, may be an example of means for performing various aspects of multiplexing CG signaling and feedback with different priorities as described herein. For example, the communications manager 1120 may include a resource manager 1125 an uplink shred channel manager 1130, or any combination thereof. Each of these components may communicate, directly or indirectly, with one another (e.g., via one or more buses) which may include communications within a protocol layer of a protocol stack, communications associated with a logical channel of a protocol stack (e.g., between protocol layers of a protocol stack, within a device, component, or virtualized component associated with a network entity 105, between devices, components, or virtualized components associated with a network entity 105), or any combination thereof.

[0168] The communications manager 1120 may support wireless communications at a network entity in accordance with examples as disclosed herein. The resource manager 1125 may be configured as or otherwise support a means for determining that one or more time-frequency resources allocated to a UE for reporting of acknowledgement feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority. The uplink shred channel manager 1130 may be configured as or otherwise support a means for receiving, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the UCI multiplexed with at least some of the ACK feedback and the CSI.

[0169] In some examples, the UCI is encoded with at least a portion of the acknowledgement feedback based on the portion of the acknowledgement feedback having a same priority type as the UCI.

[0170] In some examples, the UCI includes CG-UCI.

[0171] **FIG. 12** shows a diagram of a system 1200 including a device 1205 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The device 1205 may be an example of or include the components of a device 905, a device 1005, or a network entity 105 as described herein. The device 1205 may communicate with one or more network entities 105, one or more UEs 115, or any combination thereof, which may include communications over one or more wired interfaces, over one or more wireless interfaces, or any combination thereof. The device 1205 may include components that support outputting and obtaining communications, such as a communications manager 1220, a transceiver 1210, an antenna 1215, a memory 1225, code 1230, and a processor 1235. 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 1240).

[0172] The transceiver 1210 may support bi-directional communications via wired links, wireless links, or both as described herein. In some examples, the transceiver 1210 may include a wired transceiver and may communicate bi-directionally with another wired transceiver. Additionally, or alternatively, in some examples, the transceiver 1210 may include a wireless transceiver and may communicate bi-directionally with another wireless transceiver. In some examples, the device 1205 may include one or more antennas 1215, which may be capable of transmitting or receiving wireless transmissions (e.g., concurrently). The transceiver 1210 may also include a modem to modulate signals, to provide the modulated signals for transmission (e.g., by one or more antennas 1215, by a wired transmitter), to receive modulated signals (e.g., from one or more antennas 1215, from a wired receiver), and to demodulate signals. The transceiver 1210, or the transceiver 1210 and one or more antennas 1215 or wired interfaces, where applicable, may be an example of a transmitter 915, a transmitter 1015, a receiver 910, a receiver 1010, or any combination thereof or component thereof, as described herein. In some examples, the transceiver may be operable to support communications via one or more communications links (e.g., a communication link 125, a backhaul communication link 120, a midhaul communication link 162, a fronthaul communication link 168).

[0173] The memory 1225 may include RAM and ROM. The memory 1225 may store computer-readable, computer-executable code 1230 including instructions that, when executed by the processor 1235, cause the device 1205 to perform various functions described herein. The code 1230 may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some cases, the code 1230 may not be directly executable by the processor 1235 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some cases, the memory 1225 may contain, among other things, a BIOS which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0174] The processor 1235 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, an ASIC, a CPU, a GPU, an FPGA, a microcontroller, a programmable logic device, discrete gate or transistor logic, a discrete hardware component, or any combination thereof). In some cases, the processor 1235 may be configured to operate a memory array using a memory controller. In some other cases, a memory controller may be integrated into the processor 1235. The processor 1235 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 1225) to cause the device 1205 to perform various functions (e.g., functions or tasks supporting multiplexing CG signaling and feedback with different priorities). For example, the device 1205 or a component of the device 1205 may include a processor 1235 and memory 1225 coupled with the processor 1235, the processor 1235 and memory 1225 configured to perform various functions described herein. The processor 1235 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 1230) to perform the functions of the device 1205.

[0175] In some examples, a bus 1240 may support communications of (e.g., within) a protocol layer of a protocol stack. In some examples, a bus 1240 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 1205, or between different components of the device 1205 that may be co-located or located in different locations (e.g., where the device

1205 may refer to a system in which one or more of the communications manager 1220, the transceiver 1210, the memory 1225, the code 1230, and the processor 1235 may be located in one of the different components or divided between different components).

[0176] In some examples, the communications manager 1220 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 1220 may manage the transfer of data communications for client devices, such as one or more UEs 115. In some examples, the communications manager 1220 may manage communications with other network entities 105, and may include a controller or scheduler for controlling communications with UEs 115 in cooperation with other network entities 105. In some examples, the communications manager 1220 may support an X2 interface within an LTE/LTE-A wireless communications network technology to provide communication between network entities 105.

[0177] The communications manager 1220 may support wireless communications at a network entity in accordance with examples as disclosed herein. For example, the communications manager 1220 may be configured as or otherwise support a means for determining that one or more time-frequency resources allocated to a UE for reporting of acknowledgement feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority. The communications manager 1220 may be configured as or otherwise support a means for receiving, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the UCI multiplexed with at least some of the ACK feedback and the CSI.

[0178] By including or configuring the communications manager 1220 in accordance with examples as described herein, the device 1205 may support techniques for a UE to transmit an uplink shared channel message with multiplexed UCI and at least some ACK feedback and CSI to a network entity, which may provide for improved communication reliability, reduced latency, improved user experience related to reduced processing, reduced power consumption, more efficient utilization of communication resources, improved coordination between devices, longer battery life, or improved utilization of processing capability.

[0179] In some examples, the communications manager 1220 may be configured to perform various operations (e.g., receiving, obtaining, monitoring, outputting, transmitting) using or otherwise in cooperation with the transceiver 1210, the one or more antennas 1215 (e.g., where applicable), or any combination thereof. Although the communications manager 1220 is illustrated as a separate component, in some examples, one or more functions described with reference to the communications manager 1220 may be supported by or performed by the processor 1235, the memory 1225, the code 1230, the transceiver 1210, or any combination thereof. For example, the code 1230 may include instructions executable by the processor 1235 to cause the device 1205 to perform various aspects of multiplexing CG signaling and feedback with different priorities as described herein, or the processor 1235 and the memory 1225 may be otherwise configured to perform or support such operations.

[0180] **FIG. 13** shows a flowchart illustrating a method 1300 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The operations of the method 1300 may be implemented by a UE or its components as described herein. For example, the operations of the method 1300 may be performed by a UE 115 as described with reference to FIGs. 1 through 8. In some examples, a UE may execute a set of instructions to control the functional elements of the UE to perform the described functions. Additionally, or alternatively, the UE may perform aspects of the described functions using special-purpose hardware.

[0181] At 1305, the method may include determining that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority type. The operations of 1305 may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of 1305 may be performed by a resource component 725 as described with reference to FIG. 7.

[0182] At 1310, the method may include multiplexing the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message. The operations of 1310 may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of 1310 may be performed by an encoding component 730 as described with reference to FIG. 7.

[0183] At 1315, the method may include transmitting, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI. The operations of 1315 may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of 1315 may be performed by an uplink shared channel component 735 as described with reference to FIG. 7.

[0184] **FIG. 14** shows a flowchart illustrating a method 1400 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The operations of the method 1400 may be implemented by a UE or its components as described herein. For example, the operations of the method 1400 may be performed by a UE 115 as described with reference to FIGs. 1 through 8. In some examples, a UE may execute a set of instructions to control the functional elements of the UE to perform the described functions. Additionally, or alternatively, the UE may perform aspects of the described functions using special-purpose hardware.

[0185] At 1405, the method may include determining that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority type. 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 resource component 725 as described with reference to FIG. 7.

[0186] At 1410, the method may include multiplexing the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message. 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 an encoding component 730 as described with reference to FIG. 7.

[0187] At 1415, the method may include appending the UCI to ACK feedback of the first priority type in an ACK feedback codebook, the ACK feedback of the first priority type being at least a portion of the ACK feedback multiplexed over the uplink shared channel message. 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 an ACK feedback component 740 as described with reference to FIG. 7.

[0188] At 1420, the method may include transmitting, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI. The operations of 1420 may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of 1420 may be performed by an uplink shared channel component 735 as described with reference to FIG. 7.

[0189] **FIG. 15** shows a flowchart illustrating a method 1500 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The operations of the method 1500 may be implemented by a UE or its components as described herein. For example, the operations of the method 1500 may be performed by a UE 115 as described with reference to FIGs. 1 through 8. In some examples, a UE may execute a set of instructions to control the functional elements of the UE to perform the described functions. Additionally, or alternatively, the UE may perform aspects of the described functions using special-purpose hardware.

[0190] At 1505, the method may include determining that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority type. 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 resource component 725 as described with reference to FIG. 7.

[0191] At 1510, the method may include multiplexing the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message. 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 an encoding component 730 as described with reference to FIG. 7.

[0192] At 1515, the method may include multiplexing ACK feedback of a second priority type over the uplink shared channel message using a second encoding chain, where the ACK feedback multiplexed over the uplink shared channel message comprises entirely of the ACK feedback of the second priority type. 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 an encoding component 730 as described with reference to FIG. 7.

[0193] At 1520, the method may include multiplexing a first part of the CSI over the uplink shared channel message using a third encoding chain, where the CSI includes the first part and a second part. 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 an encoding component 730 as described with reference to FIG. 7.

[0194] At 1525, the method may include transmitting, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI. The operations of 1525 may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of 1525 may be performed by an uplink shared channel component 735 as described with reference to FIG. 7.

[0195] **FIG. 16** shows a flowchart illustrating a method 1600 that supports multiplexing CG signaling and feedback with different priorities in accordance with one or more aspects of the present disclosure. The operations of the method 1600 may be implemented by a network entity or its components as described herein. For example, the operations of the method 1600 may be performed by a network entity as described with reference to FIGs. 1 through 4 and 9 through 12. In some examples, a network entity may execute a set of instructions to control the functional elements of the network entity to perform the described functions. Additionally, or alternatively, the network entity may perform aspects of the described functions using special-purpose hardware.

[0196] At 1605, the method may include determining that one or more time-frequency resources allocated to a UE for reporting of acknowledgement feedback and CSI overlaps with a periodic resource allocation for an uplink shared channel message having associated UCI, the UCI being of a first priority. 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 resource manager 1125 as described with reference to FIG. 11.

[0197] At 1610, the method may include receiving, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the UCI multiplexed with at least some of the ACK feedback and the CSI. 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 an uplink shred channel manager 1130 as described with reference to FIG. 11.

[0198] The following provides an overview of aspects of the present disclosure:

[0199] Aspect 1: A method for wireless communications at a UE, comprising: determining that one or more time-frequency resources allocated to the UE for reporting of acknowledgment feedback and channel state information overlaps with a periodic resource allocation for a uplink shared channel message having associated uplink control information, the uplink control information being of a first priority type; multiplexing the uplink control information with at least some of the acknowledgment feedback and channel state information over the uplink shared channel message, the uplink control information being multiplexed using a first encoding chain designated for multiplexing acknowledgment feedback of the first priority type with the uplink shared channel message; and transmitting, on a configured grant uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed uplink control information and the at least some of the acknowledgment feedback and channel state information.

[0200] Aspect 2: The method of aspect 1, wherein multiplexing the uplink control information comprises: appending the uplink control information to acknowledgment feedback of the first priority type in an acknowledgment feedback codebook, the acknowledgment feedback of the first priority type being at least a portion of the acknowledgment feedback multiplexed over the uplink shared channel message.

[0201] Aspect 3: The method of aspect 2, further comprising: multiplexing the channel state information over the uplink shared channel message using a combination of a second encoding chain and a third encoding chain, wherein the acknowledgment feedback multiplexed over the uplink shared channel message is comprised entirely of the acknowledgment feedback of the first priority type, and wherein the second encoding chain and the third encoding chain are each different from the first encoding chain.

[0202] Aspect 4: The method of aspect 3, wherein multiplexing the channel state information comprises: multiplexing a first part of the channel state information using the second encoding chain; and multiplexing a second part of the channel state information using the third encoding chain.

[0203] Aspect 5: The method of any of aspects 2 through 4, further comprising: multiplexing acknowledgment feedback of a second priority type over the uplink shared channel message using a second encoding chain, wherein the acknowledgment feedback multiplexed over the uplink shared channel message comprises the acknowledgment feedback of the first priority type and the acknowledgment feedback of the second priority type; and multiplexing a first part of the channel state information over the uplink shared channel message using a third encoding chain, wherein the channel state information comprises the first part and a second part.

[0204] Aspect 6: The method of aspect 5, wherein the second part of the channel state information is not multiplexed over the uplink shared channel message.

[0205] Aspect 7: The method of any of aspects 5 through 6, wherein the first priority type is of a higher priority type than the second priority type.

[0206] Aspect 8: The method of any of aspects 5 through 6, wherein the second priority type is of a higher priority type than the first priority type.

[0207] Aspect 9: The method of any of aspects 1 through 8, further comprising: multiplexing acknowledgment feedback of a second priority type over the uplink shared channel message using a second encoding chain, wherein the acknowledgment feedback multiplexed over the uplink shared channel message is comprised entirely of the acknowledgment feedback of the second priority type; and multiplexing a first part of the channel state information over the uplink shared channel message using a third encoding chain, wherein the channel state information comprises the first part and a second part.

[0208] Aspect 10: The method of aspect 9, wherein multiplexing the uplink control information comprises: appending the uplink control information to dummy acknowledgment feedback in an acknowledgment feedback codebook.

[0209] Aspect 11: The method of any of aspects 9 through 10, wherein the second part of the channel state information is not multiplexed over the uplink shared channel message.

[0210] Aspect 12: The method of any of aspects 9 through 11, wherein the first priority type is of a higher priority type than the second priority type.

[0211] Aspect 13: The method of any of aspects 9 through 11, wherein the second priority type is of a higher priority type than the first priority type.

[0212] Aspect 14: The method of any of aspects 1 through 13, further comprising: multiplexing a first part of the channel state information over the uplink shared channel message using a second encoding chain, wherein the channel state information comprises the first part and a second part; and multiplexing the second part of the channel state information over the uplink shared channel message using a third encoding chain, wherein the uplink control information is multiplexed with the channel state information but not with the acknowledgment feedback.

[0213] Aspect 15: The method of any of aspects 1 through 14, wherein the uplink control information comprises configured grant-uplink control information.

[0214] Aspect 16: A method for wireless communications at a network entity, comprising: determining that one or more time-frequency resources allocated to a UE for reporting of acknowledgement feedback and channel state information overlaps with a periodic resource allocation for a uplink shared channel message having associated uplink control information, the uplink control information being of a first priority; and receiving, on a configured grant uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the uplink control information multiplexed with at least some of the acknowledgment feedback and the channel state information.

[0215] Aspect 17: The method of aspect 16, wherein the uplink control information is encoded with at least a portion of the acknowledgement feedback based at least in part on the portion of the acknowledgement feedback having a same priority type as the uplink control information.

[0216] Aspect 18: The method of any of aspects 16 through 17, wherein the uplink control information comprises configured grant-uplink control information.

[0217] Aspect 19: An apparatus for wireless communications at a UE, comprising a processor; memory coupled with the processor; and instructions stored in the memory and executable by the processor to cause the apparatus to perform a method of any of aspects 1 through 15.

[0218] Aspect 20: An apparatus for wireless communications at a UE, comprising at least one means for performing a method of any of aspects 1 through 15.

[0219] Aspect 21: A non-transitory computer-readable medium storing code for wireless communications at a UE, the code comprising instructions executable by a processor to perform a method of any of aspects 1 through 15.

[0220] Aspect 22: An apparatus for wireless communications at a network entity, comprising a processor; memory coupled with the processor; and instructions stored in the memory and executable by the processor to cause the apparatus to perform a method of any of aspects 16 through 18.

[0221] Aspect 23: An apparatus for wireless communications at a network entity, comprising at least one means for performing a method of any of aspects 16 through 18.

[0222] Aspect 24: A non-transitory computer-readable medium storing code for wireless communications at a network entity, the code comprising instructions executable by a processor to perform a method of any of aspects 16 through 18.

[0223] It should be noted that the methods described herein describe possible implementations, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible. Further, aspects from two or more of the methods may be combined.

[0224] 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.

[0225] 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.

[0226] The various illustrative blocks and components described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, a CPU, a GPU, 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).

[0227] The functions described herein may be implemented in 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 may 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.

[0228] Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer. By way of example, 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 where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above are also included within the scope of computer-readable media.

[0229] As used herein, including in the claims, “or” as used in a list of items (e.g., a list of items prefaced by a phrase such as “at least one of” or “one or more of”) indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase “based on” shall not be construed as a reference to a closed set of conditions. For example, an example step that is described as “based on condition A” may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase “based on” shall be construed in the same manner as the phrase “based at least in part on.” 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.

[0230] The term “determine” or “determining” encompasses a variety of actions and, therefore, “determining” 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” can include receiving (such as receiving information), accessing (such as accessing data in a memory) and the like. Also, “determining” can include resolving, obtaining, selecting, choosing, establishing and other such similar actions.

[0231] 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.

[0232] 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 instances, known structures and devices are shown in block diagram form in order to avoid obscuring the concepts of the described examples.

[0233] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

What is claimed is:

1. A method for wireless communications at a user equipment (UE), comprising:

determining that one or more time-frequency resources allocated to the UE for reporting of acknowledgment feedback and channel state information overlaps with a periodic resource allocation for an uplink shared channel message comprising associated uplink control information, the uplink control information being of a first priority type;

multiplexing the uplink control information with at least some of the acknowledgment feedback and channel state information over the uplink shared channel message, the uplink control information being multiplexed using a first encoding chain designated for multiplexing acknowledgment feedback of the first priority type with the uplink shared channel message; and

transmitting, on a configured grant uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed uplink control information and the at least some of the acknowledgment feedback and channel state information.

2. The method of claim 1, wherein multiplexing the uplink control information comprises:

appending the uplink control information to acknowledgment feedback of the first priority type in an acknowledgment feedback codebook, the acknowledgment feedback of the first priority type being at least a portion of the acknowledgment feedback multiplexed over the uplink shared channel message.

3. The method of claim 2, further comprising:

multiplexing the channel state information over the uplink shared channel message using a combination of a second encoding chain and a third encoding chain, wherein the acknowledgment feedback multiplexed over the uplink shared channel message comprises entirely of the acknowledgment feedback of the first priority type, and wherein the second encoding chain and the third encoding chain are each different from the first encoding chain.

4. The method of claim 3, wherein multiplexing the channel state information comprises:

multiplexing a first part of the channel state information using the second encoding chain; and

multiplexing a second part of the channel state information using the third encoding chain.

5. The method of claim 2, further comprising:

multiplexing acknowledgment feedback of a second priority type over the uplink shared channel message using a second encoding chain, wherein the acknowledgment feedback multiplexed over the uplink shared channel message comprises the acknowledgment feedback of the first priority type and the acknowledgment feedback of the second priority type; and

multiplexing a first part of the channel state information over the uplink shared channel message using a third encoding chain, wherein the channel state information comprises the first part and a second part.

6. The method of claim 5, wherein the second part of the channel state information is not multiplexed over the uplink shared channel message.

7. The method of claim 5, wherein the first priority type is of a higher priority type than the second priority type.

8. The method of claim 5, wherein the second priority type is of a higher priority type than the first priority type.

9. The method of claim 1, further comprising:

multiplexing acknowledgment feedback of a second priority type over the uplink shared channel message using a second encoding chain, wherein the acknowledgment feedback multiplexed over the uplink shared channel message comprises entirely of the acknowledgment feedback of the second priority type; and

multiplexing a first part of the channel state information over the uplink shared channel message using a third encoding chain, wherein the channel state information comprises the first part and a second part.

10. The method of claim 9, wherein multiplexing the uplink control information comprises:

appending the uplink control information to dummy acknowledgment feedback in an acknowledgment feedback codebook.

11. The method of claim 9, wherein the second part of the channel state information is not multiplexed over the uplink shared channel message.

12. The method of claim 9, wherein the first priority type is of a higher priority type than the second priority type.

13. The method of claim 9, wherein the second priority type is of a higher priority type than the first priority type.

14. The method of claim 1, further comprising:

multiplexing a first part of the channel state information over the uplink shared channel message using a second encoding chain, wherein the channel state information comprises the first part and a second part; and

multiplexing the second part of the channel state information over the uplink shared channel message using a third encoding chain, wherein the uplink control information is multiplexed with the channel state information but not with the acknowledgment feedback.

15. The method of claim 1, wherein the uplink control information comprises configured grant-uplink control information.

16. A method for wireless communications at a network entity, comprising:

determining that one or more time-frequency resources allocated to a user equipment (UE) for reporting of acknowledgement feedback and channel state information overlaps with a periodic resource allocation for an uplink shared channel message comprising associated uplink control information, the uplink control information being of a first priority; and

receiving, on a configured grant uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the uplink control information multiplexed with at least some of the acknowledgment feedback and the channel state information.

17. The method of claim 16, wherein the uplink control information is encoded with at least a portion of the acknowledgement feedback based at least in part on the portion of the acknowledgement feedback having a same priority type as the uplink control information.

18. The method of claim 16, wherein the uplink control information comprises configured grant-uplink control information.

19. An apparatus for wireless communications at a user equipment (UE), comprising:

at least one processor; and

memory coupled with the at least one processor, the memory storing instructions executable by the at least one processor to cause the UE to:

determine that one or more time-frequency resources allocated to the UE for reporting of acknowledgment feedback and channel state information overlaps with a periodic resource allocation for an uplink shared channel message having associated uplink control information, the uplink control information being of a first priority type;

multiplex the uplink control information with at least some of the acknowledgment feedback and channel state information over the uplink shared channel message, the uplink control information being multiplexed using a first encoding chain designated for multiplexing acknowledgment feedback of the first priority type with the uplink shared channel message; and

transmit, on a configured grant uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed uplink control information and the at least some of the acknowledgment feedback and channel state information.

20. The apparatus of claim 19, wherein the instructions to multiplex the uplink control information are executable by the at least one processor to cause the UE to:

append the uplink control information to acknowledgment feedback of the first priority type in an acknowledgment feedback codebook, the acknowledgment feedback of the first priority type being at least a portion of the acknowledgment feedback multiplexed over the uplink shared channel message.

21. The apparatus of claim 20, wherein the instructions are further executable by the at least one processor to cause the UE to:

multiplex the channel state information over the uplink shared channel message using a combination of a second encoding chain and a third encoding chain, wherein the acknowledgment feedback multiplexed over the uplink shared channel message comprises entirely of the acknowledgment feedback of the first priority type, and wherein the second encoding chain and the third encoding chain are each different from the first encoding chain.

22. The apparatus of claim 21, wherein the instructions to multiplex the channel state information are executable by the at least one processor to cause the UE to:

multiplex a first part of the channel state information using the second encoding chain; and

multiplex a second part of the channel state information using the third encoding chain.

23. The apparatus of claim 20, wherein the instructions are further executable by the at least one processor to cause the UE to:

multiplexing acknowledgment feedback of a second priority type over the uplink share channel message using a second encoding chain, wherein the acknowledgment feedback multiplexed over the uplink shared channel message comprises the acknowledgment feedback of the first priority type and the acknowledgment feedback of the second priority type; and

multiplex a first part of the channel state information over the uplink shared channel message using a third encoding chain, wherein the channel state information comprises the first part and a second part.

24. The apparatus of claim 23, wherein the second part of the channel state information is not multiplexed over the uplink shared channel message.

25. The apparatus of claim 23, wherein the first priority type is of a higher priority type than the second priority type.

26. The apparatus of claim 23, wherein the second priority type is of a higher priority type than the first priority type.

27. The apparatus of claim 19, wherein the instructions are further executable by the at least one processor to cause the UE to:

multiplexing acknowledgment feedback of a second priority type over the uplink share channel message using a second encoding chain, wherein the acknowledgment feedback multiplexed over the uplink shared channel message comprises entirely of the acknowledgment feedback of the second priority type; and

multiplex a first part of the channel state information over the uplink shared channel message using a third encoding chain, wherein the channel state information comprises the first part and a second part.

28. The apparatus of claim 27, wherein the instructions to multiplex the uplink control information are executable by the at least one processor to cause the UE to:

append the uplink control information to dummy acknowledgment feedback in an acknowledgment feedback codebook.

29. The apparatus of claim 19, wherein the instructions are further executable by the at least one processor to cause the UE to:

multiplex a first part of the channel state information over the uplink shared channel message using a second encoding chain, wherein the channel state information comprises the first part and a second part; and

multiplex the second part of the channel state information over the uplink shared channel message using a third encoding chain, wherein the uplink control information is multiplexed with the channel state information but not with the acknowledgment feedback.

30. An apparatus for wireless communications at a network entity, comprising:

at least one processor; and

memory coupled with the at least one processor, the memory storing instructions executable by the at least one processor to cause the network entity to:

determine that one or more time-frequency resources allocated to a user equipment (UE) for reporting of acknowledgement feedback and channel state information overlaps with a periodic resource allocation for an uplink shared channel message having associated uplink control information, the uplink control information being of a first priority; and

receive, on a configured grant uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the uplink control information multiplexed with at least some of the acknowledgment feedback and the channel state information.

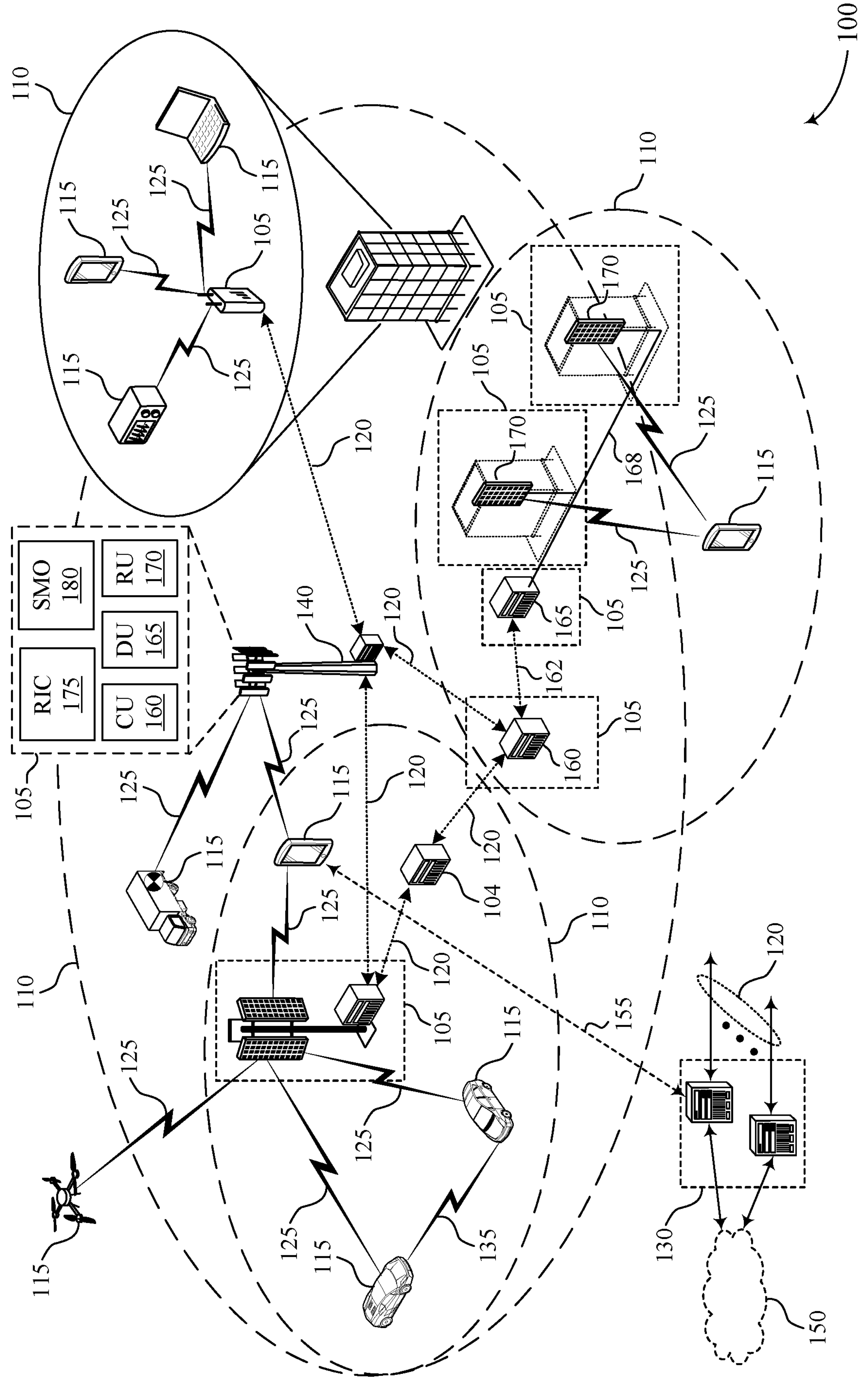
100
RIC
175
SMO
180
CU
160
DU
165
RU
170
105
110
115
120
125
130
135
140
150
155
160
162
165
168
170
104

FIG. 1

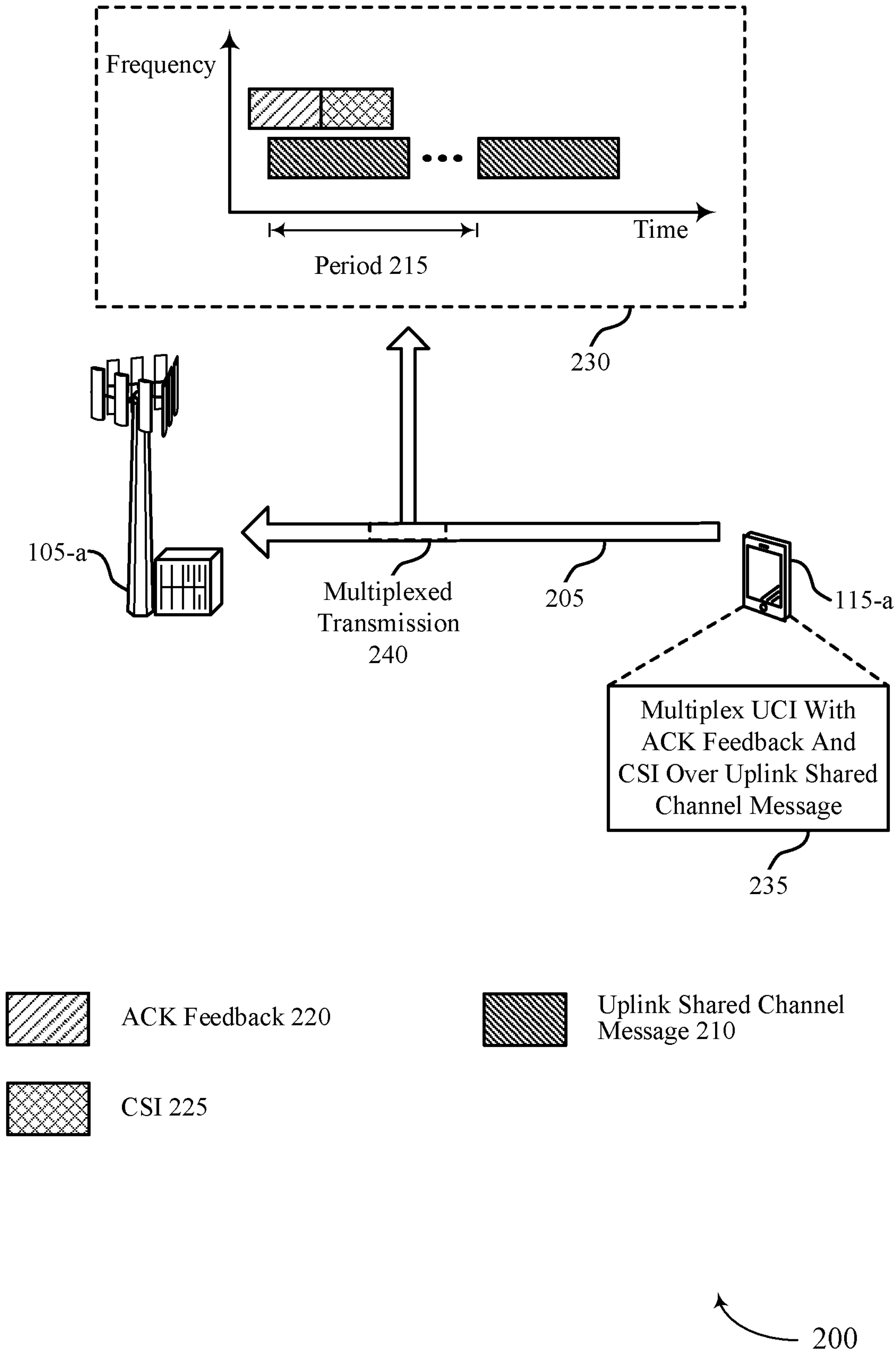
Frequency
Time
Period 215
230
105-a
Multiplexed
Transmission
240
205
115-a
Multiplex UCI With
ACK Feedback And
CSI Over Uplink Shared
Channel Message
235
ACK Feedback 220
Uplink Shared Channel
Message 210
CSI 225
200

FIG. 2

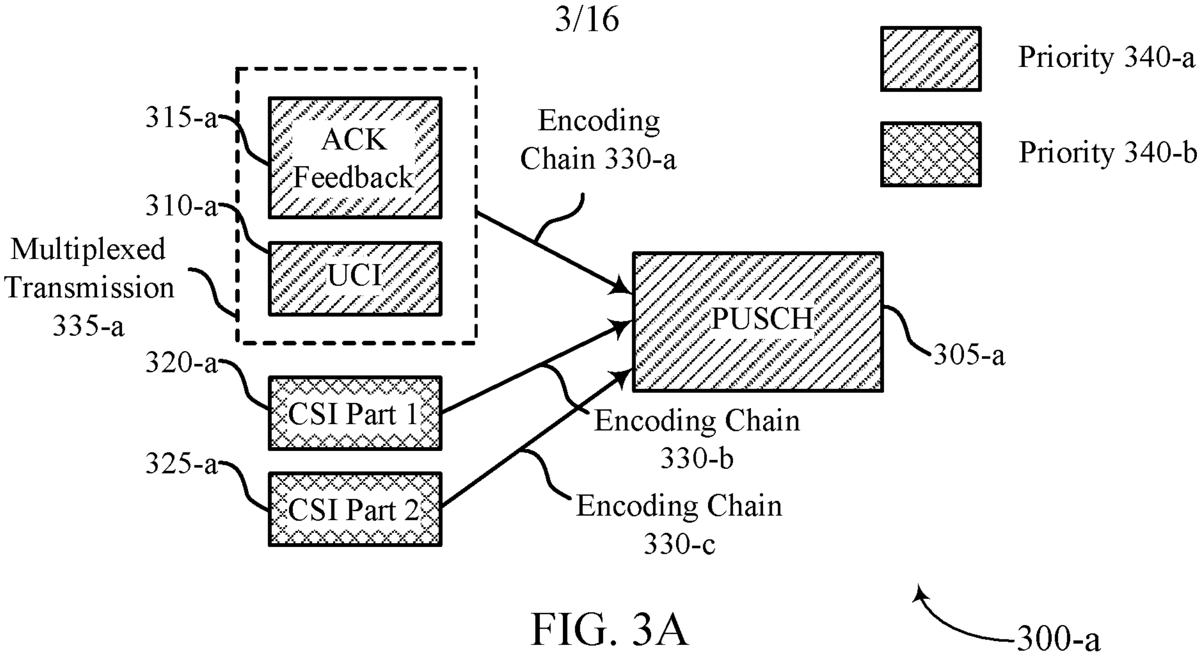

FIG. 3A

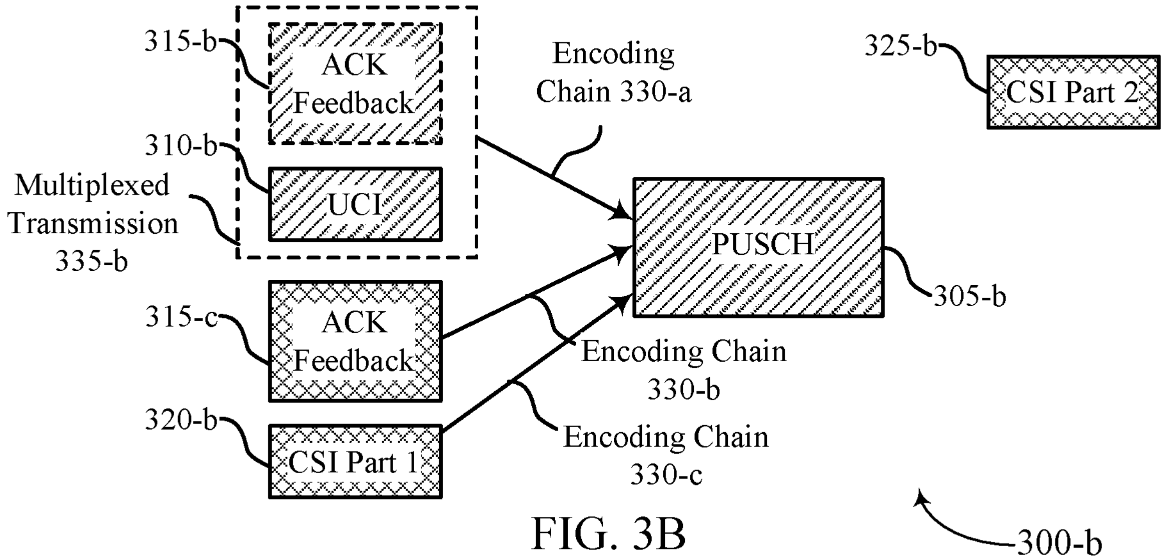

FIG. 3B

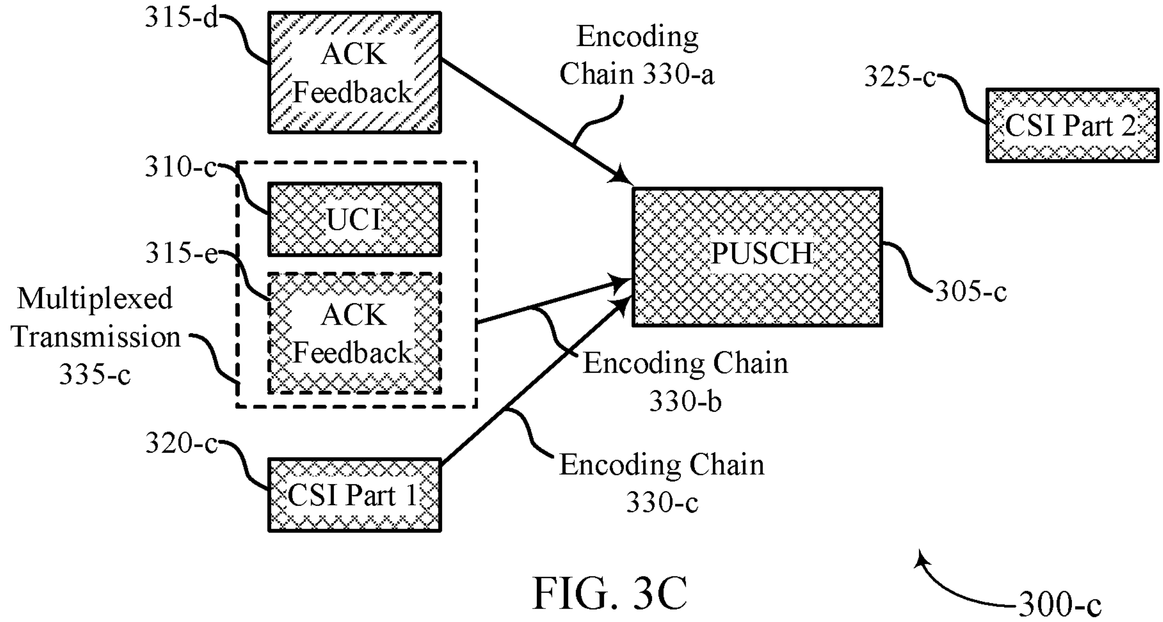

FIG. 3C

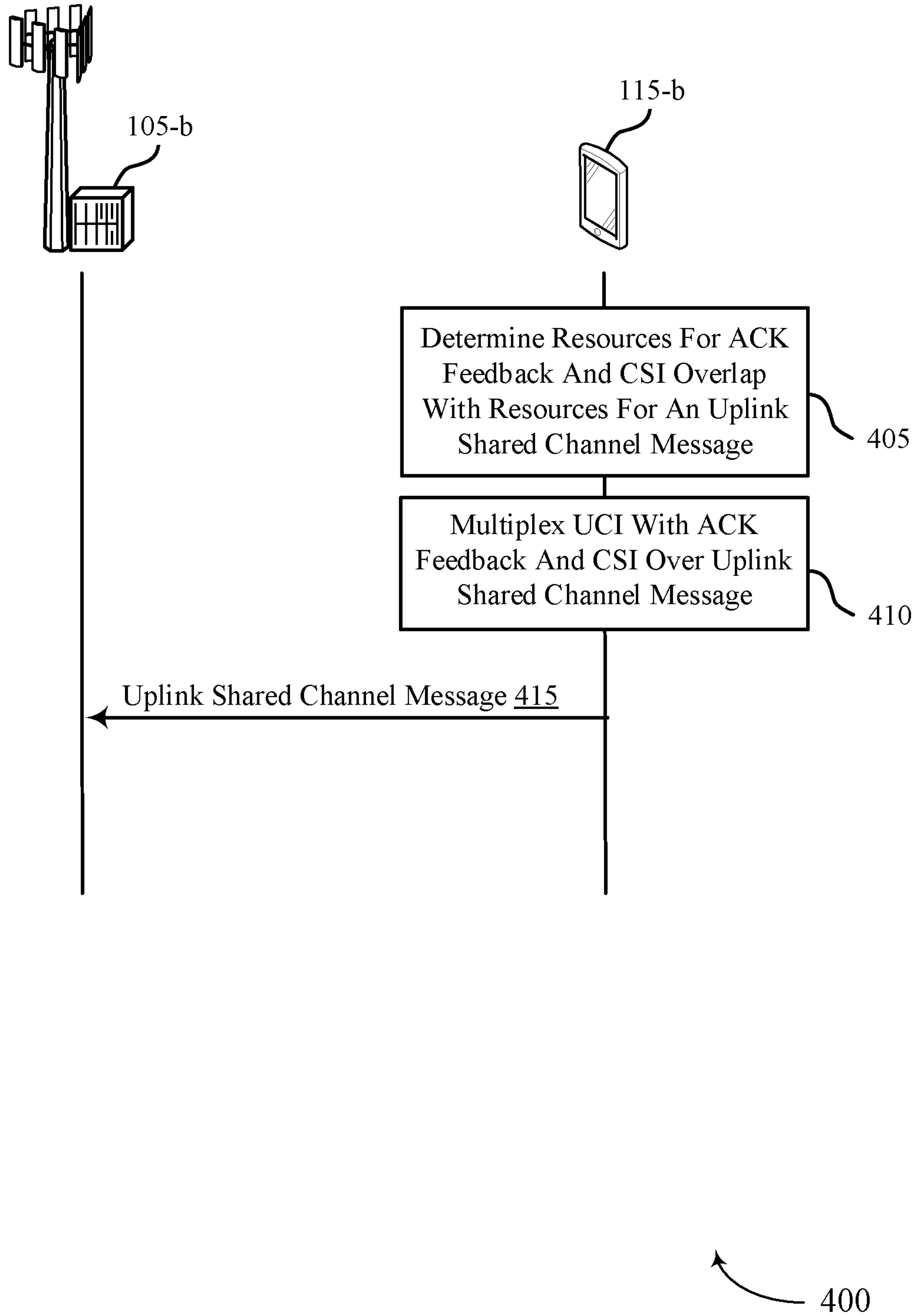
105-b
115-b
Determine Resources For ACK Feedback And CSI Overlap With Resources For An Uplink Shared Channel Message
405
Multiplex UCI With ACK Feedback And CSI Over Uplink Shared Channel Message
410
Uplink Shared Channel Message 415
400

FIG. 4

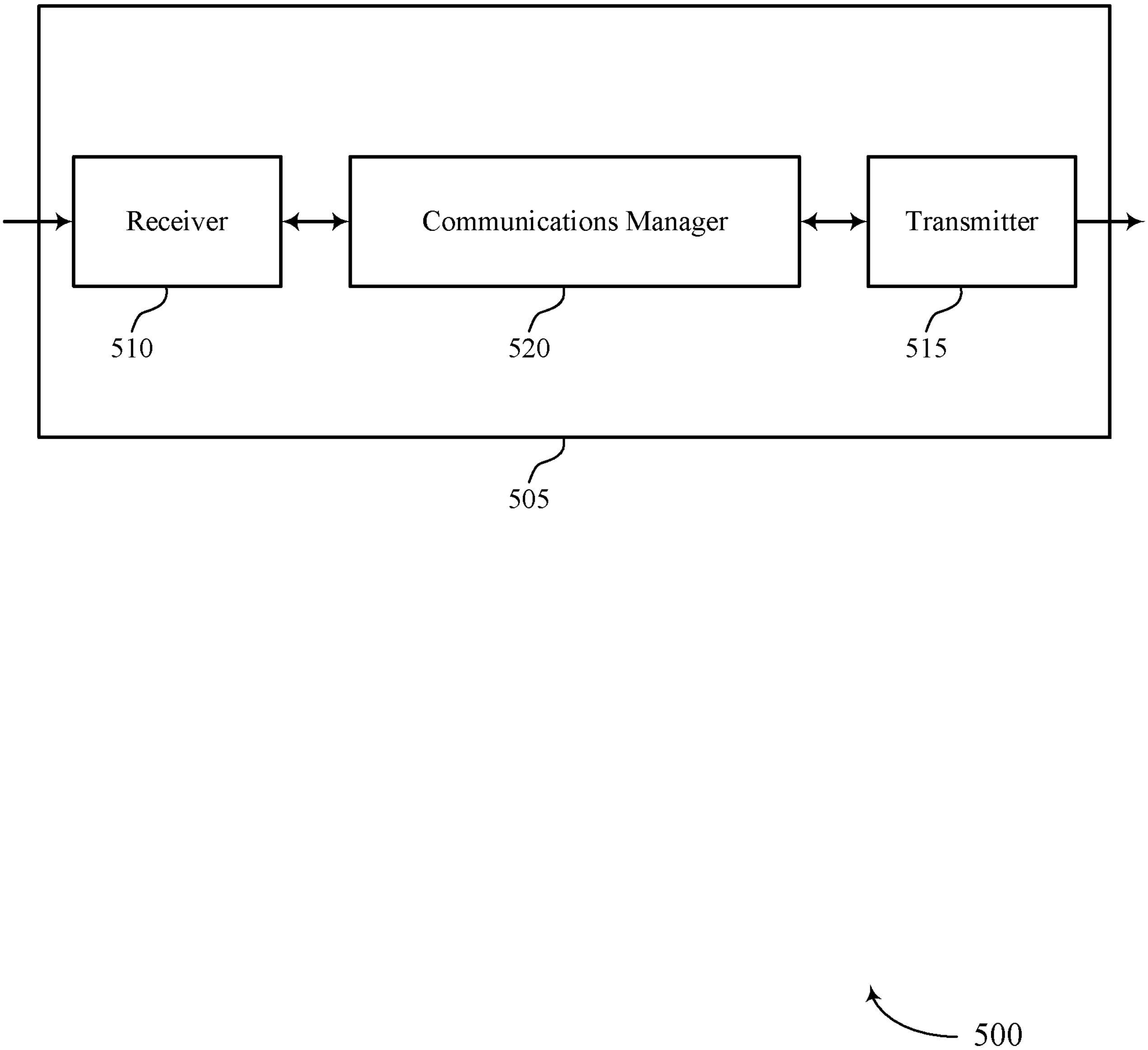
Receiver
Communications Manager
Transmitter
510
520
515
505
500

FIG. 5

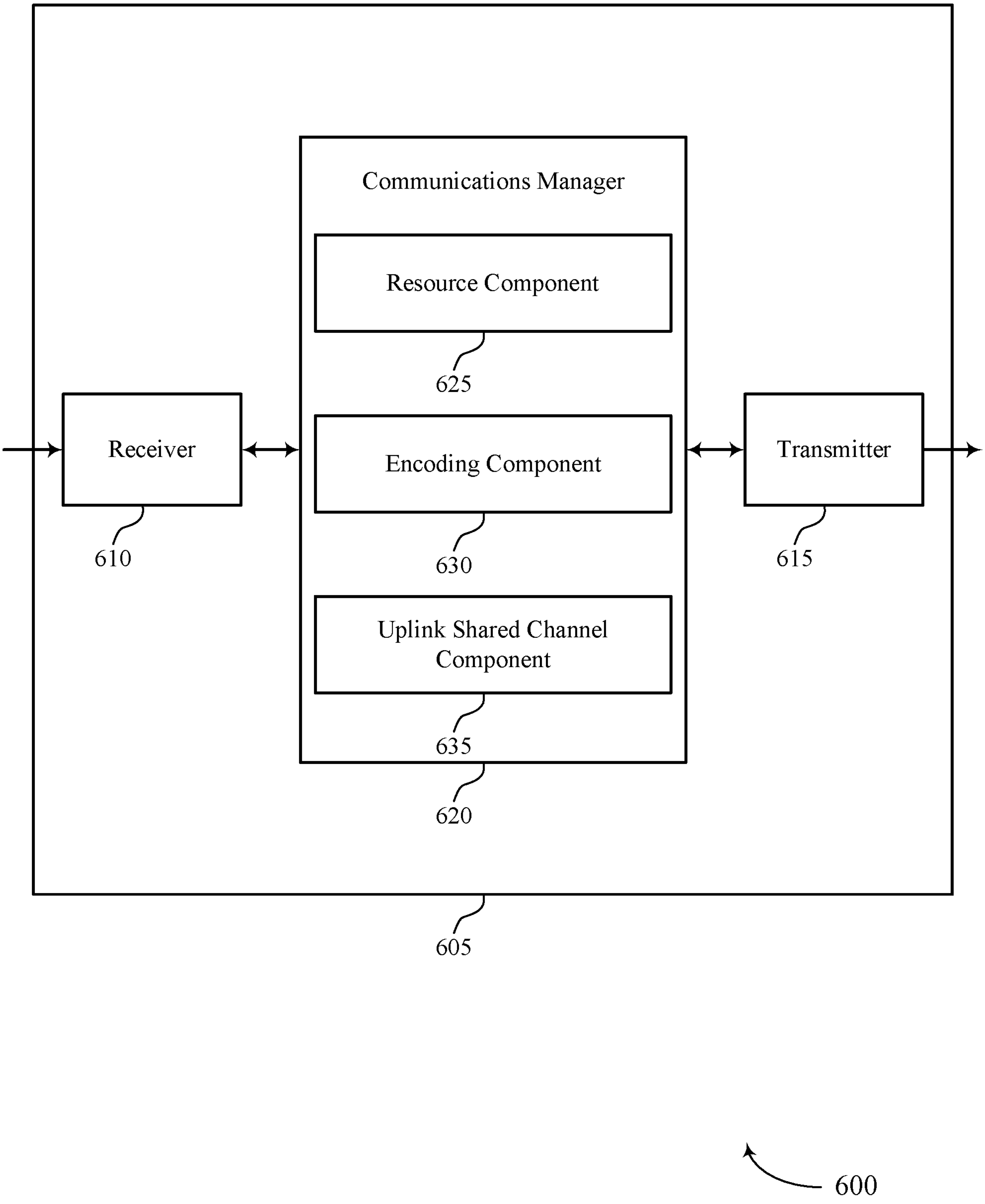
Communications Manager
Resource Component
625
Receiver
Encoding Component
Transmitter
610
630
615
Uplink Shared Channel Component
635
620
605
600

FIG. 6

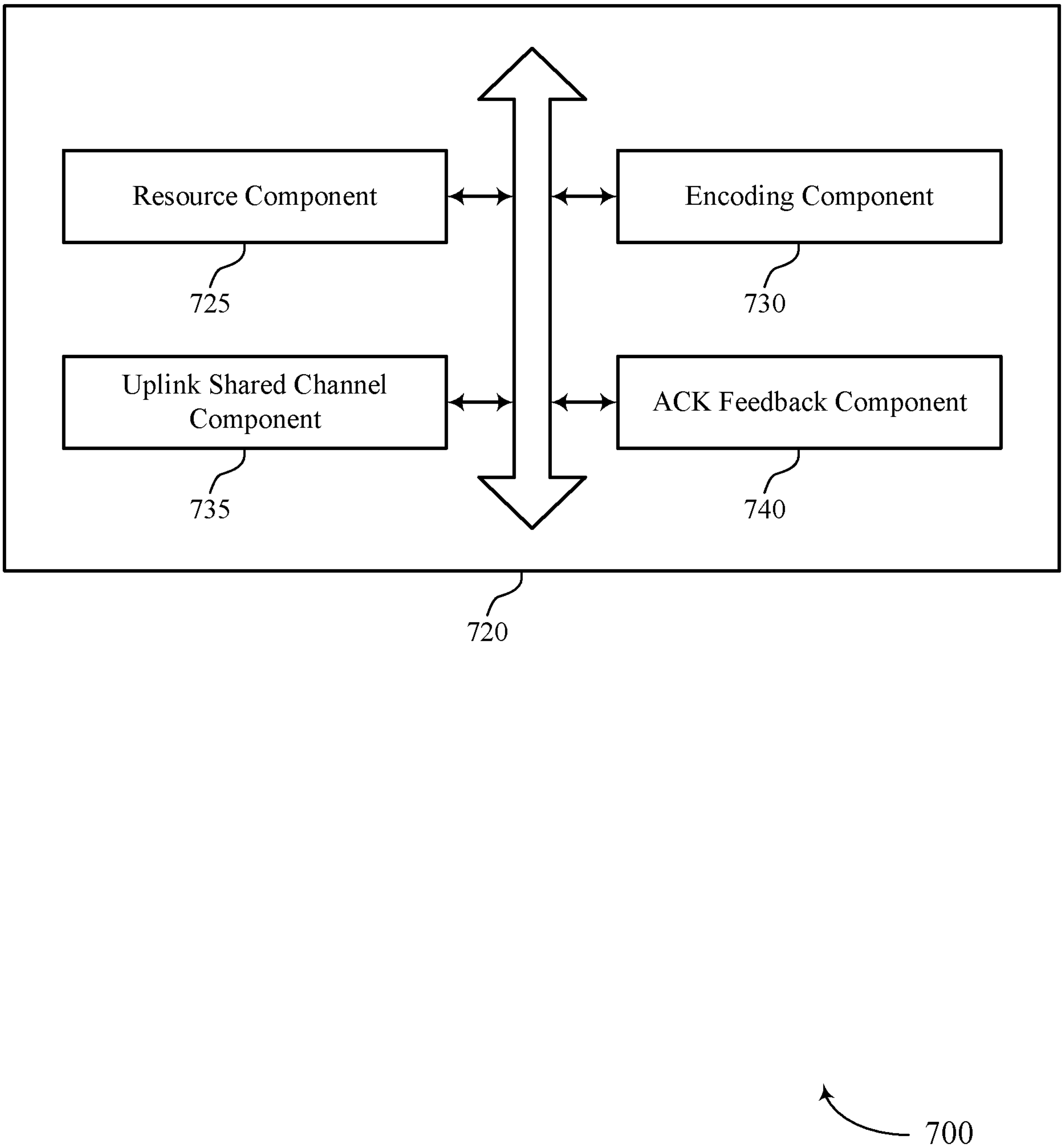
Resource Component
725
Encoding Component
730
Uplink Shared Channel Component
735
ACK Feedback Component
740
720
700

FIG. 7

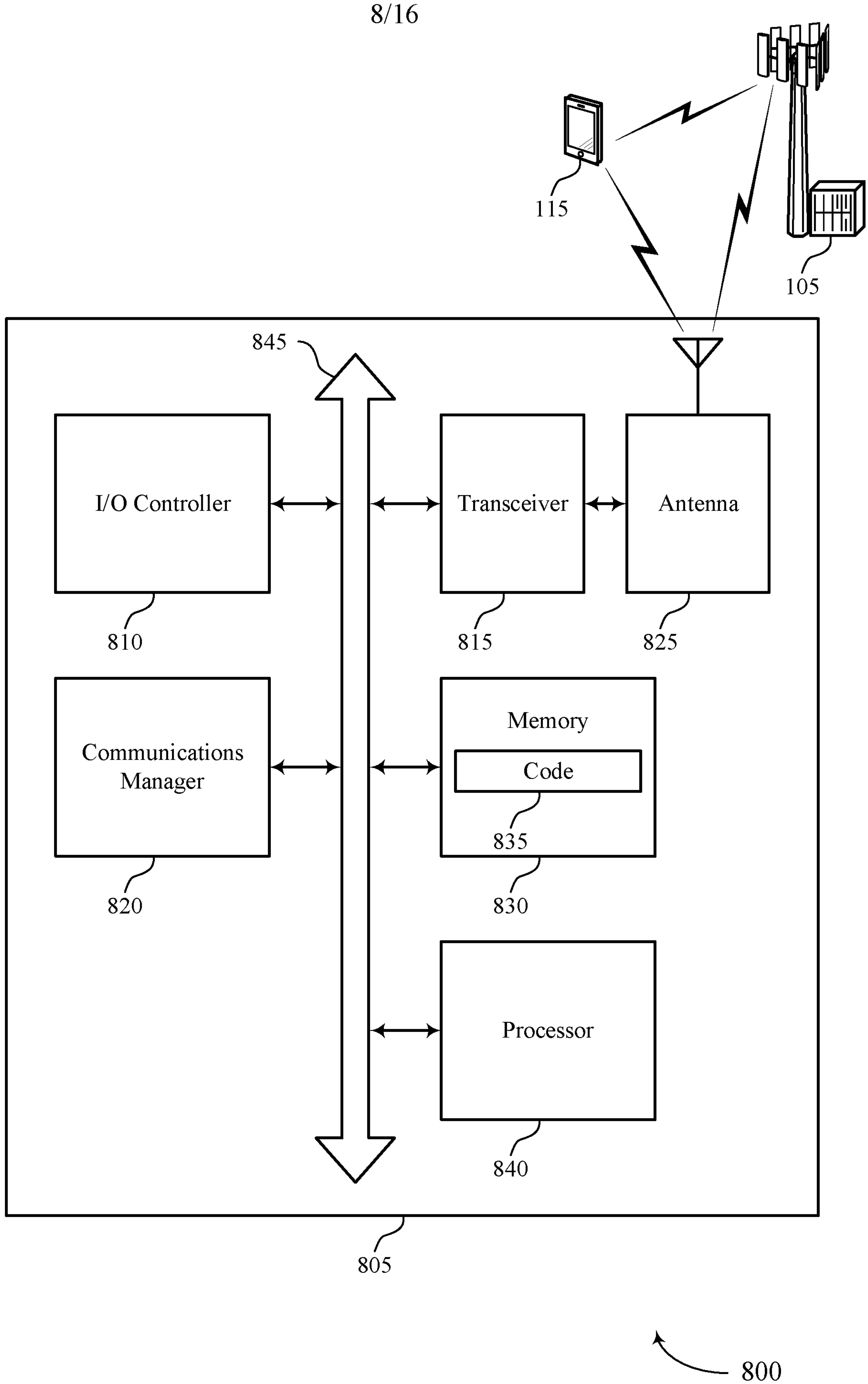
115
105
845
I/O Controller
Transceiver
Antenna
810
815
825
Communications Manager
Memory
Code
835
820
830
Processor
840
805
800

FIG. 8

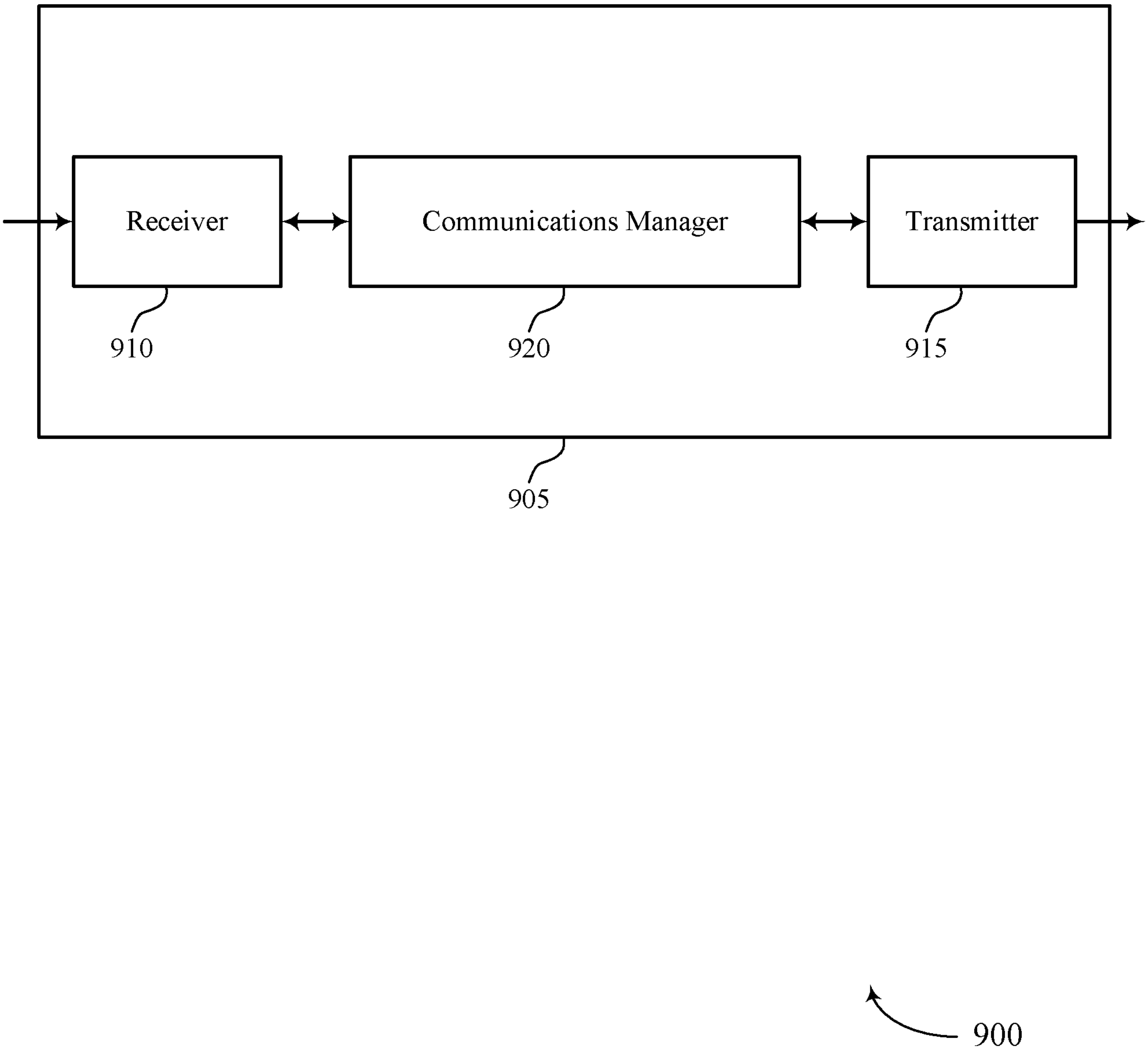
Receiver
Communications Manager
Transmitter
910
920
915
905
900

FIG. 9

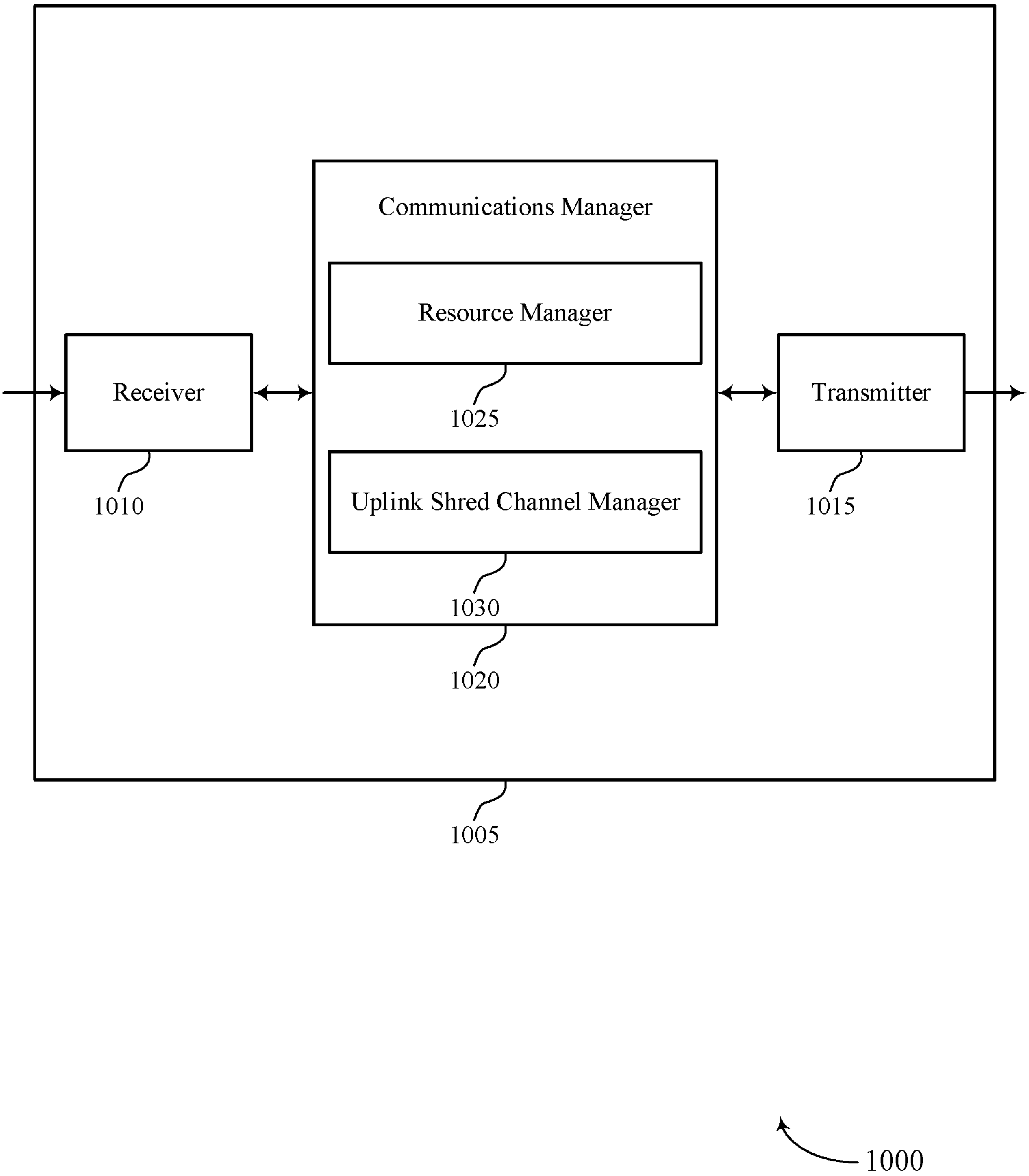
Communications Manager
Resource Manager
1025
Uplink Shred Channel Manager
1030
1020
Receiver
1010
Transmitter
1015
1005
1000

FIG. 10

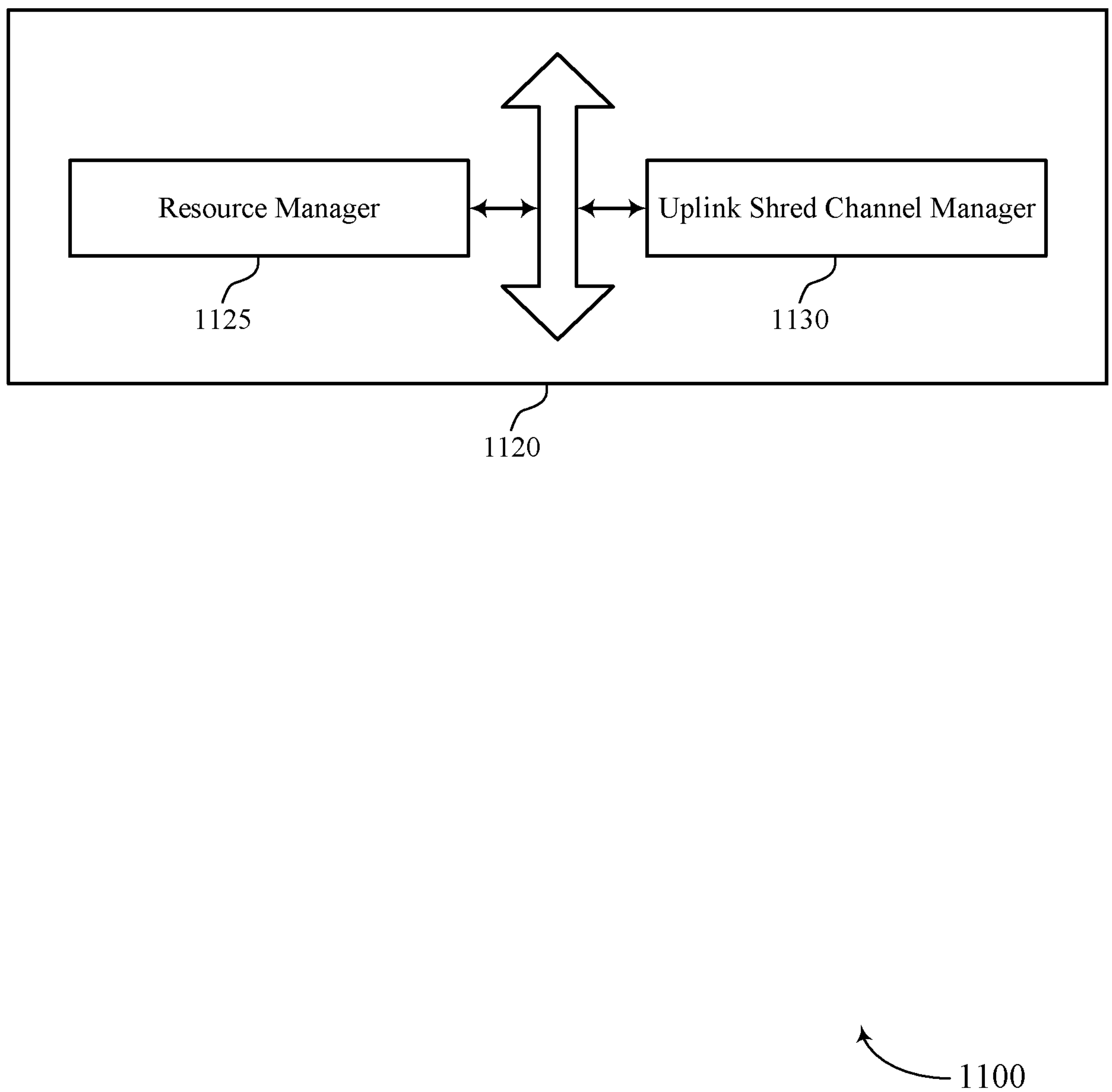
Resource Manager
Uplink Shred Channel Manager
1125
1130
1120
1100

FIG. 11

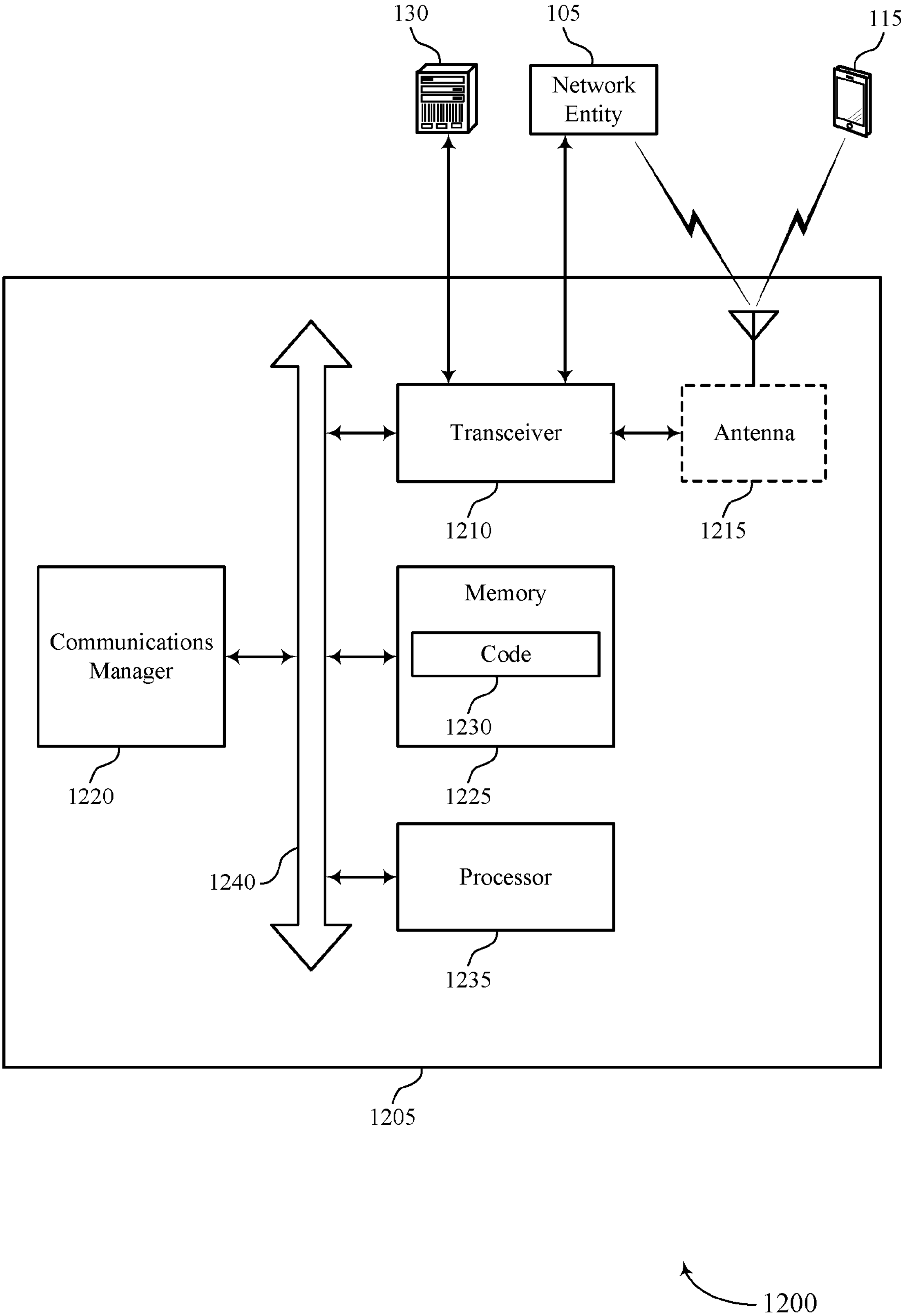
130
105
Network Entity
115
Transceiver
Antenna
1210
1215
Communications Manager
Memory
Code
1230
1220
1225
1240
Processor
1235
1205
1200

FIG. 12

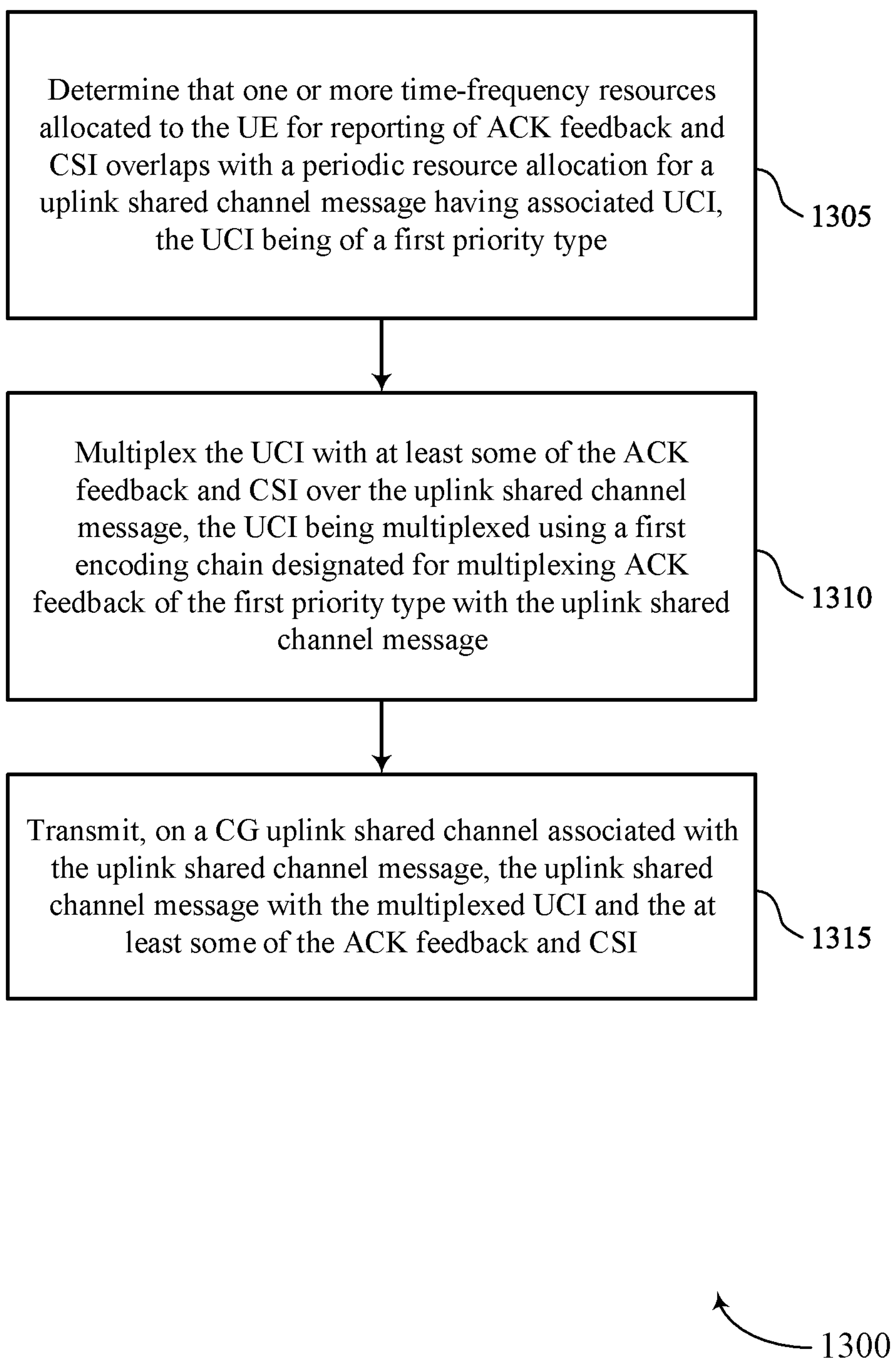
Determine that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority type
1305
Multiplex the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message
1310
Transmit, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI
1315
1300

FIG. 13

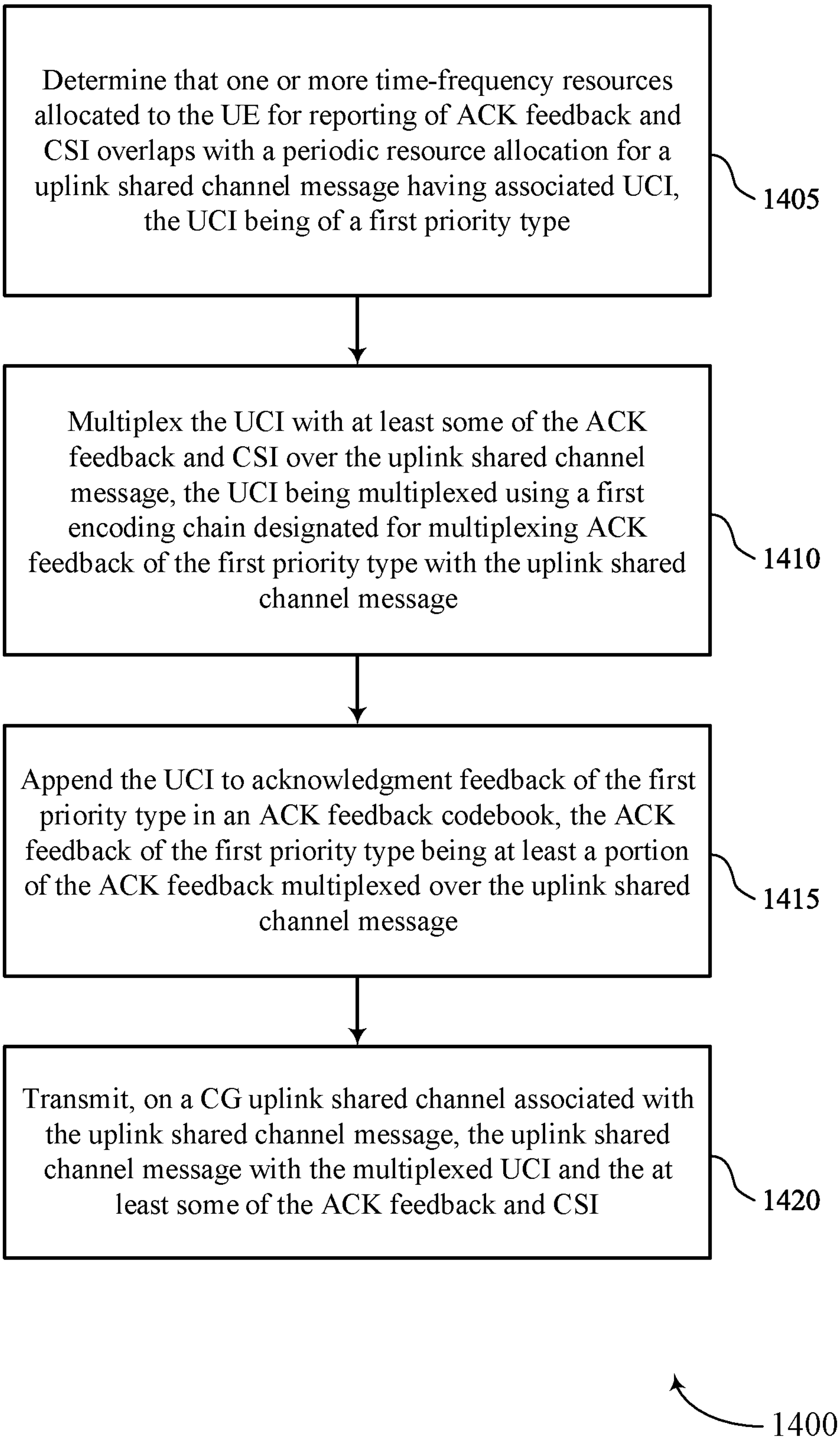
Determine that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority type
1405
Multiplex the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message
1410
Append the UCI to acknowledgment feedback of the first priority type in an ACK feedback codebook, the ACK feedback of the first priority type being at least a portion of the ACK feedback multiplexed over the uplink shared channel message
1415
Transmit, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI
1420
1400

FIG. 14

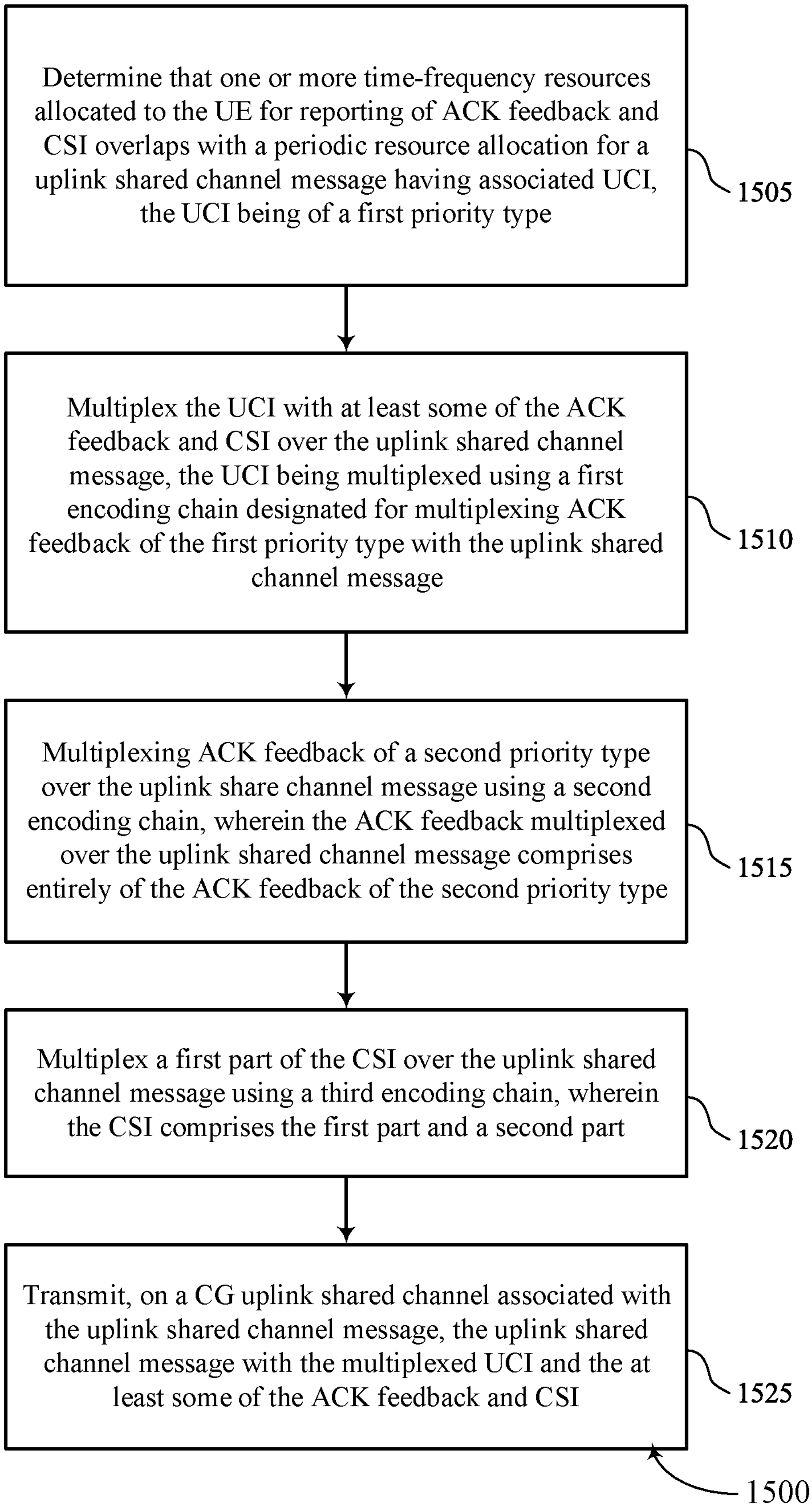
Determine that one or more time-frequency resources allocated to the UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority type
1505
Multiplex the UCI with at least some of the ACK feedback and CSI over the uplink shared channel message, the UCI being multiplexed using a first encoding chain designated for multiplexing ACK feedback of the first priority type with the uplink shared channel message
1510
Multiplexing ACK feedback of a second priority type over the uplink share channel message using a second encoding chain, wherein the ACK feedback multiplexed over the uplink shared channel message comprises entirely of the ACK feedback of the second priority type
1515
Multiplex a first part of the CSI over the uplink shared channel message using a third encoding chain, wherein the CSI comprises the first part and a second part
1520
Transmit, on a CG uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the multiplexed UCI and the at least some of the ACK feedback and CSI
1525
1500

FIG. 15

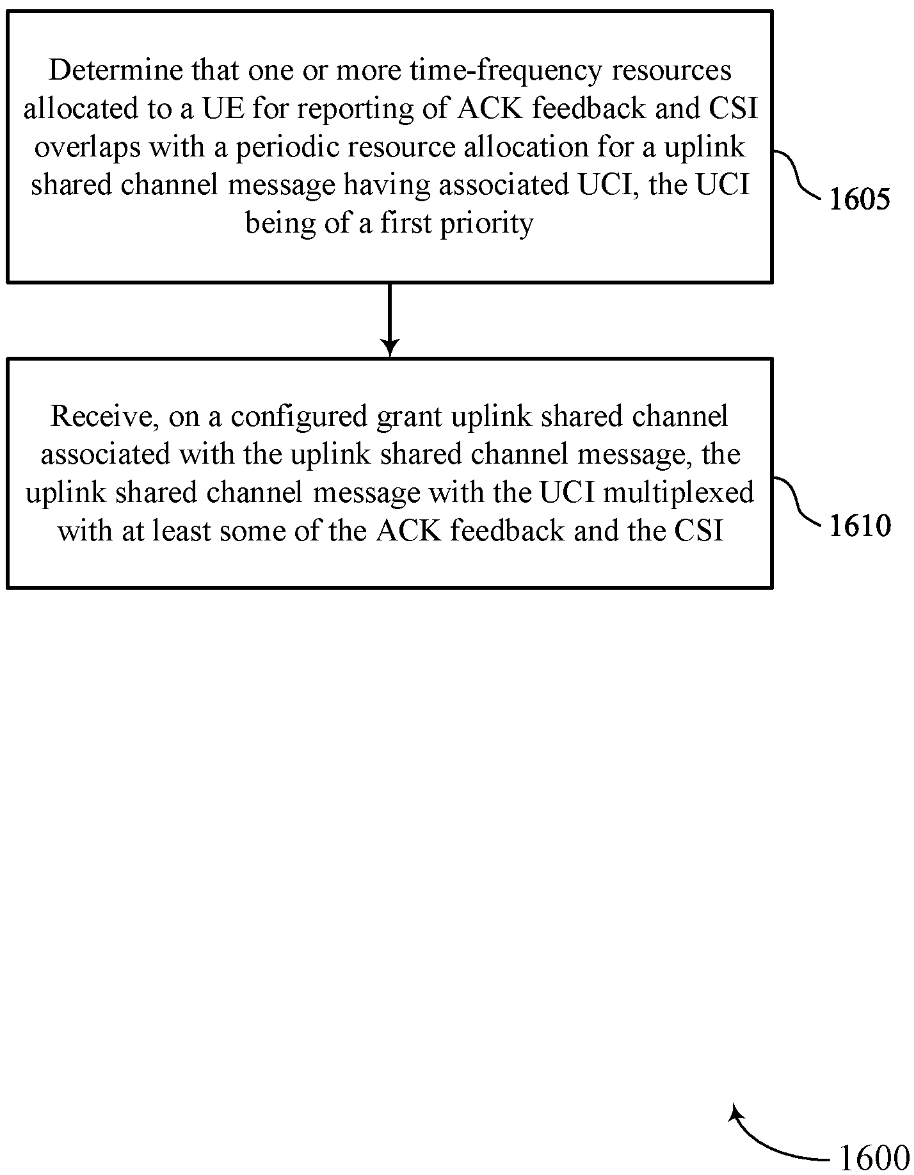
Determine that one or more time-frequency resources allocated to a UE for reporting of ACK feedback and CSI overlaps with a periodic resource allocation for a uplink shared channel message having associated UCI, the UCI being of a first priority
1605
Receive, on a configured grant uplink shared channel associated with the uplink shared channel message, the uplink shared channel message with the UCI multiplexed with at least some of the ACK feedback and the CSI
1610
1600

FIG. 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/088528

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W;H04Q;H04L

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

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

CNKI;CNPAT;WPI;EPODOC;3GPP: multiplex, priority, PUSCH, PUCCH, ACK, UCI, overlap, CSI, uplink, CG, grant, same, encod+, feedback, joint+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 113939021 A (VIVO MOBILE COMMUNICATION CO., LTD.) 14 January 2022 (2022-01-14) claims 1-14, and description, paragraphs 0094-0143	1-30
X	US 2021051671 A1 (LG ELECTRONICS INC.) 18 February 2021 (2021-02-18) description, paragraphs 0151-0326	1-30
A	CN 111836310 A (VIVO MOBILE COMMUNICATION CO., LTD.) 27 October 2020 (2020-10-27) the whole document	1-30
A	US 2021160011 A1 (SAMSUNG ELECTRONICS CO., LTD.) 27 May 2021 (2021-05-27) the whole document	1-30
A	US 2021007129 A1 (INTEL CORPORATION) 07 January 2021 (2021-01-07) the whole document	1-30
A	VIVO. "Discussion on the enhancements to configured grants" *3GPP TSG RAN WG1 #99, R1-1912015,* 22 November 2019 (2019-11-22), the whole document	1-30

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

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 November 2022	**25 November 2022**

Name and mailing address of the ISA/CN	Authorized officer
National Intellectual Property Administration, PRC 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China	**WANG,Dechuang**
Facsimile No. **(86-10)62019451**	Telephone No. **86-(10)-53961791**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/088528

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 113939021 A	14 January 2022	WO 2022012414 A1	20 January 2022
US 2021051671 A1	18 February 2021	None	
CN 111836310 A	27 October 2020	None	
US 2021160011 A1	27 May 2021	KR 20220103792 A	22 July 2022
		EP 3891914 A1	13 October 2021
		CN 113544992 A	22 October 2021
		WO 2021107555 A1	03 June 2021
US 2021007129 A1	07 January 2021	None	