United States Patent	12389393
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Panwar; Neeraj et al.

Uplink transmission port selection

Abstract

Aspects of the disclosure are directed to optimizing transmission at a user equipment (UE) such that configured grant (CG) and dynamic grant (DG) uplink communications are transmitted via the same channel or antenna port. In some examples, the UE may be configured to obtain, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus. In some examples, the UE may be configured to obtain, from the network node, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the apparatus. In some examples, the UE may be configured to output, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.

Inventors: **Panwar; Neeraj (San Diego, CA), Mahajan; Karan (Kapurthala, IN), Vommi; Deepak (San Marcos, CA), Sudhindra; Smruthi (San Diego, CA), Rungta; Pranay Sudeep (New York, NY), Singh; Kumarabhijeet (San Diego, CA)**

Applicant: **QUALCOMM Incorporated** (San Diego, CA)

Family ID: **1000008748902**

Assignee: **QUALCOMM Incorporated (San Diego, CA)**

Appl. No.: **18/146957**

Filed: **December 27, 2022**

Prior Publication Data

Document Identifier	Publication Date
US 20240215017 A1	Jun. 27, 2024

Publication Classification

Int. Cl.: **H04W72/1268** (20230101); **H04W72/23** (20230101)

U.S. Cl.:

CPC **H04W72/1268** (20130101); **H04W72/23** (20230101);

Field of Classification Search

CPC: H04W (72/1268); H04W (72/23); H04W (72/115); H04B (7/0404); H04L (5/0051)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2024/0114579	12/2023	Yao	N/A	H04W 76/19

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
2022/236495	12/2021	WO	N/A

OTHER PUBLICATIONS

International Search Report and Written Opinion dated Feb. 6, 2024 from corresponding PCT Application No. PCT/US2023/079091. cited by applicant
Fraunhofer IIS et al: "Enhancements on multi-beam operation", 3GPP Draft; R1-2107464, 3rd Generation Partnership Project (3GPP), Mobile Competence Centre; 650, Route Des Lucioles; F-06921 Sophia-Antipolis Cedex ; France; vo1. RAN WG1, No. E-meeting; Aug. 16, 2021-Aug. 27, 2021 Aug. 6, 2021 (Aug. 6, 2021), XP052033563, Retrieved from the Internet: URL:https://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_106-e/Docs/RI-2107464.zip R1-2107464.docx [retrieved on Aug. 6, 2021]. cited by applicant

---

Primary Examiner: Soe; Kyaw Z

Attorney, Agent or Firm: Arent Fox, LLP

Background/Summary

BACKGROUND
Technical Field
(1) The present disclosure generally relates to communication systems, and more particularly, aligning ports used for different types of transmission.
Introduction
(2) Wireless communication systems are widely deployed to provide various telecommunication services such as telephony, video, data, messaging, and broadcasts. Typical wireless communication systems may employ multiple-access technologies capable of supporting communication with multiple users by sharing available system resources. Examples of such multiple-access technologies include code division multiple access (CDMA) systems, time division multiple access (TDMA) systems, frequency division multiple access (FDMA) systems, orthogonal frequency division multiple access (OFDMA) systems, single-carrier frequency division multiple access (SC-FDMA) systems, and time division synchronous code division multiple access (TD-SCDMA) systems.

(3) These multiple access technologies have been adopted in various telecommunication standards to provide a common protocol that enables different wireless devices to communicate on a municipal, national, regional, and even global level. An example telecommunication standard is 5G New Radio (NR). 5G NR is part of a continuous mobile broadband evolution promulgated by Third Generation Partnership Project (3GPP) to meet new requirements associated with latency, reliability, security, scalability (e.g., with Internet of Things (IoT)), and other requirements. 5G NR includes services associated with enhanced mobile broadband (eMBB), massive machine type communications (mMTC), and ultra-reliable low latency communications (URLLC). Some aspects of 5G NR may be based on the 4G Long Term Evolution (LTE) standard. There exists a need for further improvements in 5G NR technology. These improvements may also be applicable to other multi-access technologies and the telecommunication standards that employ these technologies.

SUMMARY

(4) The following presents a simplified summary of one or more aspects in order to provide a basic understanding of such aspects. This summary is not an extensive overview of all contemplated aspects, and is intended to neither identify key or critical elements of all aspects nor delineate the scope of any or all aspects. Its sole purpose is to present some concepts of one or more aspects in a simplified form as a prelude to the more detailed description that is presented later.

(5) Certain aspects are directed to a method of wireless communication at an apparatus. In some examples, the method includes obtaining, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus. In some examples, the method includes obtaining, from the network node, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the apparatus. In some examples, the method includes outputting, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.

(6) Certain aspects are directed to a method of wireless communication at an apparatus. In some examples, the method includes outputting, for transmission to a user equipment (UE), a first signal activating a configured grant (CG) for uplink communication via a first port of the UE. In some examples, the method includes outputting, for transmission to the UE, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE. In some examples, the method includes obtaining, from the UE, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.

(7) Certain aspects are directed to an apparatus configured for wireless communication. In some examples, the apparatus includes a memory comprising instructions and one or more processors configured to execute the instructions. In some examples, the instructions are configured to cause the one or more processors to obtain, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus. In some examples, the instructions are configured to cause the one or more processors to obtain, from the network node, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the apparatus. In some examples, the instructions are configured to cause the one or more processors to output, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.

(8) Certain aspects are directed to an apparatus configured for wireless communication. In some examples, the apparatus includes a memory comprising instructions and one or more processors configured to execute the instructions. In some examples, the instructions are configured to cause the one or more processors to output, for transmission to a user equipment (UE), a first signal activating a configured grant (CG) for uplink communication via a first port of the UE. In some examples, the instructions are configured to cause the one or more processors to output, for transmission to the UE, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE. In some examples, the instructions are configured to cause the one or more processors to obtain, from the UE, a CG uplink signal via the second port of the apparatus

based on the second signal indication of the second port.
(9) Certain aspects are directed to an apparatus. In some examples, the apparatus includes means for obtaining, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus. In some examples, the apparatus includes means for obtaining, from the network node, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the apparatus. In some examples, the apparatus includes means for outputting, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.
(10) Certain aspects are directed to an apparatus. In some examples, the apparatus includes means for outputting, for transmission to a user equipment (UE), a first signal activating a configured grant (CG) for uplink communication via a first port of the UE. In some examples, the apparatus includes means for outputting, for transmission to the UE, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE. In some examples, the apparatus includes means for obtaining, from the UE, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.
(11) Certain aspects are directed to a non-transitory computer-readable medium comprising instructions that, when executed by an apparatus, cause the apparatus to perform a method. In some examples, the method includes obtaining, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus. In some examples, the method includes obtaining, from the network node, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the apparatus. In some examples, the method includes outputting, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.
(12) Certain aspects are directed to a non-transitory computer-readable medium comprising instructions that, when executed by an apparatus, cause the apparatus to perform a method. In some examples, the method includes outputting, for transmission to a user equipment (UE), a first signal activating a configured grant (CG) for uplink communication via a first port of the UE. In some examples, the method includes outputting, for transmission to the UE, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE. In some examples, the method includes obtaining, from the UE, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.
(13) To the accomplishment of the foregoing and related ends, the one or more aspects comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative features of the one or more aspects. These features are indicative, however, of but a few of the various ways in which the principles of various aspects may be employed, and this description is intended to include all such aspects and their equivalents.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a diagram illustrating an example of a wireless communications system and an access network.
(2) FIG. **2**A is a diagram illustrating an example of a first frame, in accordance with various aspects of the present disclosure.
(3) FIG. **2**B is a diagram illustrating an example of DL channels within a subframe, in accordance with various aspects of the present disclosure.
(4) FIG. **2**C is a diagram illustrating an example of a second frame, in accordance with various aspects of the present disclosure.

(5) FIG. **2**D is a diagram illustrating an example of UL channels within a subframe, in accordance with various aspects of the present disclosure.
(6) FIG. **3** is a diagram illustrating an example of a base station and user equipment (UE) in an access network.
(7) FIG. **4** is a block diagram illustrating an example disaggregated base station architecture.
(8) FIG. **5** is a call-flow diagram illustrating example communications between a UE and a network node or base station.
(9) FIG. **6** is a block diagram conceptually illustrating an example timeline within which the UE switches from a first port (e.g., TX0) to a second port (e.g., TX1).
(10) FIG. **7** is a flowchart of a method of wireless communication.
(11) FIG. **8** is a diagram illustrating an example of a hardware implementation for an example apparatus.
(12) FIG. **9** is a flowchart of a method of wireless communication.
(13) FIG. **10** is a diagram illustrating another example of a hardware implementation for another example apparatus.

DETAILED DESCRIPTION

(14) The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations and is not intended to represent the only configurations in which the concepts described herein may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some instances, well known structures and components are shown in block diagram form in order to avoid obscuring such concepts.

(15) When a user equipment (UE) is in single-input single-output (SISO) mode for uplink transmission (e.g., uplink transmissions are performed via a single antenna port instead of multiple antenna ports), the network can dynamically configure the UE to use a particular antenna for uplink transmissions based on a quality of sounding reference signal (SRSs) received by the network from multiple UE antennas. In some examples, the network may configure the UE such that an SRS transmitted by the UE via one antenna is different from another SRS transmitted via another antenna. In other words, the two SRSs may be configured by the network with codebook usage so that the network can distinguish which SRS is transmitted via which antenna port.

(16) This provides the network with the ability to determine which UE port is transmitting a relatively higher quality SRS by measuring the two SRSs, and the network can then command the UE to use the port corresponding to the higher quality SRS for uplink transmission. For example, the network may receive and decode SRSs received from different UE ports (e.g., port Tx0 and port Tx1), and schedule an uplink transmission via a physical uplink shared channel (PUSCH) by transmitting a downlink control information (DCI) message to the UE, wherein the DCI includes an SRS resource indicator (SRI) field configured to identify the port that the UE is to use for the uplink transmission.

(17) However, the above describes examples of dynamic grants (DGs) for uplink transmissions. The network may also configure the UE for uplink configured grant (CG) via RRC configuration messaging for CG Type 1 or via DCI (e.g., DCI format 0_1) for CG Type 2. Thus, the UE may be configured to use a first port for CG uplink transmissions, while also configured to use a second port for DG uplink transmissions. In such an example, the UE may be transmitting uplink signals via two different ports, wherein one of the ports provides a higher quality signal from the perspective of the network. Moreover, switching between the two ports may require more time and power consumption from the UE.

(18) Accordingly, aspects of the disclosure are directed to techniques for aligning transmission ports for both DG and CG uplink communications.

(19) Several aspects of telecommunication systems will now be presented with reference to various

apparatus and methods. These apparatus and methods will be described in the following detailed description and illustrated in the accompanying drawings by various blocks, components, circuits, processes, algorithms, etc. (collectively referred to as "elements"). These elements may be implemented using electronic hardware, computer software, or any combination thereof. Whether such elements are implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system.

(20) By way of example, an element, or any portion of an element, or any combination of elements may be implemented as a "processing system" that includes one or more processors. Examples of processors include microprocessors, microcontrollers, graphics processing units (GPUs), central processing units (CPUs), application processors, digital signal processors (DSPs), reduced instruction set computing (RISC) processors, systems on a chip (SoC), baseband processors, field programmable gate arrays (FPGAs), programmable logic devices (PLDs), state machines, gated logic, discrete hardware circuits, and other suitable hardware configured to perform the various functionality described throughout this disclosure. One or more processors in the processing system may execute software. Software shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software components, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise.

(21) Accordingly, in one or more example embodiments, the functions described may be implemented in hardware, software, or any combination thereof. If implemented in software, the functions may be stored on or encoded as one or more instructions or code on a computer-readable medium. Computer-readable media includes computer storage media. Storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise a random-access memory (RAM), a read-only memory (ROM), an electrically erasable programmable ROM (EEPROM), optical disk storage, magnetic disk storage, other magnetic storage devices, combinations of the aforementioned types of computer-readable media, or any other medium that can be used to store computer executable code in the form of instructions or data structures that can be accessed by a computer.

(22) FIG. **1** is a diagram illustrating an example of a wireless communications system and an access network **100**. The wireless communications system (also referred to as a wireless wide area network (WWAN)) includes base stations **102**, user equipment(s) (UE) **104**, an Evolved Packet Core (EPC) **160**, and another core network **190** (e.g., a 5G Core (5GC)). The base stations **102** may include macrocells (high power cellular base station) and/or small cells (low power cellular base station). The macrocells include base stations. The small cells include femtocells, picocells, and microcells.

(23) The base stations **102** configured for 4G Long Term Evolution (LTE) (collectively referred to as Evolved Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network (E-UTRAN)) may interface with the EPC **160** through first backhaul links **132** (e.g., S1 interface). The base stations **102** configured for 5G New Radio (NR) (collectively referred to as Next Generation RAN (NG-RAN)) may interface with core network **190** through second backhaul links **184**. In addition to other functions, the base stations **102** may perform one or more of the following functions: transfer of user data, radio channel ciphering and deciphering, integrity protection, header compression, mobility control functions (e.g., handover, dual connectivity), inter-cell interference coordination, connection setup and release, load balancing, distribution for non-access stratum (NAS) messages, NAS node selection, synchronization, radio access network (RAN) sharing, Multimedia Broadcast Multicast Service (MBMS), subscriber and equipment trace, RAN information management (RIM), paging, positioning, and delivery of warning messages. The base stations **102** may communicate directly or indirectly (e.g., through the EPC **160** or core network **190**) with each other over third backhaul links **134** (e.g., X2 interface). The first backhaul

links **132**, the second backhaul links **184**, and the third backhaul links **134** may be wired or wireless.

(24) The base stations **102** may wirelessly communicate with the UEs **104**. Each of the base stations **102** may provide communication coverage for a respective geographic coverage area **110**. There may be overlapping geographic coverage areas **110**. For example, the small cell **102**′ may have a coverage area **110**′ that overlaps the coverage area **110** of one or more macro base stations **102**. A network that includes both small cell and macrocells may be known as a heterogeneous network. A heterogeneous network may also include Home Evolved Node Bs (eNBs) (HeNBs), which may provide service to a restricted group known as a closed subscriber group (CSG). The communication links **120** between the base stations **102** and the UEs **104** may include uplink (UL) (also referred to as reverse link) transmissions from a UE **104** to a base station **102** and/or downlink (DL) (also referred to as forward link) transmissions from a base station **102** to a UE **104**. The communication links **120** may use multiple-input and multiple-output (MIMO) antenna technology, including spatial multiplexing, beamforming, and/or transmit diversity. The communication links may be through one or more carriers. The base stations **102**/UEs **104** may use spectrum up to Y megahertz (MHz) (e.g., 5, 10, 15, 20, 100, 400, etc. MHz) bandwidth per carrier allocated in a carrier aggregation of up to a total of Yx MHz (x component carriers) used for transmission in each direction. The carriers may or may not be adjacent to each other. Allocation of carriers may be asymmetric with respect to DL and UL (e.g., more or fewer carriers may be allocated for DL than for UL). The component carriers may include a primary component carrier and one or more secondary component carriers. A primary component carrier may be referred to as a primary cell (PCell) and a secondary component carrier may be referred to as a secondary cell (SCell).

(25) Certain UEs **104** may communicate with each other using device-to-device (D2D) communication link **158**. The D2D communication link **158** may use the DL/UL WWAN spectrum. The D2D communication link **158** may use one or more sidelink channels, such as a physical sidelink broadcast channel (PSBCH), a physical sidelink discovery channel (PSDCH), a physical sidelink shared channel (PSSCH), and a physical sidelink control channel (PSCCH). D2D communication may be through a variety of wireless D2D communications systems, such as for example, WiMedia, Bluetooth, ZigBee, Wi-Fi based on the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard, LTE, or NR.

(26) The wireless communications system may further include a Wi-Fi access point (AP) **150** in communication with Wi-Fi stations (STAs) **152** via communication links **154**, e.g., in a 5 gigahertz (GHz) unlicensed frequency spectrum or the like. When communicating in an unlicensed frequency spectrum, the STAs **152**/AP **150** may perform a clear channel assessment (CCA) prior to communicating in order to determine whether the channel is available.

(27) The small cell **102**′ may operate in a licensed and/or an unlicensed frequency spectrum. When operating in an unlicensed frequency spectrum, the small cell **102**′ may employ NR and use the same unlicensed frequency spectrum (e.g., 5 GHz, or the like) as used by the Wi-Fi AP **150**. The small cell **102**′, employing NR in an unlicensed frequency spectrum, may boost coverage to and/or increase capacity of the access network.

(28) The electromagnetic spectrum is often subdivided, based on frequency/wavelength, into various classes, bands, channels, etc. In 5G NR, two initial operating bands have been identified as frequency range designations FR1 (410 MHz-7.125 GHz) and FR2 (24.25 GHz-52.6 GHz). The frequencies between FR1 and FR2 are often referred to as mid-band frequencies. Although a portion of FR1 is greater than 6 GHz, FR1 is often referred to (interchangeably) as a “sub-6 GHz” band in various documents and articles. A similar nomenclature issue sometimes occurs with regard to FR2, which is often referred to (interchangeably) as a “millimeter wave” band in documents and articles, despite being different from the extremely high frequency (EHF) band (30 GHz-300 GHz) which is identified by the International Telecommunications Union (ITU) as a “millimeter wave” band.

(29) With the above aspects in mind, unless specifically stated otherwise, it should be understood that the term “sub-6 GHz” or the like if used herein may broadly represent frequencies that may be less than 6 GHz, may be within FR1, or may include mid-band frequencies. Further, unless specifically stated otherwise, it should be understood that the term “millimeter wave” or the like if used herein may broadly represent frequencies that may include mid-band frequencies, may be within FR2, or may be within the EHF band.
(30) A base station **102**, whether a small cell **102′** or a large cell (e.g., macro base station), may include and/or be referred to as an eNB, gNodeB (gNB), or another type of base station. Some base stations, such as gNB **180** may operate in a traditional sub 6 GHz spectrum, in millimeter wave frequencies, and/or near millimeter wave frequencies in communication with the UE **104**. When the gNB **180** operates in millimeter wave or near millimeter wave frequencies, the gNB **180** may be referred to as a millimeter wave base station. The millimeter wave base station **180** may utilize beamforming **182** with the UE **104** to compensate for the path loss and short range. The base station **180** and the UE **104** may each include a plurality of antennas, such as antenna elements, antenna panels, and/or antenna arrays to facilitate the beamforming.
(31) The base station **180** may transmit a beamformed signal to the UE **104** in one or more transmit directions **182′**. The UE **104** may receive the beamformed signal from the base station **180** in one or more receive directions **182″**. The UE **104** may also transmit a beamformed signal to the base station **180** in one or more transmit directions. The base station **180** may receive the beamformed signal from the UE **104** in one or more receive directions. The base station **180**/UE **104** may perform beam training to determine the best receive and transmit directions for each of the base station **180**/UE **104**. The transmit and receive directions for the base station **180** may or may not be the same. The transmit and receive directions for the UE **104** may or may not be the same.
(32) The EPC **160** may include a Mobility Management Entity (MME) **162**, other MMEs **164**, a Serving Gateway **166**, an MBMS Gateway **168**, a Broadcast Multicast Service Center (BM-SC) **170**, and a Packet Data Network (PDN) Gateway **172**. The MME **162** may be in communication with a Home Subscriber Server (HSS) **174**. The MME **162** is the control node that processes the signaling between the UEs **104** and the EPC **160**. Generally, the MME **162** provides bearer and connection management. All user Internet protocol (IP) packets are transferred through the Serving Gateway **166**, which itself is connected to the PDN Gateway **172**. The PDN Gateway **172** provides UE IP address allocation as well as other functions. The PDN Gateway **172** and the BM-SC **170** are connected to the IP Services **176**. The IP Services **176** may include the Internet, an intranet, an IP Multimedia Subsystem (IMS), a PS Streaming Service, and/or other IP services. The BM-SC **170** may provide functions for MBMS user service provisioning and delivery. The BM-SC **170** may serve as an entry point for content provider MBMS transmission, may be used to authorize and initiate MBMS Bearer Services within a public land mobile network (PLMN), and may be used to schedule MBMS transmissions. The MBMS Gateway **168** may be used to distribute MBMS traffic to the base stations **102** belonging to a Multicast Broadcast Single Frequency Network (MBSFN) area broadcasting a particular service, and may be responsible for session management (start/stop) and for collecting eMBMS related charging information.
(33) The core network **190** may include a Access and Mobility Management Function (AMF) **192**, other AMFs **193**, a Session Management Function (SMF) **194**, and a User Plane Function (UPF) **195**. The AMF **192** may be in communication with a Unified Data Management (UDM) **196**. The AMF **192** is the control node that processes the signaling between the UEs **104** and the core network **190**. Generally, the AMF **192** provides Quality of Service (QoS) flow and session management. All user IP packets are transferred through the UPF **195**. The UPF **195** provides UE IP address allocation as well as other functions. The UPF **195** is connected to the IP Services **197**. The IP Services **197** may include the Internet, an intranet, an IMS, a Packet Switch (PS) Streaming Service, and/or other IP services.
(34) The base station may include and/or be referred to as a gNB, Node B, eNB, an access point, a

base transceiver station, a radio base station, a radio transceiver, a transceiver function, a basic service set (BSS), an extended service set (ESS), a transmit reception point (TRP), or some other suitable terminology. The base station **102** provides an access point to the EPC **160** or core network **190** for a UE **104**. Examples of UEs **104** include a cellular phone, a smart phone, a session initiation protocol (SIP) phone, a laptop, a personal digital assistant (PDA), a satellite radio, a global positioning system, a multimedia device, a video device, a digital audio player (e.g., MP3 player), a camera, a game console, a tablet, a smart device, a wearable device, a vehicle, an electric meter, a gas pump, a large or small kitchen appliance, a healthcare device, an implant, a sensor/actuator, a display, or any other similar functioning device. Some of the UEs **104** may be referred to as IoT devices (e.g., parking meter, gas pump, toaster, vehicles, heart monitor, etc.). The UE **104** may also be referred to as a station, a mobile station, a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a wireless communications device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless terminal, a remote terminal, a handset, a user agent, a mobile client, a client, or some other suitable terminology.

(35) Referring again to FIG. **1**, in certain aspects, the UE **104** may be configured with a port module **199** configured to obtain, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus; obtain, from the network node, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the apparatus; and output, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.

(36) Referring again to FIG. **1**, in certain aspects, the base station **102/180** may be configured with a port module **198** configured to receive, via the transceiver, a first signal activating a configured grant (CG) for uplink communication via a first port of the UE; receive, via the transceiver, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE; and transmit, via the transceiver, a CG uplink signal via the second port of the UE based on the second signal indication of the second port.

(37) FIG. **2**A is a diagram **200** illustrating an example of a first subframe within a 5G NR frame structure. FIG. **2**B is a diagram **230** illustrating an example of DL channels within a 5G NR subframe. FIG. **2**C is a diagram **250** illustrating an example of a second subframe within a 5G NR frame structure. FIG. **2**D is a diagram **280** illustrating an example of UL channels within a 5G NR subframe. The 5G NR frame structure may be frequency division duplexed (FDD) in which for a particular set of subcarriers (carrier system bandwidth), subframes within the set of subcarriers are dedicated for either DL or UL, or may be time division duplexed (TDD) in which for a particular set of subcarriers (carrier system bandwidth), subframes within the set of subcarriers are dedicated for both DL and UL. In the examples provided by FIGS. **2**A, **2**C, the 5G NR frame structure is assumed to be TDD, with subframe 4 being configured with slot format 28 (with mostly DL), where D is DL, U is UL, and F is flexible for use between DL/UL, and subframe 3 being configured with slot format 34 (with mostly UL). While subframes 3, 4 are shown with slot formats 34, 28, respectively, any particular subframe may be configured with any of the various available slot formats 0-61. Slot formats 0, 1 are all DL, UL, respectively. Other slot formats 2-61 include a mix of DL, UL, and flexible symbols. UEs are configured with the slot format (dynamically through DL control information (DCI), or semi-statically/statically through radio resource control (RRC) signaling) through a received slot format indicator (SFI). Note that the description infra applies also to a 5G NR frame structure that is TDD.

(38) Other wireless communication technologies may have a different frame structure and/or different channels. A frame, e.g., of 10 milliseconds (ms), may be divided into 10 equally sized subframes (1 ms). Each subframe may include one or more time slots. Subframes may also include mini-slots, which may include 7, 4, or 2 symbols. Each slot may include 7 or 14 symbols, depending on the slot configuration. For slot configuration 0, each slot may include 14 symbols,

and for slot configuration 1, each slot may include 7 symbols. The symbols on DL may be cyclic prefix (CP) orthogonal frequency-division multiplexing (OFDM) (CP-OFDM) symbols. The symbols on UL may be CP-OFDM symbols (for high throughput scenarios) or discrete Fourier transform (DFT) spread OFDM (DFT-s-OFDM) symbols (also referred to as single carrier frequency-division multiple access (SC-FDMA) symbols) (for power limited scenarios; limited to a single stream transmission). The number of slots within a subframe is based on the slot configuration and the numerology. For slot configuration 0, different numerologies μ 0 to 4 allow for 1, 2, 4, 8, and 16 slots, respectively, per subframe. For slot configuration 1, different numerologies 0 to 2 allow for 2, 4, and 8 slots, respectively, per subframe. Accordingly, for slot configuration 0 and numerology μ, there are 14 symbols/slot and 2.sup.μ slots/subframe. The subcarrier spacing and symbol length/duration are a function of the numerology. The subcarrier spacing may be equal to 2.sup.μ*15 kilohertz (kHz), where μ is the numerology 0 to 4. As such, the numerology μ=0 has a subcarrier spacing of 15 kHz and the numerology μ=4 has a subcarrier spacing of 240 kHz. The symbol length/duration is inversely related to the subcarrier spacing. FIGS. **2**A-**2**D provide an example of slot configuration 0 with 14 symbols per slot and numerology μ=2 with 4 slots per subframe. The slot duration is 0.25 ms, the subcarrier spacing is 60 kHz, and the symbol duration is approximately 16.67 μs. Within a set of frames, there may be one or more different bandwidth parts (BWPs) (see FIG. **2**B) that are frequency division multiplexed. Each BWP may have a particular numerology.

(39) A resource grid may be used to represent the frame structure. Each time slot includes a resource block (RB) (also referred to as physical RBs (PRBs)) that extends 12 consecutive subcarriers. The resource grid is divided into multiple resource elements (REs). The number of bits carried by each RE depends on the modulation scheme.

(40) As illustrated in FIG. **2**A, some of the REs carry reference (pilot) signals (RS) for the UE. The RS may include demodulation RS (DM-RS) (indicated as R.sub.x for one particular configuration, where 100x is the port number, but other DM-RS configurations are possible) and channel state information reference signals (CSI-RS) for channel estimation at the UE. The RS may also include beam measurement RS (BRS), beam refinement RS (BRRS), and phase tracking RS (PT-RS).

(41) FIG. **2**B illustrates an example of various DL channels within a subframe of a frame. The physical downlink control channel (PDCCH) carries DCI within one or more control channel elements (CCEs), each CCE including nine RE groups (REGs), each REG including four consecutive REs in an OFDM symbol. A PDCCH within one BWP may be referred to as a control resource set (CORESET). Additional BWPs may be located at greater and/or lower frequencies across the channel bandwidth. A primary synchronization signal (PSS) may be within symbol 2 of particular subframes of a frame. The PSS is used by a UE **104** to determine subframe/symbol timing and a physical layer identity. A secondary synchronization signal (SSS) may be within symbol 4 of particular subframes of a frame. The SSS is used by a UE to determine a physical layer cell identity group number and radio frame timing. Based on the physical layer identity and the physical layer cell identity group number, the UE can determine a physical cell identifier (PCI). Based on the PCI, the UE can determine the locations of the aforementioned DM-RS. The physical broadcast channel (PBCH), which carries a master information block (MIB), may be logically grouped with the PSS and SSS to form a synchronization signal (SS)/PBCH block (also referred to as SS block (SSB)). The MIB provides a number of RBs in the system bandwidth and a system frame number (SFN). The physical downlink shared channel (PDSCH) carries user data, broadcast system information not transmitted through the PBCH such as system information blocks (SIBs), and paging messages.

(42) As illustrated in FIG. **2**C, some of the REs carry DM-RS (indicated as R for one particular configuration, but other DM-RS configurations are possible) for channel estimation at the base station. The UE may transmit DM-RS for the physical uplink control channel (PUCCH) and DM-RS for the physical uplink shared channel (PUSCH). The PUSCH DM-RS may be transmitted in

the first one or two symbols of the PUSCH. The PUCCH DM-RS may be transmitted in different configurations depending on whether short or long PUCCHs are transmitted and depending on the particular PUCCH format used. The UE may transmit sounding reference signals (SRS). The SRS may be transmitted in the last symbol of a subframe. The SRS may have a comb structure, and a UE may transmit SRS on one of the combs. The SRS may be used by a base station for channel quality estimation to enable frequency-dependent scheduling on the UL.

(43) FIG. **2**D illustrates an example of various UL channels within a subframe of a frame. The PUCCH may be located as indicated in one configuration. The PUCCH carries uplink control information (UCI), such as scheduling requests, a channel quality indicator (CQI), a precoding matrix indicator (PMI), a rank indicator (RI), and hybrid automatic repeat request (HARQ) acknowledgement (ACK)/non-acknowledgement (NACK) feedback. The PUSCH carries data, and may additionally be used to carry a buffer status report (BSR), a power headroom report (PHR), and/or UCI.

(44) FIG. **3** is a block diagram of a base station **310** in communication with a UE **350** in an access network. In the DL, IP packets from the EPC **160** may be provided to a controller/processor **375**. The controller/processor **375** implements layer 3 and layer 2 functionality. Layer 3 includes a radio resource control (RRC) layer, and layer 2 includes a service data adaptation protocol (SDAP) layer, a packet data convergence protocol (PDCP) layer, a radio link control (RLC) layer, and a medium access control (MAC) layer. The controller/processor **375** provides RRC layer functionality associated with broadcasting of system information (e.g., MIB, SIBs), RRC connection control (e.g., RRC connection paging, RRC connection establishment, RRC connection modification, and RRC connection release), inter radio access technology (RAT) mobility, and measurement configuration for UE measurement reporting; PDCP layer functionality associated with header compression/decompression, security (ciphering, deciphering, integrity protection, integrity verification), and handover support functions; RLC layer functionality associated with the transfer of upper layer packet data units (PDUs), error correction through ARQ, concatenation, segmentation, and reassembly of RLC service data units (SDUs), re-segmentation of RLC data PDUs, and reordering of RLC data PDUs; and MAC layer functionality associated with mapping between logical channels and transport channels, multiplexing of MAC SDUs onto transport blocks (TBs), demultiplexing of MAC SDUs from TBs, scheduling information reporting, error correction through HARQ, priority handling, and logical channel prioritization.

(45) The transmit (TX) processor **316** and the receive (RX) processor **370** implement layer 1 functionality associated with various signal processing functions. Layer 1, which includes a physical (PHY) layer, may include error detection on the transport channels, forward error correction (FEC) coding/decoding of the transport channels, interleaving, rate matching, mapping onto physical channels, modulation/demodulation of physical channels, and MIMO antenna processing. The TX processor **316** handles mapping to signal constellations based on various modulation schemes (e.g., binary phase-shift keying (BPSK), quadrature phase-shift keying (QPSK), M-phase-shift keying (M-PSK), M-quadrature amplitude modulation (M-QAM)). The coded and modulated symbols may then be split into parallel streams. Each stream may then be mapped to an OFDM subcarrier, multiplexed with a reference signal (e.g., pilot) in the time and/or frequency domain, and then combined together using an Inverse Fast Fourier Transform (IFFT) to produce a physical channel carrying a time domain OFDM symbol stream. The OFDM stream is spatially precoded to produce multiple spatial streams. Channel estimates from a channel estimator **374** may be used to determine the coding and modulation scheme, as well as for spatial processing. The channel estimate may be derived from a reference signal and/or channel condition feedback transmitted by the UE **350**. Each spatial stream may then be provided to a different antenna **320** via a separate transmitter **318**TX. Each transmitter **318**TX may modulate an RF carrier with a respective spatial stream for transmission.

(46) At the UE **350**, each receiver **354**RX receives a signal through its respective antenna **352**. Each

receiver **354**RX recovers information modulated onto an RF carrier and provides the information to the receive (RX) processor **356**. The TX processor **368** and the RX processor **356** implement layer 1 functionality associated with various signal processing functions. The RX processor **356** may perform spatial processing on the information to recover any spatial streams destined for the UE **350**. If multiple spatial streams are destined for the UE **350**, they may be combined by the RX processor **356** into a single OFDM symbol stream. The RX processor **356** then converts the OFDM symbol stream from the time-domain to the frequency domain using a Fast Fourier Transform (FFT). The frequency domain signal comprises a separate OFDM symbol stream for each subcarrier of the OFDM signal. The symbols on each subcarrier, and the reference signal, are recovered and demodulated by determining the most likely signal constellation points transmitted by the base station **310**. These soft decisions may be based on channel estimates computed by the channel estimator **358**. The soft decisions are then decoded and deinterleaved to recover the data and control signals that were originally transmitted by the base station **310** on the physical channel. The data and control signals are then provided to the controller/processor **359**, which implements layer 3 and layer 2 functionality.

(47) The controller/processor **359** can be associated with a memory **360** that stores program codes and data. The memory **360** may be referred to as a computer-readable medium. In the UL, the controller/processor **359** provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, and control signal processing to recover IP packets from the EPC **160**. The controller/processor **359** is also responsible for error detection using an ACK and/or NACK protocol to support HARQ operations.

(48) Similar to the functionality described in connection with the DL transmission by the base station **310**, the controller/processor **359** provides RRC layer functionality associated with system information (e.g., MIB, SIBs) acquisition, RRC connections, and measurement reporting; PDCP layer functionality associated with header compression/decompression, and security (ciphering, deciphering, integrity protection, integrity verification); RLC layer functionality associated with the transfer of upper layer PDUs, error correction through ARQ, concatenation, segmentation, and reassembly of RLC SDUs, re-segmentation of RLC data PDUs, and reordering of RLC data PDUs; and MAC layer functionality associated with mapping between logical channels and transport channels, multiplexing of MAC SDUs onto TBs, demultiplexing of MAC SDUs from TBs, scheduling information reporting, error correction through HARQ, priority handling, and logical channel prioritization.

(49) Channel estimates derived by a channel estimator **358** from a reference signal or feedback transmitted by the base station **310** may be used by the TX processor **368** to select the appropriate coding and modulation schemes, and to facilitate spatial processing. The spatial streams generated by the TX processor **368** may be provided to different antenna **352** via separate transmitters **354**TX. Each transmitter **354**TX may modulate an RF carrier with a respective spatial stream for transmission.

(50) The UL transmission is processed at the base station **310** in a manner similar to that described in connection with the receiver function at the UE **350**. Each receiver **318**RX receives a signal through its respective antenna **320**. Each receiver **318**RX recovers information modulated onto an RF carrier and provides the information to a RX processor **370**.

(51) The controller/processor **375** can be associated with a memory **376** that stores program codes and data. The memory **376** may be referred to as a computer-readable medium. In the UL, the controller/processor **375** provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, control signal processing to recover IP packets from the UE **350**. IP packets from the controller/processor **375** may be provided to the EPC **160**. The controller/processor **375** is also responsible for error detection using an ACK and/or NACK protocol to support HARQ operations.

(52) FIG. **4** is a block diagram illustrating an example disaggregated base station **400** architecture.

The disaggregated base station **400** architecture may include one or more CUs **410** that can communicate directly with a core network **420** via a backhaul link, or indirectly with the core network **420** through one or more disaggregated base station units (such as a near real-time (RT) RIC **425** via an E2 link, or a non-RT RIC **415** associated with a service management and orchestration (SMO) Framework **405**, or both). A CU **410** may communicate with one or more DUs **430** via respective midhaul links, such as an F1 interface. The DUs **430** may communicate with one or more RUs **440** via respective fronthaul links. The RUs **440** may communicate with respective UEs **104** via one or more radio frequency (RF) access links. In some implementations, the UE **104** may be simultaneously served by multiple RUs **440**.
(53) Each of the units, i.e., the CUs **410**, the DUs **430**, the RUs **440**, as well as the near-RT RICs **425**, the non-RT RICs **415** and the SMO framework **405**, may include one or more interfaces or be coupled to one or more interfaces configured to receive or transmit signals, data, or information (collectively, signals) via a wired or wireless transmission medium. Each of the units, or an associated processor or controller providing instructions to the communication interfaces of the units, can be configured to communicate with one or more of the other units via the transmission medium. For example, the units can include a wired interface configured to receive or transmit signals over a wired transmission medium to one or more of the other units. Additionally, the units can include a wireless interface, which may include a receiver, a transmitter or transceiver (such as a radio frequency (RF) transceiver), configured to receive or transmit signals, or both, over a wireless transmission medium to one or more of the other units.
(54) In some aspects, the CU **410** may host higher layer control functions. Such control functions can include radio resource control (RRC), packet data convergence protocol (PDCP), service data adaptation protocol (SDAP), or the like. Each control function can be implemented with an interface configured to communicate signals with other control functions hosted by the CU **410**. The CU **410** may be configured to handle user plane functionality (i.e., central unit-user plane (CU-UP)), control plane functionality (i.e., central unit-control plane (CU-CP)), or a combination thereof. In some implementations, the CU **410** can be logically split into one or more CU-UP units and one or more CU-CP units. The CU-UP unit can communicate bidirectionally with the CU-CP unit via an interface, such as the E1 interface when implemented in an O-RAN configuration. The CU **410** can be implemented to communicate with the DU **430**, as necessary, for network control and signaling.
(55) The DU **430** may correspond to a logical unit that includes one or more base station functions to control the operation of one or more RUs **440**. In some aspects, the DU **430** may host one or more of a radio link control (RLC) layer, a medium access control (MAC) layer, and one or more high physical (PHY) layers (such as modules for forward error correction (FEC) encoding and decoding, scrambling, modulation and demodulation, or the like) depending, at least in part, on a functional split, such as those defined by the 3.sup.rd Generation Partnership Project (3GPP). In some aspects, the DU **430** may further host one or more low PHY layers. Each layer (or module) can be implemented with an interface configured to communicate signals with other layers (and modules) hosted by the DU **430**, or with the control functions hosted by the CU **410**.
(56) Lower-layer functionality can be implemented by one or more RUs **440**. In some deployments, an RU **440**, controlled by a DU **430**, may correspond to a logical node that hosts RF processing functions, or low-PHY layer functions (such as performing fast Fourier transform (FFT), inverse FFT (iFFT), digital beamforming, physical random access channel (PRACH) extraction and filtering, or the like), or both, based at least in part on the functional split, such as a lower layer functional split. In such an architecture, the RU(s) **440** can be implemented to handle over the air (OTA) communication with one or more UEs **104**. In some implementations, real-time and non-real-time aspects of control and user plane communication with the RU(s) **440** can be controlled by the corresponding DU **430**. In some scenarios, this configuration can enable the DU(s) **430** and the CU **410** to be implemented in a cloud-based RAN architecture, such as a virtual RAN (vRAN)

architecture.
(57) The SMO Framework **405** may be configured to support RAN deployment and provisioning of non-virtualized and virtualized network elements. For non-virtualized network elements, the SMO framework **405** may be configured to support the deployment of dedicated physical resources for RAN coverage requirements, which may be managed via an operations and maintenance interface (such as an O1 interface). For virtualized network elements, the SMO framework **405** may be configured to interact with a cloud computing platform (such as an open cloud (O-cloud) **490**) to perform network element life cycle management (such as to instantiate virtualized network elements) via a cloud computing platform interface (such as an O2 interface). Such virtualized network elements can include, but are not limited to, CUs **410**, DUs **430**, RUs **440** and near-RT RICs **425**. In some implementations, the SMO framework **405** can communicate with a hardware aspect of a 4G RAN, such as an open eNB (O-eNB) **411**, via an O1 interface. Additionally, in some implementations, the SMO Framework **405** can communicate directly with one or more RUs **440** via an O1 interface. The SMO framework **405** also may include the non-RT RIC **415** configured to support functionality of the SMO Framework **405**.
(58) The non-RT RIC **415** may be configured to include a logical function that enables non-real-time control and optimization of RAN elements and resources, artificial intelligence/machine learning (AI/ML) workflows including model training and updates, or policy-based guidance of applications/features in the near-RT RIC **425**. The non-RT RIC **415** may be coupled to or communicate with (such as via an A1 interface) the near-RT RIC **425**. The near-RT RIC **425** may be configured to include a logical function that enables near-real-time control and optimization of RAN elements and resources via data collection and actions over an interface (such as via an E2 interface) connecting one or more CUs **410**, one or more DUs **430**, or both, as well as an O-eNB, with the near-RT RIC **425**.
(59) In some implementations, to generate AI/ML models to be deployed in the near-RT RIC **425**, the non-RT RIC **415** may receive parameters or external enrichment information from external servers. Such information may be utilized by the near-RT RIC **425** and may be received at the SMO Framework **405** or the non-RT RIC **415** from non-network data sources or from network functions. In some examples, the non-RT RIC **415** or the near-RT RIC **425** may be configured to tune RAN behavior or performance. For example, the non-RT RIC **415** may monitor long-term trends and patterns for performance and employ AI/ML models to perform corrective actions through the SMO Framework **405** (such as reconfiguration via O1) or via creation of RAN management policies (such as A1 policies).
(60) At least one of the TX processor **368**, the RX processor **356**, and the controller/processor **359** may be configured to perform aspects in connection with **198** of FIG. **1**.
(61) At least one of the TX processor **316**, the RX processor **370**, and the controller/processor **375** may be configured to perform aspects in connection with **198** of FIG. **1**.
Examples of Aligning Ports for Different Types of Uplink at a UE
(62) The UE may be configured for SISO mode for uplink transmission (e.g., uplink transmissions are performed via a single antenna port instead of multiple antenna ports). In the case of a DG, the network (e.g., a network node or base station **102/180** or a disaggregated portion of the network node such as an RU/DU as illustrated in FIG. **4**) may dynamically configure the UE to use a particular antenna for uplink transmissions based on a quality of SRSs received by the network from multiple UE antennas. In some examples, SRSs may be configured by the network with codebook usage so that the network can distinguish which SRS is transmitted via which antenna port.
(63) Thus, the network may determine which UE port is transmitting a relatively higher quality SRS by measuring the two SRSs, and the network can then command the UE to use the port corresponding to the higher quality SRS for uplink transmission. The network may also configure the UE for uplink CG via RRC configuration messaging for CG Type 1 or via DCI (e.g., DCI

format 0_1) for CG Type 2. However, the UE **104** may be configured to use a first port for CG uplink transmissions, while also configured to use a second port for DG uplink transmissions. In such an example, the UE may be transmitting uplink signals via two different ports, wherein one of the ports provides a higher quality signal from the perspective of the network. Moreover, switching between the two ports may require more time and power consumption from the UE.
(64) FIG. **5** is a call-flow diagram illustrating example communications between a UE **104** and a network node or base station **102/180**.
(65) At a first communication **502**, the network node **102** transmits an RRC configuration message and/or other PDCCH signaling to the UE **104**, configuring the UE **104** for CG uplink communications. In some examples, the RRC configuration may include an indication of an antenna port (e.g., TX0) that the UE **104** may use for transmitting uplink communications to the network node **102**. The CG configuration may provide the UE **104** with a schedule and/or resources for uplink transmissions that eliminates the need for the UE **104** to request and the network node **102** to assign resources for each packet transmission by pre-allocating resources to the UE. In other words, CGs configure the UE **104** for uplink transmissions without the need for the UE to request resources from the network node using an SR. In one example, if there is a voice over new radio (VoNR) call in place at the UE **104**, the network node **102** may assign periodic resources using CGs for uplink packets transmitted via an internet protocol (IP) multimedia subsystem (IMS) bearer as long as the call is active.
(66) At a second communication **504**, the UE **104** may transmit an uplink signal via TX0 to the network node **102** using CG resources/schedule.
(67) At a first process **506**, the UE **104** may optionally skip a CG uplink. That is, if the UE **104** does not have any uplink data to transmit to the network node **102**, then the UE **104** may omit an uplink transmission using a CG uplink resource. For example, if a VoNR call or an IMS call has a silent duration, the UE **104** may not have any data to transmit via a CG uplink resource.
(68) It should be noted, if there is a call in place or any other process through which a CG may be provided to the UE **104**, the network node **102** may provide the UE **104** with periodic resources (e.g., provide the UE **104** with a schedule and resources that the UE **104** can use for uplink transmissions in the future). In this example, the skipped CG uplink resource may be a one of multiple periodic scheduled resources reserved for the UE for uplink transmission. In such a case, the identified UE port (e.g., TX0) may remain the same, meaning that the UE **104** may use the same port for uplink transmission for the multiple periodic scheduled uplink resources.
(69) At a third communication **508**, the UE **104** may transmit a scheduling request (SR) requesting a DG for uplink transmission from the network node **102**. In a fourth communication **510**, in response to the SR, the network node **102** may transmit a DG to the UE **104** providing the UE **104** with resources for uplink transmission. Over the course of communications, the UE **104** may transmit SRSs to the network node via multiple ports at the UE **104**. For example, the UE **104** may transmit a first SRS via a first port (e.g., TX0) and a second SRS via a second port (e.g., TX1). The DG may be transmitted via a DCI message.
(70) As noted, the CG may be configured for the UE **104** to transmit uplink over TX0. However, if after the CG configuration the network node **102** determines that an SRS received via TX1 of the UE **104** is a higher quality signal, then the network node **102** may configure the DG such that the UE **104** transmits the DG uplink using TX1. In such an example, the UE **104** may have to switch between ports for CG and DG uplink transmissions if the CG is configured for TX0 and the DG is configured for TX1. Such a scenario may require additional time between uplink transmissions and additional power consumption at the UE **104** when it switches between ports.
(71) Thus, at a second process **512**, the UE **104** may use the DG provided in the fourth communication **510** as an implicit command to update the CG uplink port to match the DG port if the ports of the CG configuration and the DG configuration are different. Accordingly, the UE **104** may update the port used for uplink transmissions from TX0 to TX1.

(72) At a fifth communication **514** the UE **104** may transmit an uplink signal via TX1 in accordance with the DG configuration of the fourth communication **510**. At a sixth communication **516**, the UE **104** may transmit an uplink communication using CG resources via TX1 despite receiving no explicit command or indication to change the CG port from TX0 to TX1. Instead, the DG of the fourth communication **510** may trigger the UE **104** to switch the CG port from TX0 to TX1 for future CG uplinks.
(73) FIG. **6** is a block diagram conceptually illustrating an example timeline within which the UE **104** switches from a first port (e.g., TX0) to a second port (e.g., TX1) for uplink transmissions associated with both DG and CG. In this example, the apparatus may be configured for SISO uplink communications.
(74) The UE **104** transmitter **354**TX includes the first port **602** and the second port **604**. Initially, the UE **104** may receive, from the network node, a CG configuration indicating a mapping between the first port **602** and a first SRI value, and the second port **604** and a second SRI value. In some examples, the configuration is received via an RRC message. It should be noted that in some examples, the RRC message may activate uplink transmissions according to the CG at the UE **104**. However, in other examples, the RRC message may configure the UE **104** for CG uplink transmissions, but the network node may transmit another signal (e.g., a PHY activation via DCI) to the UE **104** to activate uplink transmissions according to the CG configuration.
(75) At a first CG uplink transmission **606**, the UE **104** may transmit an uplink signal according to the CG configuration that instructs the UE **104** to transmit via the first port **602**. The UE **104** may also transmit a request (e.g., SR) for a DG to the network node. In response to request, the UE **104** may receive, from the network node, a DG for uplink communication via the first port **602** of the UE **104**. The UE **104** may then transmit a first uplink signal **608** according to the DG that instructs the UE **104** to transmit the uplink via the first port **602**. For example, the DG may be transmitted via a DCI that includes an SRI value that maps to the first port **602**.
(76) The UE **104** may then transmit another SR to the network node requesting another DG. In this example, the network node may transmit another DG to the UE **104** instructing the UE **104** to transmit the next uplink signal via the second port **604**. For example, the DG may be a DCI having an SRI value that maps to the second port **604**.
(77) The UE **104** may then transmit a second uplink signal **610** using the second port **604**. However, because the UE **104** is still configured to transmit CG uplink signals via the first port **602**, the UE **104** may switch the port used for CG uplink signals to the second port so that uplink signals transmitted for DG and CG are transmitted using the same port. Thus, at a next CG resource, the UE **104** may transmit the CG uplink signal **612** via the second port **604**.
(78) FIG. **7** is a flowchart **700** of a method of wireless communication. The method may be performed by a UE (e.g., the UE **104**; the apparatus **1002**). At **702**, the UE may optionally output, for transmission to the network node, a request for a dynamic grant (DG). For example, **702** may be performed by a transmitting component **840**.
(79) At **704**, the UE may optionally obtain, from the network node, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value. For example, **704** may be performed by a receiving component **842**.
(80) At **706**, the UE may obtain, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus. For example, **706** may be performed by the receiving component **842**.
(81) At **708**, the UE may obtain, from the network node, a second signal indicating the DG for uplink communication via a second port of the apparatus. For example, **708** may be performed by the receiving component **842**.
(82) At **710**, the UE may optionally switch from the first port to the second port for CG uplink communications, the switch based on the second signal indication of the second port. For example, **710** may be performed by a switching component **844**.

(83) At **712**, the UE may output, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port. For example, **712** may be performed by a transmitting component **840**.
(84) In certain aspects, the first signal is obtained via a downlink control information (DCI) signal, and wherein the DCI signal comprises a sounding reference signal (SRS) resource indicator (SRI) configured to identify the first port for outputting the CG uplink communication.
(85) In certain aspects, the CG configuration is obtained via a radio resource control (RRC) message.
(86) In certain aspects, the apparatus is configured for single-input single-output (SISO) communication.
(87) FIG. **8** is a diagram **800** illustrating an example of a hardware implementation for an apparatus **802**. The apparatus **802** is a UE and includes a cellular baseband processor **804** (also referred to as a modem) coupled to a cellular RF transceiver **822** and one or more subscriber identity modules (SIM) cards **820**, an application processor **806** coupled to a secure digital (SD) card **808** and a screen **810**, a Bluetooth module **812**, a wireless local area network (WLAN) module **814**, a Global Positioning System (GPS) module **816**, and a power supply **818**. The cellular baseband processor **804** communicates through the cellular RF transceiver **822** with the UE **104** and/or BS **102/180**. The cellular baseband processor **804** may include a computer-readable medium/memory. The computer-readable medium/memory may be non-transitory. The cellular baseband processor **804** is responsible for general processing, including the execution of software stored on the computer-readable medium/memory. The software, when executed by the cellular baseband processor **804**, causes the cellular baseband processor **804** to perform the various functions described supra. The computer-readable medium/memory may also be used for storing data that is manipulated by the cellular baseband processor **804** when executing software. The cellular baseband processor **804** further includes a reception component **830**, a communication manager **832**, and a transmission component **834**. The communication manager **832** includes the one or more illustrated components. The components within the communication manager **832** may be stored in the computer-readable medium/memory and/or configured as hardware within the cellular baseband processor **804**. The cellular baseband processor **804** may be a component of the UE **350** and may include the memory **360** and/or at least one of the TX processor **368**, the RX processor **356**, and the controller/processor **359**. In one configuration, the apparatus **802** may be a modem chip and include just the baseband processor **804**, and in another configuration, the apparatus **802** may be the entire UE (e.g., see **350** of FIG. **3**) and include the aforediscussed additional modules of the apparatus **802**.
(88) The communication manager **832** includes a transmitting component **840** that is configured to output, for transmission to the network node, a request for the DG; and output, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port, e.g., as described in connection with FIG. **7**.
(89) The communication manager **832** further includes a receiving component **842** configured to obtain, from the network node, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value; obtain, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus; obtain, from the network node, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the apparatus; e.g., as described in connection with FIG. **7**.
(90) The communication manager **832** further includes a switching component **844** configured to switch from the first port to the second port for CG uplink communications, the switch based on the second signal indication of the second port, e.g., as described in connection with FIG. **7**.
(91) The apparatus may include additional components that perform each of the blocks of the algorithm in the aforementioned flowchart of FIG. **7**. As such, each block in the aforementioned flowchart may be performed by a component and the apparatus may include one or more of those

components. The components may be one or more hardware components specifically configured to carry out the stated processes/algorithm, implemented by a processor configured to perform the stated processes/algorithm, stored within a computer-readable medium for implementation by a processor, or some combination thereof.
(92) In one configuration, the apparatus **802**, and in particular the cellular baseband processor **804**, includes means for outputting, for transmission to the network node, a request for the DG; means for obtaining, from the network node, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value; means for obtaining, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus; means for obtaining, from the network node, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the apparatus; means for switching from the first port to the second port for CG uplink communications, the switch based on the second signal indication of the second port; and means for outputting, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.
(93) The aforementioned means may be one or more of the aforementioned components of the apparatus **802** configured to perform the functions recited by the aforementioned means. As described supra, the apparatus **802** may include the TX Processor **368**, the RX Processor **356**, and the controller/processor **359**. As such, in one configuration, the aforementioned means may be the TX Processor **368**, the RX Processor **356**, and the controller/processor **359** configured to perform the functions recited by the aforementioned means.
(94) FIG. **9** is a flowchart **900** of a method of wireless communication. The method may be performed by a network node or base station (e.g., the base station **102**/**180**; the apparatus **1002**). At **902**, the network node may optionally obtain, from the UE, a request for the DG. For example, **902** may be performed by a receiving component **1040**.
(95) At **904**, the network node may optionally output, for transmission to the UE, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value. For example, **904** may be performed by a transmitting component **1042**.
(96) At **906**, the network node may output, for transmission to a user equipment (UE), a first signal activating a configured grant (CG) for uplink communication via a first port of the UE. For example, **906** may be performed by the transmitting component **1042**.
(97) At **908**, the network node may output, for transmission to the UE, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE. For example, **908** may be performed by the transmitting component **1042**.
(98) Finally, at **910**, the network node may obtain, from the UE, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port. For example, **910** may be performed by the receiving component **1040**.
(99) In certain aspects, the second signal indication of the second port is configured to switch CG uplink signaling via the first port to the second port.
(100) In certain aspects, the first signal comprises a downlink control information (DCI) signal, and wherein the DCI signal comprises a sounding reference signal (SRS) resource indicator (SRI) configured to identify the first port for outputting the CG uplink communication.
(101) In certain aspects, the CG configuration is output for transmission via a radio resource control (RRC) message.
(102) FIG. **10** is a diagram **1000** illustrating an example of a hardware implementation for an apparatus **1002**. The apparatus **1002** is a BS and includes a baseband unit **1004**. The baseband unit **1004** may communicate through a cellular RF transceiver with the UE **104**. The baseband unit **1004** may include a computer-readable medium/memory. The baseband unit **1004** is responsible for general processing, including the execution of software stored on the computer-readable medium/memory. The software, when executed by the baseband unit **1004**, causes the baseband

unit **1004** to perform the various functions described supra. The computer-readable medium/memory may also be used for storing data that is manipulated by the baseband unit **1004** when executing software. The baseband unit **1004** further includes a reception component **1030**, a communication manager **1032**, and a transmission component **1034**. The communication manager **1032** includes the one or more illustrated components. The components within the communication manager **1032** may be stored in the computer-readable medium/memory and/or configured as hardware within the baseband unit **1004**. The baseband unit **1004** may be a component of the BS **310** and may include the memory **376** and/or at least one of the TX processor **316**, the RX processor **370**, and the controller/processor **375**.

(103) The communication manager **1032** includes a receiving component **1040** configured to obtain, from the UE, a request for the DG; and obtain, from the UE, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port; e.g., as described in connection with FIG. **9**.

(104) The communication manager **1032** further includes a transmitting component **1042** configured to output, for transmission to the UE, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value; output, for transmission to a user equipment (UE), a first signal activating a configured grant (CG) for uplink communication via a first port of the UE; and output, for transmission to the UE, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE; e.g., as described in connection with FIG. **9**.

(105) The apparatus may include additional components that perform each of the blocks of the algorithm in the aforementioned flowchart of FIG. **9**. As such, each block in the aforementioned flowchart of FIG. **9** may be performed by a component and the apparatus may include one or more of those components. The components may be one or more hardware components specifically configured to carry out the stated processes/algorithm, implemented by a processor configured to perform the stated processes/algorithm, stored within a computer-readable medium for implementation by a processor, or some combination thereof.

(106) In one configuration, the apparatus **1002**, and in particular the baseband unit **1004**, includes means for obtaining, from the UE, a request for the DG; means for outputting, for transmission to the UE, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value; means for outputting, for transmission to a user equipment (UE), a first signal activating a configured grant (CG) for uplink communication via a first port of the UE; means for outputting, for transmission to the UE, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE; means for obtaining, from the UE, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.

(107) The aforementioned means may be one or more of the aforementioned components of the apparatus **1002** configured to perform the functions recited by the aforementioned means. As described supra, the apparatus **1002** may include the TX Processor **316**, the RX Processor **370**, and the controller/processor **375**. As such, in one configuration, the aforementioned means may be the TX Processor **316**, the RX Processor **370**, and the controller/processor **375** configured to perform the functions recited by the aforementioned means.

Additional Considerations

(108) Means for receiving or means for obtaining may include a receiver (such as the receive processor **370**) or an antenna(s) **320** of the BS **102**/**180** or the receive processor **356** or antenna(s) **352** of the UE **104** illustrated in FIG. **3**. Means for transmitting or means for outputting may include a transmitter (such as the transmit processor **316**) or an antenna(s) **320** of the BS **102**/**180** or the transmit processor **368** or antenna(s) **352** of the UE **104** illustrated in FIG. **3**. Means for switching may include a processing system, which may include one or more processors, such as the receive processor **370**/**356**, the transmit processor **316**/**368**, or the controller **359**/**375** of the BS

102/**180** and the UE **104** illustrated in FIG. **3**.
(109) In some cases, rather than actually transmitting a frame a device may have an interface to output a frame for transmission (a means for outputting). For example, a processor may output a frame, via a bus interface, to a radio frequency (RF) front end for transmission. Similarly, rather than actually receiving a frame, a device may have an interface to obtain a frame received from another device (a means for obtaining). For example, a processor may obtain (or receive) a frame, via a bus interface, from an RF front end for reception.
(110) It is understood that the specific order or hierarchy of blocks in the processes/flowcharts disclosed is an illustration of example approaches. Based upon design preferences, it is understood that the specific order or hierarchy of blocks in the processes/flowcharts may be rearranged. Further, some blocks may be combined or omitted. The accompanying method claims present elements of the various blocks in a sample order, and are not meant to be limited to the specific order or hierarchy presented.
(111) The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Terms such as "if," "when," and "while" should be interpreted to mean "under the condition that" rather than imply an immediate temporal relationship or reaction. That is, these phrases, e.g., "when," do not imply an immediate action in response to or during the occurrence of an action, but simply imply that if a condition is met then an action will occur, but without requiring a specific or immediate time constraint for the action to occur. The word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any aspect described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other aspects. Unless specifically stated otherwise, the term "some" refers to one or more. Combinations such as "at least one of A, B, or C," "one or more of A, B, or C," "at least one of A, B, and C," "one or more of A, B, and C," and "A, B, C, or any combination thereof" include any combination of A, B, and/or C, and may include multiples of A, multiples of B, or multiples of C. Specifically, combinations such as "at least one of A, B, or C," "one or more of A, B, or C," "at least one of A, B, and C," "one or more of A, B, and C," and "A, B, C, or any combination thereof" may be A only, B only, C only, A and B, A and C, B and C, or A and B and C, where any such combinations may contain one or more member or members of A, B, or C. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. The words "module," "mechanism," "element," "device," and the like may not be a substitute for the word "means." As such, no claim element is to be construed as a means plus function unless the element is expressly recited using the phrase "means for."
EXAMPLE ASPECTS
(112) The following examples are illustrative only and may be combined with aspects of other embodiments or teachings described herein, without limitation. Example 1 is a method of wireless communication at an apparatus, comprising: obtaining, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus; obtaining, from the network node, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the apparatus; and outputting, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port. Example 2 is the method of example 1, wherein the method further comprises:

switching from the first port to the second port for CG uplink communications, the switch based on the second signal indication of the second port. Example 3 is the method of any of examples 1 and 2, wherein the first signal is obtained via a downlink control information (DCI) signal, and wherein the DCI signal comprises a sounding reference signal (SRS) resource indicator (SRI) configured to identify the first port for outputting the CG uplink communication. Example 4 is the method of example 3, wherein the method further comprises: obtaining, from the network node, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value. Example 5 is the method of example 4, wherein the CG configuration is obtained via a radio resource control (RRC) message. Example 6 is the method of any of examples 1-5, wherein the method further comprises: outputting, for transmission to the network node, a request for the DG. Example 7 is the method of any of examples 1-6, wherein the apparatus is configured for single-input single-output (SISO) communication. Example 8 is a method of wireless communication at an apparatus, comprising: outputting, for transmission to a user equipment (UE), a first signal activating a configured grant (CG) for uplink communication via a first port of the UE; outputting, for transmission to the UE, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE; and obtaining, from the UE, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port. Example 9 is the method of example 8, wherein the second signal indication of the second port is configured to switch CG uplink signaling via the first port to the second port. Example 10 is the method of any of examples 8 and 9, wherein the first signal comprises a downlink control information (DCI) signal, and wherein the DCI signal comprises a sounding reference signal (SRS) resource indicator (SRI) configured to identify the first port for outputting the CG uplink communication. Example 11 is the method of example 10, wherein the method further comprises: outputting, for transmission to the UE, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value. Example 12 is the method of example 11, wherein the CG configuration is output for transmission via a radio resource control (RRC) message. Example 13 is the method of any of examples 8-12, wherein the method further comprises: obtaining, from the UE, a request for the DG. Example 14 is a UE, comprising: a transceiver; a memory comprising instructions; and one or more processors configured to execute the instructions to cause the UE to perform a method in accordance with any one of examples 1-7, wherein the transceiver is configured to: receive the first signal; receive the second signal; and transmit the CG uplink signal. Example 15 is a network node, comprising: a transceiver; a memory comprising instructions; and one or more processors configured to execute the instructions and cause the network node to perform a method in accordance with any one of examples 8-13, wherein the transceiver is configured to: transmit the first signal; transmit the second signal; and receive the CG uplink signal. Example 16 is an apparatus for wireless communications, comprising means for performing a method in accordance with any one of examples 1-7. Example 17 is an apparatus for wireless communications, comprising means for performing a method in accordance with any one of examples 8-13. Example 18 is a non-transitory computer-readable medium comprising instructions that, when executed by an apparatus, cause the apparatus to perform a method in accordance with any one of examples 1-7. Example 19 is a non-transitory computer-readable medium comprising instructions that, when executed by an apparatus, cause the apparatus to perform a method in accordance with any one of examples 8-13. Example 20 is an apparatus for wireless communications, comprising: a memory comprising instructions; and one or more processors configured to execute the instructions to cause the apparatus to perform a method in accordance with any one of examples 1-7. Example 21 is apparatus for wireless communications, comprising: a memory comprising instructions; and one or more processors configured to execute the instructions to cause the apparatus to perform a method in accordance with any one of examples 8-13.

Claims

1. An apparatus configured for wireless communication, comprising: a memory comprising instructions; and one or more processors configured to execute the instructions and cause the apparatus to: obtain, from a network node, a first signal activating a configured grant (CG) for uplink communication via a first port of the apparatus; obtain, from the network node, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the apparatus; and output, for transmission to the network node, a CG uplink signal via the second port of the apparatus based on the second signal indication of the second port.
2. The apparatus of claim 1, wherein the one or more processors are further configured to cause the apparatus to: switch from the first port to the second port for CG uplink communications, the switch based on the second signal indication of the second port.
3. The apparatus of claim 1, wherein the first signal is obtained via a downlink control information (DCI) signal, and wherein the DCI signal comprises a sounding reference signal (SRS) resource indicator (SRI) configured to identify the first port for outputting the CG uplink communication.
4. The apparatus of claim 3, wherein the one or more processors are further configured to cause the apparatus to: obtain, from the network node, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value.
5. The apparatus of claim 4, wherein the CG configuration is obtained via a radio resource control (RRC) message.
6. The apparatus of claim 1, wherein the one or more processors are further configured to cause the apparatus to: output, for transmission to the network node, a request for the DG.
7. The apparatus of claim 1, wherein the apparatus is configured for single-input single-output (SISO) communication.
8. A user equipment (UE), comprising: a transceiver; a memory comprising instructions; and one or more processors configured to execute the instructions and cause the UE to: receive, via the transceiver, a first signal activating a configured grant (CG) for uplink communication via a first port of the UE; receive, via the transceiver, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE; and transmit, via the transceiver, a CG uplink signal via the second port of the UE based on the second signal indication of the second port.
9. The UE of claim 8, wherein the one or more processors are further configured to cause the UE to: switch from the first port to the second port for CG uplink communications, the switch based on the second signal indication of the second port.
10. The UE of claim 8, wherein the first signal is obtained via a downlink control information (DCI) signal, and wherein the DCI signal comprises a sounding reference signal (SRS) resource indicator (SRI) configured to identify the first port for outputting the CG uplink communication.
11. The UE of claim 10, wherein the one or more processors are further configured to cause the UE to: receive, via the transceiver, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value.
12. The UE of claim 11, wherein the CG configuration is obtained via a radio resource control (RRC) message.
13. The UE of claim 8, wherein the one or more processors are further configured to cause the UE to: transmit, via the transceiver, a request for the DG.
14. An apparatus configured for wireless communication, comprising: a memory comprising instructions; and one or more processors configured to execute the instructions and cause the apparatus to: output, for transmission to a user equipment (UE), a first signal activating a configured grant (CG) for uplink communication via a first port of the UE; output, for transmission to the UE, a second signal indicating a dynamic grant (DG) for uplink communication via a second port of the UE; and obtain, from the UE, a CG uplink signal via the second port of the apparatus

based on the second signal indication of the second port.

15. The apparatus of claim 14, wherein the second signal indication of the second port is configured to switch CG uplink signaling via the first port to the second port.

16. The apparatus of claim 14, wherein the first signal comprises a downlink control information (DCI) signal, and wherein the DCI signal comprises a sounding reference signal (SRS) resource indicator (SRI) configured to identify the first port for outputting the CG uplink communication.

17. The apparatus of claim 16, wherein the one or more processors are further configured to cause the apparatus to: output, for transmission to the UE, a CG configuration indicating a mapping between the first port and a first SRI value, and the second port and a second SRI value.

18. The apparatus of claim 17, wherein the CG configuration is output for transmission via a radio resource control (RRC) message.

19. The apparatus of claim 14, wherein the one or more processors are further configured to cause the apparatus to: obtain, from the UE, a request for the DG.

20. The apparatus of claim 14, further comprising a transceiver configured to: transmit the first signal; transmit the second signal; and receive the CG uplink signal, wherein the apparatus is configured as a network node.