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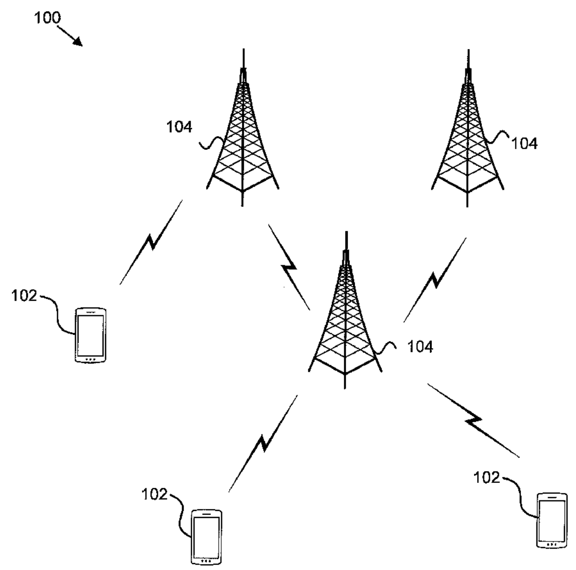


FIG. 1

**(57) Abstract:** Apparatuses, methods, and systems are disclosed for downlink configuration. One apparatus (200) includes a receiver (212) that receives (702) configuration information indicating a set of time durations and multiple receive beams for receiving downlink information. The apparatus (200) also includes a processor (202) that determines (704) a time duration of the set of time durations and a receive beam of the multiple receive beams for receiving downlink information based on the configuration information. The receiver (212) receives (706) downlink information during the time duration using the receive beam.

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# DOWNLINK CONFIGURATION

## FIELD

[0001] The subject matter disclosed herein relates generally to wireless communications and more particularly relates to downlink configuration.

## BACKGROUND

[0002] The following abbreviations are herewith defined, at least some of which are referred to within the following description: Third Generation Partnership Project ("3GPP"), Positive-Acknowledgment ("ACK"), Binary Phase Shift Keying ("BPSK"), Clear Channel Assessment ("CCA"), Cyclic Prefix ("CP"), Channel State Information ("CSI"), Common Search Space ("CSS"), Discrete Fourier Transform Spread ("DFTS"), Downlink Control Information ("DCI"), Downlink ("DL"), Downlink Pilot Time Slot ("DwPTS"), Enhanced Clear Channel Assessment ("eCCA"), Enhanced Mobile Broadband ("eMBB"), Evolved Node B ("eNB"), European Telecommunications Standards Institute ("ETSI"), Frame Based Equipment ("FBE"), Frequency Division Duplex ("FDD"), Frequency Division Multiple Access ("FDMA"), Guard Period ("GP"), Hybrid Automatic Repeat Request ("HARQ"), Internet-of-Things ("IoT"), Licensed Assisted Access ("LAA"), Load Based Equipment ("LBE"), Listen-Before-Talk ("LBT"), Long Term Evolution ("LTE"), Multiple Access ("MA"), Modulation Coding Scheme ("MCS"), Machine Type Communication ("MTC"), Multiple Input Multiple Output ("MIMO"), Multi User Shared Access ("MUSA"), Narrowband ("NB"), Negative-Acknowledgment ("NACK") or ("NAK"), Next Generation Node B ("gNB"), Non-Orthogonal Multiple Access ("NOMA"), Orthogonal Frequency Division Multiplexing ("OFDM"), Primary Cell ("PCell"), Physical Broadcast Channel ("PBCH"), Physical Downlink Control Channel ("PDCCH"), Physical Downlink Shared Channel ("PDSCH"), Pattern Division Multiple Access ("PDMA"), Physical Hybrid ARQ Indicator Channel ("PHICH"), Physical Random Access Channel ("PRACH"), Physical Resource Block ("PRB"), Physical Uplink Control Channel ("PUCCH"), Physical Uplink Shared Channel ("PUSCH"), Quality of Service ("QoS"), Quadrature Phase Shift Keying ("QPSK"), Radio Resource Control ("RRC"), Random Access Procedure ("RACH"), Random Access Response ("RAR"), Reference Signal ("RS"), Resource Spread Multiple Access ("RSMA"), Round Trip Time ("RTT"), Receive ("RX"), Sparse Code Multiple Access ("SCMA"), Scheduling Request ("SR"), Single Carrier Frequency Division Multiple Access ("SC-FDMA"), Secondary Cell ("SCell"), Shared Channel ("SCH"), Signal-to-Interference-Plus-Noise Ratio ("SINR"), System Information Block ("SIB"), Transport Block ("TB"), Transport Block Size ("TBS"), Time-Division Duplex ("TDD"), Time Division

Multiplex ("TDM"), Transmission Time Interval ("TTI"), Transmit ("TX"), Uplink Control Information ("UCI"), User Entity/Equipment (Mobile Terminal) ("UE"), Uplink ("UL"), Universal Mobile Telecommunications System ("UMTS"), Uplink Pilot Time Slot ("UpPTS"), Ultra-reliability and Low-latency Communications ("URLLC"), and Worldwide Interoperability for Microwave Access ("WiMAX"). As used herein, "HARQ-ACK" may represent collectively the Positive Acknowledge ("ACK") and the Negative Acknowledge ("NAK"). ACK means that a TB is correctly received while NAK means a TB is erroneously received.

[0003] In certain wireless communications networks, a high carrier frequency (e.g., >6GHz) may be used, such as millimeter wave. Propagation characteristics at higher frequencies (e.g., 6GHz, 30GHz, 70GHz, etc.) may be significantly different from those at lower frequencies (e.g., 1.8GHz, 2.6GHz, etc.). For example, at higher frequencies path loss may be much higher than at lower frequencies. In various configurations, beamforming may be used at high frequencies to compensate for a large path loss.

[0004] In certain configurations, a beamforming technique based on multiple antennas may be used. In some configurations, due to an antenna size decreasing with an increasing carrier frequency, a number of antennas at a high carrier frequency may be much larger than a number of antennas at a low carrier frequency. The large number of antennas may facilitate a large beamforming gain to compensate for a large path loss.

[0005] In various configurations, three methods may be used to perform beamforming. For example, there may be digital beamforming, analog beamforming, and hybrid beamforming. In some configurations, for hybrid beamforming a transmitter beam and a receiver beam may be aligned to have beamforming gain.

[0006] Multiple digital beamforms may be transmitted or received in a same time in an FDM or a CDM manner. Unlike digital beamforming, different analog beamforming or the analog part of different hybrid beamforming may not be transmitted or received in the same time because of limitation of hardware implementation. Therefore, analog beamforming may only be used in a TDM manner.

[0007] In some configurations, an analog beamforming part in RF of hybrid beamforming may only implement one beam at the same time. In contrast, a digital beamforming part in baseband of hybrid beamforming may implement multiple beams at the same time. In certain configurations, a proper analog beamforming may be determined before transmission or reception.

[0008] In various configurations, a corresponding TX beam and RX beam may be determined or known before a transmission between a gNB and a UE. If a good linkage is maintained between a gNB and a UE, at least a pair of TX beam and RX beam may be maintained at the base station side and the UE side.

[0009] In certain configurations, a UE may determine its best RX beam by doing RX beam sweeping in the reception of downlink transmission and a gNB may determine its best TX beam by doing TX beam sweeping in the transmission of downlink transmission. In some configurations, a gNB may use a corresponding best TX beam to serve a UE, and the UE may use a corresponding best RX beam to receive a downlink signal. In various configurations, a gNB may only schedule UEs with a same best TX beam in the gNB at a time which may limit the scheduling of the gNB when only the best pair of TX beam and RX beam information is maintained in the gNB and UEs. In some configurations, beam grouping may mean that for a gNB or UE multiple Tx and/or Rx beam(s) and/or beam pair(s) may be grouped into one subset of beams.

[0010] In some configurations, if a UE has multiple beams in RX, it may know or determine a RX beam in advance for a downlink transmission even if it receives the downlink transmission using blind decoding. In various configurations, if only a best pair of TX beam and RX beam is maintained in a downlink between a gNB and a UE, then the UE may use the RX beam of the best beam pair to receive the downlink transmission even if there is no downlink transmission for it. In certain configurations, if multiple pairs of TX beams and RX beams are maintained in a downlink between a gNB and a UE in which multiple TX beams in the gNB may be used to serve the UE and multiple RX beams may be used to receive a downlink transmission, then the RX beam of the UE may be indicated by the gNB to receive the downlink transmission. Interference may occur with downlink transmissions for multiple UEs using conflicting TX and RX beam pairs.

## BRIEF SUMMARY

[0011] Apparatuses for downlink configuration are disclosed. Methods and systems also perform the functions of the apparatus. In one embodiment, the apparatus includes a receiver that receives configuration information indicating a set of time durations and multiple receive beams for receiving downlink information. The apparatus also includes a processor that determines a time duration of the set of time durations and a receive beam of the multiple receive beams for receiving downlink information based on the configuration information. In some embodiments, the receiver receives downlink information during the time duration using the receive beam.

[0012] In one embodiment, the set of time durations has a corresponding transmit beam pattern. In a further embodiment, each time duration of the set of time durations has a corresponding transmit beam. In certain embodiments, the configuration information includes information indicating the set of time durations for a period of time and its corresponding transmit beam pattern. In some embodiments, the configuration information includes information indicating a subset of the set of time durations for a period of time and its corresponding receive beam pattern.

[0013] In various embodiments, the configuration information includes information for determining a receive beam of the multiple receive beams based on a transmit beam pattern and beam grouping information. In some embodiments, the receive beam is determined based on reference signal received power. In one embodiment, the receive beam is determined randomly. In various embodiments, the configuration information indicating the set of time durations and the multiple receive beams for receiving downlink information is determined based on beam grouping information. In some embodiments, the beam grouping information includes information identifying a group of transmit and receive beam pairs.

[0014] A method for downlink configuration, in one embodiment, includes receiving configuration information indicating a set of time durations and multiple receive beams for receiving downlink information. The method also includes determining a time duration of the set of time durations and a receive beam of the multiple receive beams for receiving downlink information based on the configuration information. The method includes receiving downlink information during the time duration using the receive beam.

[0015] In one embodiment, an apparatus includes a processor that determines configuration information indicating a set of time durations and multiple receive beams for a remote unit to receive downlink information. In various embodiments, the apparatus includes a transmitter that transmits the configuration information to the remote unit and transmits downlink information based on the configuration information.

[0016] In one embodiment, the set of time durations has a corresponding transmit beam pattern. In a further embodiment, each time duration of the set of time durations has a corresponding transmit beam. In certain embodiments, the configuration information includes information indicating the set of time durations for a period of time and its corresponding transmit beam pattern. In some embodiments, the configuration information includes information indicating a subset of the set of time durations for a period of time and its corresponding receive beam pattern.

[0017] In various embodiments, the configuration information includes information for determining a receive beam of the multiple receive beams based on a transmit beam pattern and beam grouping information. In some embodiments, the receive beam is determined based on reference signal received power. In one embodiment, the receive beam is determined randomly. In various embodiments, the configuration information indicating the set of time durations and the multiple receive beams for receiving downlink information is determined based on beam grouping information. In some embodiments, the beam grouping information includes information identifying a group of transmit and receive beam pairs.

[0018] A method for downlink configuration, in one embodiment, includes determining configuration information indicating a set of time durations and multiple receive beams for a remote unit to receive downlink information. The method also includes transmitting the configuration information to the remote unit. The method includes transmitting downlink information based on the configuration information.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0019] A more particular description of the embodiments briefly described above will be rendered by reference to specific embodiments that are illustrated in the appended drawings. Understanding that these drawings depict only some embodiments and are not therefore to be considered to be limiting of scope, the embodiments will be described and explained with additional specificity and detail through the use of the accompanying drawings, in which:

[0020] Figure 1 is a schematic block diagram illustrating one embodiment of a wireless communication system for downlink configuration;

[0021] Figure 2 is a schematic block diagram illustrating one embodiment of an apparatus that may be used for downlink configuration;

[0022] Figure 3 is a schematic block diagram illustrating one embodiment of an apparatus that may be used for downlink configuration;

[0023] Figure 4 illustrates one embodiment of communications for downlink configuration;

[0024] Figures 5A-5C are schematic block diagrams illustrating one embodiment of a transmission configuration for transmissions from a gNB;

[0025] Figures 6A-6C are schematic block diagrams illustrating another embodiment of a transmission configuration for transmissions from a gNB;

[0026] Figure 7 is a schematic flow chart diagram illustrating one embodiment of a method for downlink configuration; and

[0027] Figure 8 is a schematic flow chart diagram illustrating another embodiment of a method for downlink configuration.

## DETAILED DESCRIPTION

[0028] As will be appreciated by one skilled in the art, aspects of the embodiments may be embodied as a system, apparatus, method, or program product. Accordingly, embodiments may take the form of an entirely hardware embodiment, an entirely software embodiment (including firmware, resident software, micro-code, etc.) or an embodiment combining software and hardware aspects that may all generally be referred to herein as a "circuit," "module" or "system." Furthermore, embodiments may take the form of a program product embodied in one or more computer readable storage devices storing machine readable code, computer readable code, and/or program code, referred hereafter as code. The storage devices may be tangible, non-transitory, and/or non-transmission. The storage devices may not embody signals. In a certain embodiment, the storage devices only employ signals for accessing code.

[0029] Certain of the functional units described in this specification may be labeled as modules, in order to more particularly emphasize their implementation independence. For example, a module may be implemented as a hardware circuit comprising custom very-large-scale integration ("VLSI") circuits or gate arrays, off-the-shelf semiconductors such as logic chips, transistors, or other discrete components. A module may also be implemented in programmable hardware devices such as field programmable gate arrays, programmable array logic, programmable logic devices or the like.

[0030] Modules may also be implemented in code and/or software for execution by various types of processors. An identified module of code may, for instance, include one or more physical or logical blocks of executable code which may, for instance, be organized as an object, procedure, or function. Nevertheless, the executables of an identified module need not be physically located together, but may include disparate instructions stored in different locations which, when joined logically together, include the module and achieve the stated purpose for the module.

[0031] Indeed, a module of code may be a single instruction, or many instructions, and may even be distributed over several different code segments, among different programs, and across several memory devices. Similarly, operational data may be identified and illustrated herein within modules, and may be embodied in any suitable form and organized within any suitable type of data structure. The operational data may be collected as a single data set, or may be distributed over different locations including over different computer readable storage devices. Where a module or portions of a module are implemented in software, the software portions are stored on one or more computer readable storage devices.

[0032] Any combination of one or more computer readable medium may be utilized. The computer readable medium may be a computer readable storage medium. The computer readable storage medium may be a storage device storing the code. The storage device may be, for example, but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, holographic, micromechanical, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing.

[0033] More specific examples (a non-exhaustive list) of the storage device would include the following: an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory ("RAM"), a read-only memory ("ROM"), an erasable programmable read-only memory ("EPROM" or Flash memory), a portable compact disc read-only memory ("CD-ROM"), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing. In the context of this document, a computer readable storage medium may be any tangible medium that can contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device.

[0034] Code for carrying out operations for embodiments may be any number of lines and may be written in any combination of one or more programming languages including an object oriented programming language such as Python, Ruby, Java, Smalltalk, C++, or the like, and conventional procedural programming languages, such as the "C" programming language, or the like, and/or machine languages such as assembly languages. The code may execute entirely on the user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server. In the latter scenario, the remote computer may be connected to the user's computer through any type of network, including a local area network ("LAN") or a wide area network ("WAN"), or the connection may be made to an external computer (for example, through the Internet using an Internet Service Provider).

[0035] Reference throughout this specification to "one embodiment," "an embodiment," or similar language means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, appearances of the phrases "in one embodiment," "in an embodiment," and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment, but mean "one or more but not all embodiments" unless expressly specified otherwise. The terms "including," "comprising," "having," and variations thereof mean "including but not limited to," unless expressly specified otherwise. An enumerated listing of items does not imply that any or all of the items are mutually exclusive, unless expressly specified otherwise. The terms “a,” “an,” and “the” also refer to “one or more” unless expressly specified otherwise.

[0036] Furthermore, the described features, structures, or characteristics of the embodiments may be combined in any suitable manner. In the following description, numerous specific details are provided, such as examples of programming, software modules, user selections, network transactions, database queries, database structures, hardware modules, hardware circuits, hardware chips, etc., to provide a thorough understanding of embodiments. One skilled in the relevant art will recognize, however, that embodiments may be practiced without one or more of the specific details, or with other methods, components, materials, and so forth. In other instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring aspects of an embodiment.

[0037] Aspects of the embodiments are described below with reference to schematic flowchart diagrams and/or schematic block diagrams of methods, apparatuses, systems, and program products according to embodiments. It will be understood that each block of the schematic flowchart diagrams and/or schematic block diagrams, and combinations of blocks in the schematic flowchart diagrams and/or schematic block diagrams, can be implemented by code. These code may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the schematic flowchart diagrams and/or schematic block diagrams block or blocks.

[0038] The code may also be stored in a storage device that can direct a computer, other programmable data processing apparatus, or other devices to function in a particular manner, such that the instructions stored in the storage device produce an article of manufacture including instructions which implement the function/act specified in the schematic flowchart diagrams and/or schematic block diagrams block or blocks.

[0039] The code may also be loaded onto a computer, other programmable data processing apparatus, or other devices to cause a series of operational steps to be performed on the computer, other programmable apparatus or other devices to produce a computer implemented process such that the code which execute on the computer or other programmable apparatus provide processes for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

[0040] The schematic flowchart diagrams and/or schematic block diagrams in the Figures illustrate the architecture, functionality, and operation of possible implementations of apparatuses, systems, methods and program products according to various embodiments. In this regard, each block in the schematic flowchart diagrams and/or schematic block diagrams may represent a module, segment, or portion of code, which includes one or more executable instructions of the code for implementing the specified logical function(s).

[0041] It should also be noted that, in some alternative implementations, the functions noted in the block may occur out of the order noted in the Figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. Other steps and methods may be conceived that are equivalent in function, logic, or effect to one or more blocks, or portions thereof, of the illustrated Figures.

[0042] Although various arrow types and line types may be employed in the flowchart and/or block diagrams, they are understood not to limit the scope of the corresponding embodiments. Indeed, some arrows or other connectors may be used to indicate only the logical flow of the depicted embodiment. For instance, an arrow may indicate a waiting or monitoring period of unspecified duration between enumerated steps of the depicted embodiment. It will also be noted that each block of the block diagrams and/or flowchart diagrams, and combinations of blocks in the block diagrams and/or flowchart diagrams, can be implemented by special purpose hardware-based systems that perform the specified functions or acts, or combinations of special purpose hardware and code.

[0043] The description of elements in each figure may refer to elements of proceeding figures. Like numbers refer to like elements in all figures, including alternate embodiments of like elements.

[0044] Figure 1 depicts an embodiment of a wireless communication system 100 for downlink configuration. In one embodiment, the wireless communication system 100 includes remote units 102 and base units 104. Even though a specific number of remote units 102 and base units 104 are depicted in Figure 1, one of skill in the art will recognize that any number of remote units 102 and base units 104 may be included in the wireless communication system 100.

[0045] In one embodiment, the remote units 102 may include computing devices, such as desktop computers, laptop computers, personal digital assistants ("PDAs"), tablet computers, smart phones, smart televisions (e.g., televisions connected to the Internet), set-top boxes, game consoles, security systems (including security cameras), vehicle on-board computers, network devices (e.g., routers, switches, modems), or the like. In some embodiments, the remote units 102 include wearable devices, such as smart watches, fitness bands, optical head-mounted displays, or the like. Moreover, the remote units 102 may be referred to as subscriber units, mobiles, mobile stations, users, terminals, mobile terminals, fixed terminals, subscriber stations, UE, user terminals, a device, or by other terminology used in the art. The remote units 102 may communicate directly with one or more of the base units 104 via UL communication signals.

[0046] The base units 104 may be distributed over a geographic region. In certain embodiments, a base unit 104 may also be referred to as an access point, an access terminal, a base, a base station, a Node-B, an eNB, a gNB, a Home Node-B, a relay node, a device, or by any other terminology used in the art. The base units 104 are generally part of a radio access network that includes one or more controllers communicably coupled to one or more corresponding base units 104. The radio access network is generally communicably coupled to one or more core networks, which may be coupled to other networks, like the Internet and public switched telephone networks, among other networks. These and other elements of radio access and core networks are not illustrated but are well known generally by those having ordinary skill in the art.

[0047] In one implementation, the wireless communication system 100 is compliant with the LTE of the 3GPP protocol, wherein the base unit 104 transmits using an OFDM modulation scheme on the DL and the remote units 102 transmit on the UL using a SC-FDMA scheme or an OFDM scheme. More generally, however, the wireless communication system 100 may implement some other open or proprietary communication protocol, for example, WiMAX, among other protocols. The present disclosure is not intended to be limited to the implementation of any particular wireless communication system architecture or protocol.

[0048] The base units 104 may serve a number of remote units 102 within a serving area, for example, a cell or a cell sector via a wireless communication link. The base units 104 transmit DL communication signals to serve the remote units 102 in the time, frequency, and/or spatial domain.

[0049] In one embodiment, a base unit 104 may determine configuration information indicating a set of time durations and multiple receive beams for a remote unit 102 to receive downlink information. In some embodiments, the base unit 104 may transmit the configuration information to the remote unit 102. In certain embodiments, the base unit 104 may transmit downlink information based on the configuration information. Accordingly, a base unit 104 may be used for downlink configuration.

[0050] In another embodiment, a remote unit 102 may receive configuration information indicating a set of time durations and multiple receive beams for receiving downlink information. The remote unit 102 may determine a time duration of the set of time durations and a receive beam of the multiple receive beams for receiving downlink information based on the configuration information. The remote unit 102 may receive downlink information during the time duration using the receive beam. Accordingly, a remote unit 102 may be used for downlink configuration.

[0051] Figure 2 depicts one embodiment of an apparatus 200 that may be used for downlink configuration. The apparatus 200 includes one embodiment of the remote unit 102. Furthermore, the remote unit 102 may include a processor 202, a memory 204, an input device 206, a display 208, a transmitter 210, and a receiver 212. In some embodiments, the input device 206 and the display 208 are combined into a single device, such as a touchscreen. In certain embodiments, the remote unit 102 may not include any input device 206 and/or display 208. In various embodiments, the remote unit 102 may include one or more of the processor 202, the memory 204, the transmitter 210, and the receiver 212, and may not include the input device 206 and/or the display 208.

[0052] The processor 202, in one embodiment, may include any known controller capable of executing computer-readable instructions and/or capable of performing logical operations. For example, the processor 202 may be a microcontroller, a microprocessor, a central processing unit ("CPU"), a graphics processing unit ("GPU"), an auxiliary processing unit, a field programmable gate array ("FPGA"), or similar programmable controller. In some embodiments, the processor 202 executes instructions stored in the memory 204 to perform the methods and routines described herein. The processor 202, in various embodiments, may determine a time duration of a set of time durations and a receive beam of multiple receive beams for receiving downlink information based on configuration information. The processor 202 is communicatively coupled to the memory 204, the input device 206, the display 208, the transmitter 210, and the receiver 212.

[0053] The memory 204, in one embodiment, is a computer readable storage medium. In some embodiments, the memory 204 includes volatile computer storage media. For example, the memory 204 may include a RAM, including dynamic RAM ("DRAM"), synchronous dynamic RAM ("SDRAM"), and/or static RAM ("SRAM"). In some embodiments, the memory 204 includes non-volatile computer storage media. For example, the memory 204 may include a hard disk drive, a flash memory, or any other suitable non-volatile computer storage device. In some embodiments, the memory 204 includes both volatile and non-volatile computer storage media. In some embodiments, the memory 204 stores data relating to downlink configuration. In some embodiments, the memory 204 also stores program code and related data, such as an operating system or other controller algorithms operating on the remote unit 102.

[0054] The input device 206, in one embodiment, may include any known computer input device including a touch panel, a button, a keyboard, a stylus, a microphone, or the like. In some embodiments, the input device 206 may be integrated with the display 208, for example, as a touchscreen or similar touch-sensitive display. In some embodiments, the input device 206 includes a touchscreen such that text may be input using a virtual keyboard displayed on the touchscreen and/or by handwriting on the touchscreen. In some embodiments, the input device 206 includes two or more different devices, such as a keyboard and a touch panel.

[0055] The display 208, in one embodiment, may include any known electronically controllable display or display device. The display 208 may be designed to output visual, audible, and/or haptic signals. In some embodiments, the display 208 includes an electronic display capable of outputting visual data to a user. For example, the display 208 may include, but is not limited to, an LCD display, an LED display, an OLED display, a projector, or similar display device capable of outputting images, text, or the like to a user. As another, non-limiting, example, the display 208 may include a wearable display such as a smart watch, smart glasses, a heads-up display, or the like. Further, the display 208 may be a component of a smart phone, a personal digital assistant, a television, a table computer, a notebook (laptop) computer, a personal computer, a vehicle dashboard, or the like.

[0056] In certain embodiments, the display 208 includes one or more speakers for producing sound. For example, the display 208 may produce an audible alert or notification (e.g., a beep or chime). In some embodiments, the display 208 includes one or more haptic devices for producing vibrations, motion, or other haptic feedback. In some embodiments, all or portions of the display 208 may be integrated with the input device 206. For example, the input device 206 and display 208 may form a touchscreen or similar touch-sensitive display. In other embodiments, the display 208 may be located near the input device 206.

[0057] The transmitter 210 is used to provide UL communication signals to the base unit 104 and the receiver 212 is used to receive DL communication signals from the base unit 104. In various embodiments, the receiver 212 may be used to receive configuration information indicating a set of time durations and multiple receive beams for receiving downlink information. In some embodiments, the receiver 212 may be used to receive downlink information during a time duration using a receive beam. Although only one transmitter 210 and one receiver 212 are illustrated, the remote unit 102 may have any suitable number of transmitters 210 and receivers 212. The transmitter 210 and the receiver 212 may be any suitable type of transmitters and receivers. In one embodiment, the transmitter 210 and the receiver 212 may be part of a transceiver.

[0058] Figure 3 depicts one embodiment of an apparatus 300 that may be used for downlink configuration. The apparatus 300 includes one embodiment of the base unit 104. Furthermore, the base unit 104 may include a processor 302, a memory 304, an input device 306, a display 308, a transmitter 310, and a receiver 312. As may be appreciated, the processor 302, the memory 304, the input device 306, the display 308, the transmitter 310, and the receiver 312 may be substantially similar to the processor 202, the memory 204, the input device 206, the display 208, the transmitter 210, and the receiver 212 of the remote unit 102, respectively.

[0059] In one embodiment, the processor 302 may determine configuration information indicating a set of time durations and multiple receive beams for a remote unit 102 to received downlink information. In various embodiment, the transmitter 310 is used to transmit the configuration information to the remote unit 102. In some embodiments, the transmitter 310 may be used to transmit downlink information based on the configuration information. Although only one transmitter 310 and one receiver 312 are illustrated, the base unit 104 may have any suitable number of transmitters 310 and receivers 312. The transmitter 310 and the receiver 312 may be any suitable type of transmitters and receivers. In one embodiment, the transmitter 310 and the receiver 312 may be part of a transceiver.

[0060] Figure 4 illustrates one embodiment of communications 400 for downlink configuration. Specifically, communications 400 between a UE 402 and a gNB 404 are illustrated. The communications 400 may facilitate downlink transmission from the gNB 404 to the UE 402 based on beam grouping. The embodiment illustrated in Figure 4 has beam grouping applied. The beam grouping information may be obtained in the gNB 404 and the UE 402 by beam measurement and feedback. In some embodiments, the downlink transmission based on beam grouping may increase the flexibility of scheduling and the UE 402 may decrease blind decoding of the downlink transmission.

[0061] A first communication 406 may include a message transmitted from the gNB 404 to the UE 402. The first communication 406 may include configuration information used to configure the UE 402 for receiving an upcoming downlink transmission. In one embodiment, the configuration information may include a configuration of a periodic or semi-periodic set of time durations and/or corresponding TX beam patterns applied in the set of time durations. In certain embodiments, the configuration information may be signaled using broadcast system information in which case all UEs (including the UE 402) may know the whole configuration of the set of time durations and the corresponding TX beam pattern in each time duration of the set of time durations.

[0062] In various embodiments, the gNB 404 may indicate to each UE (e.g., the UE 402) the periodic or semi-periodic subset of time durations of the set of time durations and their corresponding RX beam pattern applied in the subset to receive the downlink transmission by RRC signaling or L1 signaling. In such embodiments, each UE doesn't know the whole configuration of the set of time durations and the corresponding TX beam pattern in each time duration of the set of time duration.

[0063] In certain embodiments, the gNB 404 may determine the RX beam for the UE 402 based on the TX beam pattern used by the gNB 404 and the beam group information of the UE 402. In various embodiments, multiple RX beams of the UE 402 may be used to receive the downlink transmission using a same TX beam according its beam group information. In such embodiments, the gNB 404 may indicate the RX beam to the UE 402 after choosing one RX beam from the multiple beams. For example, if the gNB 404 knows which RX beam from multiple RX beams which are associated to a same TX beam has a strongest reference signal received power ("RSRP"), then the gNB 404 may choose the RX beam with the strongest RSRP for the UE's reception. As another example, if the gNB 404 doesn't have the RSRP information of the RX beams of the UE 402, then the gNB 404 may choose a RX beam from the multiple RX beams randomly.

[0064] In some embodiments, the periodic or semi-periodic set of time durations may be configured by the gNB 404 and/or the corresponding TX beam pattern applied in each time duration of the set of time durations may be semi-static configured by the gNB 404. In various embodiments, each time duration of the configured set of time durations may have a one to one mapping to a TX beam of the gNB 404.

[0065] In certain embodiments, the gNB 404 may schedule UEs in each time duration of the configured set of time durations based on beam grouping information of the UEs and the configured TX beam pattern applied in each time duration of the set of time durations.

[0066] In some embodiments, if the configuration of the periodic or semi-periodic set of time durations and the corresponding TX beam pattern applied in the set of time durations is signaled by using broadcast system information, then the UE 402 may receive, in a second communication 408, downlink transmissions in those time durations during which mapping TX beams are in the beam group of the UE 402 by using a corresponding RX beam to receive the TX beam of the time duration. In various embodiments, if there are multiple RX beams corresponding to one TX beam based on the beam grouping information of the UE 402, the UE 402 may choose the RX beam for the reception with a strongest RSRP corresponding to the TX beam of the gNB 404.

[0067] In certain embodiments, if the gNB 404 indicates to the UE 402 the periodic or semi-periodic subset of time durations and the corresponding RX beam pattern applied in the subset to receive these downlink transmissions, then the UE 402 may follow the indication of the gNB 404 to receive the downlink transmission in the indicated time duration by using the indicated RX beam.

[0068] Figures 5A-5C are schematic block diagrams illustrating one embodiment of a transmission configuration 500 for transmissions from a gNB (e.g., the gNB 404, the base unit 104). Specifically, the transmission configuration 500 includes a first set of time durations 502 in a time period 504 and a second set of time durations 506 which may also have the same time period 504. The first set of time durations 502 includes a first time duration 508 ("S0"), a second time duration 510 ("S1"), a third time duration 512 ("S2"), a fourth time duration 514 ("S3"), a fifth time duration 516 ("S4"), and a sixth time duration 518 ("S5"). The second set of time durations 506 includes a first time duration 520 ("S0"), a second time duration 522 ("S1"), a third time duration 524 ("S2"), a fourth time duration 526 ("S3"), a fifth time duration 528 ("S4"), and a sixth time duration 530 ("S5").

[0069] The gNB has 6 TX beams (e.g., TX B0, TX B1, TX B2, TX B3, TX B4, and TX B5). The TX beam pattern applied in each of the first and second sets of time durations 502 and 506 is TX B0 for S0, TX B1 for S1, TX B2 for S2, TX B3 for S3, TX B4 for S4, and TX B5 for S5 which may be semi-static configured by the gNB as illustrated in Figure 5A.

[0070] In certain embodiments, the configuration of the periodic or semi-periodic set of time durations and the corresponding TX beam pattern may be signaled to UEs by broadcast system information. In the embodiment illustrated in Figures 5A-5C, only two UEs (e.g., UE1 and UE2) are used.

[0071] The beam group information for UE1 may include a first beam group having (TX B1, RX B2) and (TX B5, RX B2) and a second beam group having (TX B1, RX B3) and (TX B4, RX B3). Moreover, the beam group information for UE2 may include a first beam group having (TX B0, RX B0) and (TX B5, RX B0) and a second beam group having (TX B2, RX B2) and (TX B4, RX B2).

[0072] In certain embodiments, the gNB may schedule the UE1 and UE2 based on the beam group information. Accordingly, in S0 the gNB may only schedule UE2 because the TX beam of S0 is TX B0 which is only included in the beam group of UE2 but not included in the beam group of UE1. Further, in S1 the gNB may only schedule UE1 because the TX beam of S1 is TX B1 which is only included in the beam group of UE1 but not included in the beam group of UE2. Moreover, in S2 the gNB may only schedule UE2 because the TX beam of S2 is TX B2 which is only included in the beam group of UE2 but not included in the beam group of UE1. In S3 the gNB may not schedule UE1 or UE2 because the TX beam of S3 is TX B3 which is not included in the beam group of UE1 or in the beam group of UE2, but the gNB may schedule other UEs in which TX B3 is included in their beam group. Further, in S4 and S5 the gNB may schedule both UE1 and UE2 because the TX beams of S4 and S5 are TX B4 and TX B5 respectively which are both included in the beam groups of UE1 and UE2.

[0073] Based on the possible scheduling options just described, the gNB may schedule UE1 in S1, S4, and S5, and UE2 in S2 and S4 in the first set of time durations 502, as illustrated in Figure 5A. Moreover, the gNB may schedule UE1 in S2 and S5, and UE2 in S0, S4, and S5 in the second set of time durations 506, as illustrated in Figure 5A.

[0074] For UE1, it may only attempt to receive downlink transmissions in S1, S4, and S5 because TX B1, TX B4, and TX B5 are included in its beam group. Moreover, UE1 may determine its corresponding RX beam for S1, S4, and S5 based on its beam group information. Because there are two RX beams (RX B2 and RX B3) that UE1 may use to receive the downlink transmission in S1 whose associated TX beam is TX B1, UE1 may use RX B2 to receive in the S1 if the RSRP of RX B2 is larger than the RSRP of RX B3. For the reception of S4 and S5, UE1 may use RX B3 and RX B2 respectively based on its beam group information. The RX beams of UE1 are illustrated in Figure 5B.

[0075] As shown by the shaded boxes in Figure 5B, UE1 may detect the downlink transmission for it only in S1, S4, and S5 of the first set of time durations 502, and may detect the downlink transmission for it only in S1 and S5 of the second set of time durations 506.

[0076] For UE2, it may only attempt to receive downlink transmissions in S0, S2, S4, and S5 because TX B0, TX B2, TX B4, and TX B5 are included in its beam group. Moreover, UE2 may determine its corresponding RX beam for S0, S2, S4, and S5 based on its beam group information. For the receptions of S0, S2, S4, and S5, UE2 may use RX B0, RX B2, RX B2, and RX B0 respectively based on its beam group information. The RX beams of UE2 are illustrated in Figure 5C.

[0077] As shown by the shaded boxes in Figure 5C, UE2 may detect the downlink transmission for it only in S2 and S4 of the first set of time durations 502, and may detect the downlink transmission for it only in S0, S4, and S5 of the second set of time durations 506.

[0078] Figures 6A-6C are schematic block diagrams illustrating another embodiment of a transmission configuration 600 for transmissions from a gNB (e.g., the gNB 404, the base unit 104). Specifically, the transmission configuration 600 includes a first set of time durations 602 in a time period 604 and a second set of time durations 606 which may also have the same time period 604. The first set of time durations 602 includes a first time duration 608 ("S0"), a second time duration 610 ("S1"), a third time duration 612 ("S2"), a fourth time duration 614 ("S3"), a fifth time duration 616 ("S4"), and a sixth time duration 618 ("S5"). The second set of time durations 606 includes a first time duration 620 ("S0"), a second time duration 622 ("S1"), a third time duration 624 ("S2"), a fourth time duration 626 ("S3"), a fifth time duration 628 ("S4"), and a sixth time duration 630 ("S5").

[0079] The gNB has 4 TX beams (e.g., TX B0, TX B1, TX B2, and TX B3). The TX beam pattern applied in each of the first and second sets of time durations 602 and 606 is TX B0 for S0, TX B1 for S1, TX B1 for S2, TX B2 for S3, TX B2 for S4, and TX B3 for S5 which may be semi-static configured by the gNB as illustrated in Figure 6A.

[0080] In certain embodiments, the configuration of the periodic or semi-periodic set of time durations and the corresponding TX beam pattern may be signaled to UEs by broadcast system information. In the embodiment illustrated in Figures 6A-6C, only two UEs (e.g., UE1 and UE2) are used. In the illustrated embodiment, the gNB may indicate the configuration information for reception of UE1 and UE2 by informing the UEs to receive during specific time durations and with specific RX beams during those time durations.

[0081] The beam group information for UE1 may include a first beam group having (TX B1, RX B0) and (TX B3, RX B0) and a second beam group having (TX B1, RX B2) and (TX B2, RX B2). Moreover, the beam group information for UE2 may include a first beam group having (TX B0, RX B1) and (TX B2, RX B1) and a second beam group having (TX B1, RX B2) and (TX B2, RX B2).

[0082] The gNB may not have information about which RX beam has a strongest RSRP, and therefore may randomly choose one RX beam from multiple RX beams to be associated with a specific TX beam. Moreover, the configuration information specific to UE1 that includes time durations for UE1 and specific RX beams corresponding to those time durations may include time durations S1, S2, S3, S4, and S5 with corresponding RX beams being respectively B0, B0, B2, B2, and B0. Furthermore, the configuration information specific to UE2 that includes time durations for UE2 and specific RX beams corresponding to those time durations may include time durations S0, S1, S2, S3, and S4 with corresponding RX beams being respectively B1, B2, B2, B1, and B1.

[0083] In certain embodiments, the gNB may schedule the UE1 and UE2 based on the beam group information. Accordingly, in S0 the gNB may only schedule UE2 because the TX beam of S0 is TX B0 which is only included in the beam group of UE2 but not included in the beam group of UE1. Further, in S1, S2, S3, and S4 the gNB may schedule both UE1 and UE2 because the TX beam of S1 and S2 is TX B1 which is included in both the beam group of UE1 and UE2 and the TX beam of S3 and S4 is TX B2 which is included in both the beam group of UE1 and UE2. Further, in S5 the gNB may only schedule UE1 because the TX beam of S5 is TX B3 which is only included in the beam group of UE1 but not included in the beam group of UE2. Thus, the gNB may schedule the UE1 in S1, S2, S3, S4, and S5, and the gNB may schedule the UE2 in S0, S1, S2, S3, and S4.

[0084] Based on the possible scheduling options just described, the gNB may schedule UE1 in S1, S3, and S5, and UE2 in S0, S1, S2, and S4 in the first set of time durations 602, as illustrated in Figure 6A. Moreover, the gNB may schedule UE1 in S2, S3, and S4, and UE2 in S1, S2, and S4 in the second set of time durations 606, as illustrated in Figure 6A.

[0085] For UE1, it may only attempt to receive downlink transmissions in S1, S2, S3, S4, and S5 using RX B0, RX B0, RX B2, RX B2, and RX B0 respectively based on the configuration information for reception of UE1. The RX beams of UE1 are illustrated in Figure 6B.

[0086] As shown by the shaded boxes in Figure 6B, UE1 may detect the downlink transmission for it only in S1, S3, and S5 of the first set of time durations 602, and may detect the downlink transmission for it only in S2, S3, and S4 of the second set of time durations 606.

[0087] For UE2, it may only attempt to receive downlink transmissions in S0, S1, S2, S3, and S4 using RX B1, RX B2, RX B2, RX B1, and RX B1 respectively based on the configuration information for reception of UE2. The RX beams of UE2 are illustrated in Figure 6C.

[0088] As shown by the shaded boxes in Figure 6C, UE2 may detect the downlink transmission for it only in S0, S1, S2, and S4 of the first set of time durations 602, and may detect the downlink transmission for it only in S1, S2, and S4 of the second set of time durations 606.

[0089] Figure 7 is a schematic flow chart diagram illustrating one embodiment of a method 700 for downlink configuration. In some embodiments, the method 700 is performed by an apparatus, such as the remote unit 102. In certain embodiments, the method 700 may be performed by a processor executing program code, for example, a microcontroller, a microprocessor, a CPU, a GPU, an auxiliary processing unit, a FPGA, or the like.

[0090] The method 700 may include receiving 702 configuration information indicating a set of time durations and multiple receive beams for receiving downlink information. The method 700 also includes determining 704 a time duration of the set of time durations and a receive beam of the multiple receive beams for receiving downlink information based on the configuration information. In one embodiment, the method 700 includes receiving 706 downlink information during the time duration using the receive beam.

[0091] In one embodiment, the set of time durations has a corresponding transmit beam pattern. In a further embodiment, each time duration of the set of time durations has a corresponding transmit beam. In certain embodiments, the configuration information includes information indicating the set of time durations for a period of time and its corresponding transmit beam pattern. In some embodiments, the configuration information includes information indicating a subset of the set of time durations for a period of time and its corresponding receive beam pattern.

[0092] In various embodiments, the configuration information includes information for determining a receive beam of the multiple receive beams based on a transmit beam pattern and beam grouping information. In some embodiments, the receive beam is determined based on reference signal received power. In one embodiment, the receive beam is determined randomly. In various embodiments, the configuration information indicating the set of time durations and the multiple receive beams for receiving downlink information is determined based on beam grouping information. In some embodiments, the beam grouping information includes information identifying a group of transmit and receive beam pairs.

[0093] Figure 8 is a schematic flow chart diagram illustrating one embodiment of a method 800 for downlink configuration. In some embodiments, the method 800 is performed by an apparatus, such as the base unit 104. In certain embodiments, the method 800 may be performed by a processor executing program code, for example, a microcontroller, a microprocessor, a CPU, a GPU, an auxiliary processing unit, a FPGA, or the like.

[0094] The method 800 may include determining 802 configuration information indicating a set of time durations and multiple receive beams for a remote unit 102 to received downlink information. The method 800 also includes transmitting 804 the configuration information to the remote unit 102. The method 800 includes transmitting 806 downlink information based on the configuration information

[0095] In one embodiment, the set of time durations has a corresponding transmit beam pattern. In a further embodiment, each time duration of the set of time durations has a corresponding transmit beam. In certain embodiments, the configuration information includes information indicating the set of time durations for a period of time and its corresponding transmit beam pattern. In some embodiments, the configuration information includes information indicating a subset of the set of time durations for a period of time and its corresponding receive beam pattern.

[0096] In various embodiments, the configuration information includes information for determining a receive beam of the multiple receive beams based on a transmit beam pattern and beam grouping information. In some embodiments, the receive beam is determined based on reference signal received power. In one embodiment, the receive beam is determined randomly. In various embodiments, the configuration information indicating the set of time durations and the multiple receive beams for receiving downlink information is determined based on beam grouping information. In some embodiments, the beam grouping information includes information identifying a group of transmit and receive beam pairs.

[0097] Embodiments may be practiced in other specific forms. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

CLAIMS

1. An apparatus comprising:
a receiver that receives configuration information indicating a set of time durations and a plurality of receive beams for receiving downlink information; and
a processor that determines a time duration of the set of time durations and a receive beam of the plurality of receive beams for receiving downlink information based on the configuration information, wherein the receiver receives downlink information during the time duration using the receive beam.

2. The apparatus of claim 1, wherein the set of time durations has a corresponding transmit beam pattern.

3. The apparatus of claim 2, wherein each time duration of the set of time durations has a corresponding transmit beam.

4. The apparatus of claim 1, wherein the configuration information comprises information indicating the set of time durations for a period of time and its corresponding transmit beam pattern.

5. The apparatus of claim 1, wherein the configuration information comprises information indicating a subset of the set of time durations for a period of time and its corresponding receive beam pattern.

6. The apparatus of claim 1, wherein the configuration information comprises information for determining a receive beam of the plurality of receive beams based on a transmit beam pattern and beam grouping information.

7. The apparatus of claim 6, wherein the receive beam is determined based on reference signal received power.

8. The apparatus of claim 6, wherein the receive beam is determined randomly.

9. The apparatus of claim 1, wherein the configuration information indicating the set of time durations and the plurality of receive beams for receiving downlink information is determined based on beam grouping information.

10. The apparatus of claim 9, wherein the beam grouping information comprises information identifying a group of transmit and receive beam pairs.

11. A method comprising:
receiving configuration information indicating a set of time durations and a plurality of receive beams for receiving downlink information;
determining a time duration of the set of time durations and a receive beam of the plurality of receive beams for receiving downlink information based on the configuration information; and
receiving downlink information during the time duration using the receive beam.

12. The method of claim 11, wherein the set of time durations has a corresponding transmit beam pattern.

13. The method of claim 12, wherein each time duration of the set of time durations has a corresponding transmit beam.

14. The method of claim 11, wherein the configuration information comprises information indicating the set of time durations for a period of time and its corresponding transmit beam pattern.

15. The method of claim 11, wherein the configuration information comprises information indicating a subset of the set of time durations for a period of time and its corresponding receive beam pattern.

16. The method of claim 11, wherein the configuration information comprises information for determining a receive beam of the plurality of receive beams based on a transmit beam pattern and beam grouping information.

17. The method of claim 16, wherein the receive beam is determined based on reference signal received power.

18. The method of claim 16, wherein the receive beam is determined randomly.

19. The method of claim 11, wherein the configuration information indicating the set of time durations and the plurality of receive beams for receiving downlink information is determined based on beam grouping information.

20. The method of claim 19, wherein the beam grouping information comprises information identifying a group of transmit and receive beam pairs.

21. An apparatus comprising:
a processor that determines configuration information indicating a set of time durations and a plurality of receive beams for a remote unit to receive downlink information; and
a transmitter that:
transmits the configuration information to the remote unit; and
transmits downlink information based on the configuration information.

22. The apparatus of claim 21, wherein the set of time durations has a corresponding transmit beam pattern.

23. The apparatus of claim 22, wherein each time duration of the set of time durations has a corresponding transmit beam.

24. The apparatus of claim 21, wherein the configuration information comprises information indicating the set of time durations for a period of time and its corresponding transmit beam pattern.

25. The apparatus of claim 21, wherein the configuration information comprises information indicating a subset of the set of time durations for a period of time and its corresponding receive beam pattern.

26. The apparatus of claim 21, wherein the configuration information comprises information for determining a receive beam of the plurality of receive beams based on a transmit beam pattern and beam grouping information.

27. The apparatus of claim 26, wherein the receive beam is determined based on reference signal received power.

28. The apparatus of claim 26, wherein the receive beam is determined randomly.

29. The apparatus of claim 21, wherein the configuration information indicating the set of time durations and the plurality of receive beams for receiving downlink information is determined based on beam grouping information.

30. The apparatus of claim 29, wherein the beam grouping information comprises information identifying a group of transmit and receive beam pairs.

31. A method comprising:
determining configuration information indicating a set of time durations and a plurality of receive beams for a remote unit to receive downlink information;
transmitting the configuration information to the remote unit; and
transmitting downlink information based on the configuration information.

32. The method of claim 31, wherein the set of time durations has a corresponding transmit beam pattern.

33. The method of claim 32, wherein each time duration of the set of time durations has a corresponding transmit beam.

34. The method of claim 31, wherein the configuration information comprises information indicating the set of time durations for a period of time and its corresponding transmit beam pattern.

35. The method of claim 31, wherein the configuration information comprises information indicating a subset of the set of time durations for a period of time and its corresponding receive beam pattern.

36. The method of claim 31, wherein the configuration information comprises information for determining a receive beam of the plurality of receive beams based on a transmit beam pattern and beam grouping information.

37. The method of claim 36, wherein the receive beam is determined based on reference signal received power.

38. The method of claim 36, wherein the receive beam is determined randomly.

39. The method of claim 31, wherein the configuration information indicating the set of time durations and the plurality of receive beams for receiving downlink information is determined based on beam grouping information.

40. The method of claim 39, wherein the beam grouping information comprises information identifying a group of transmit and receive beam pairs.

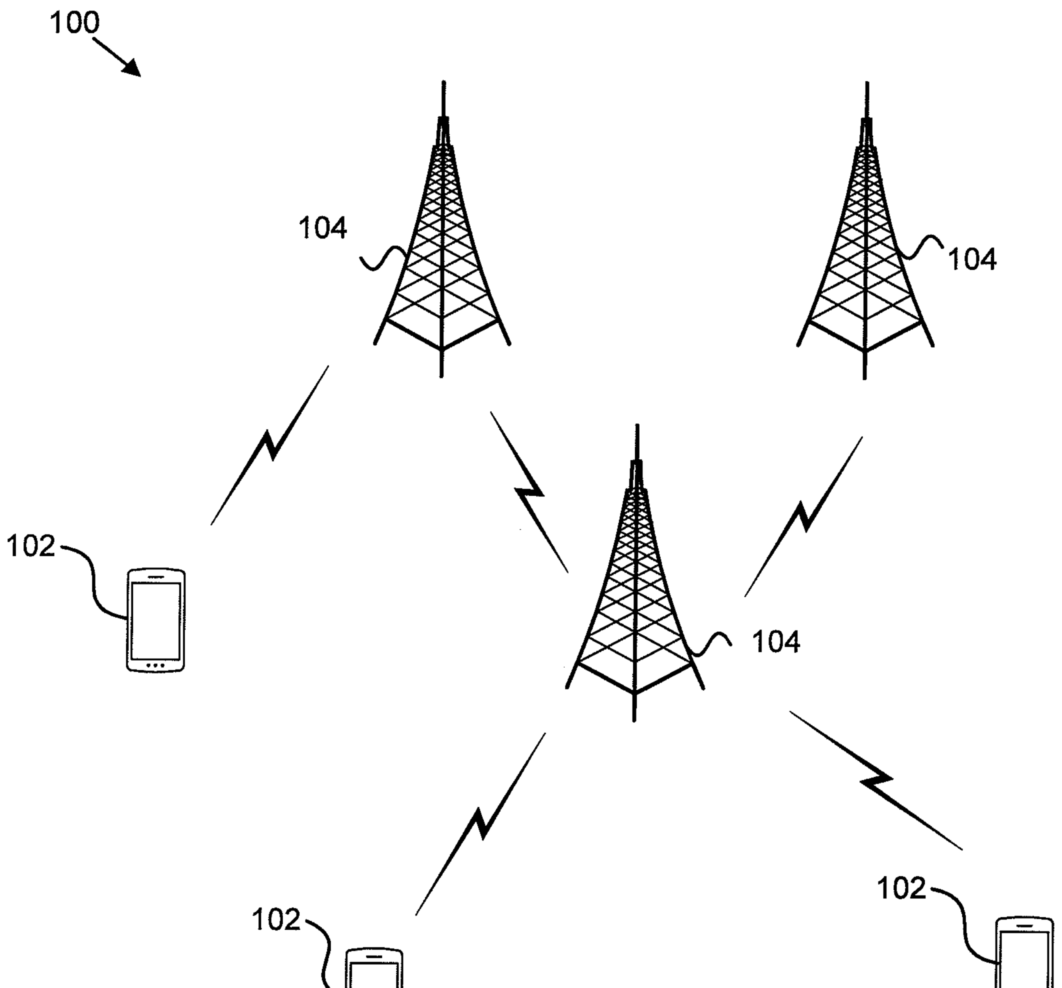
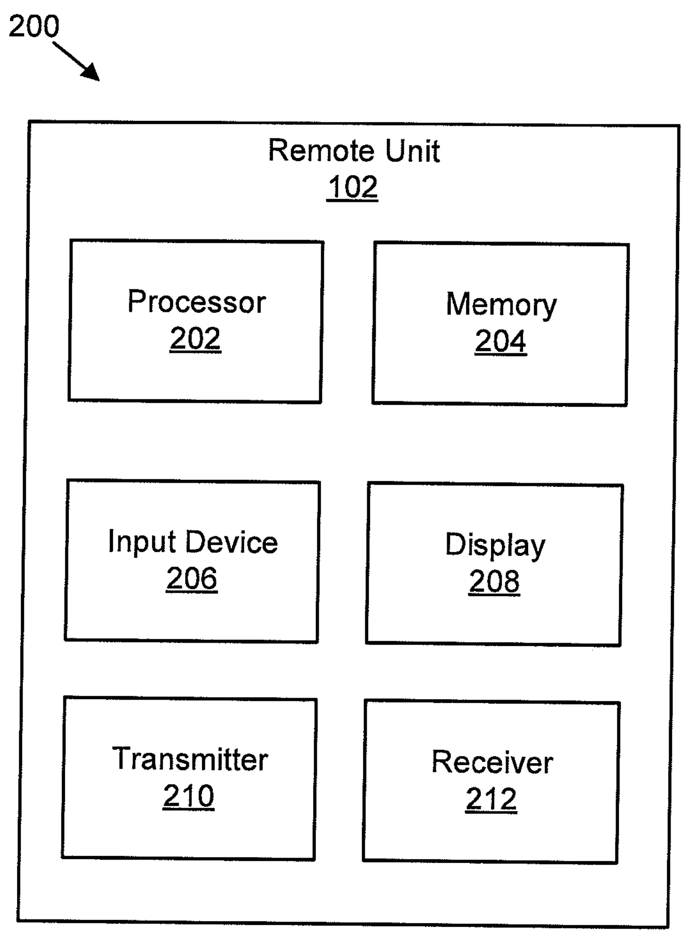



FIG. 1


200
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Processor
202
Memory
204
Input Device
206
Display
208
Transmitter
210
Receiver
212

FIG. 2

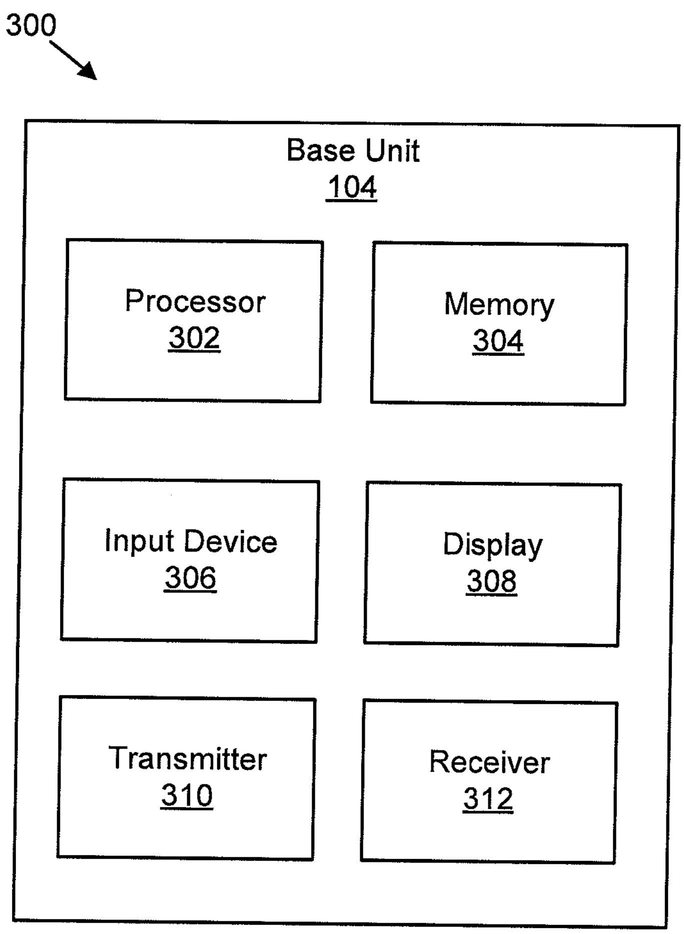
300
Base Unit
104
Processor
302
Memory
304
Input Device
306
Display
308
Transmitter
310
Receiver
312

FIG. 3

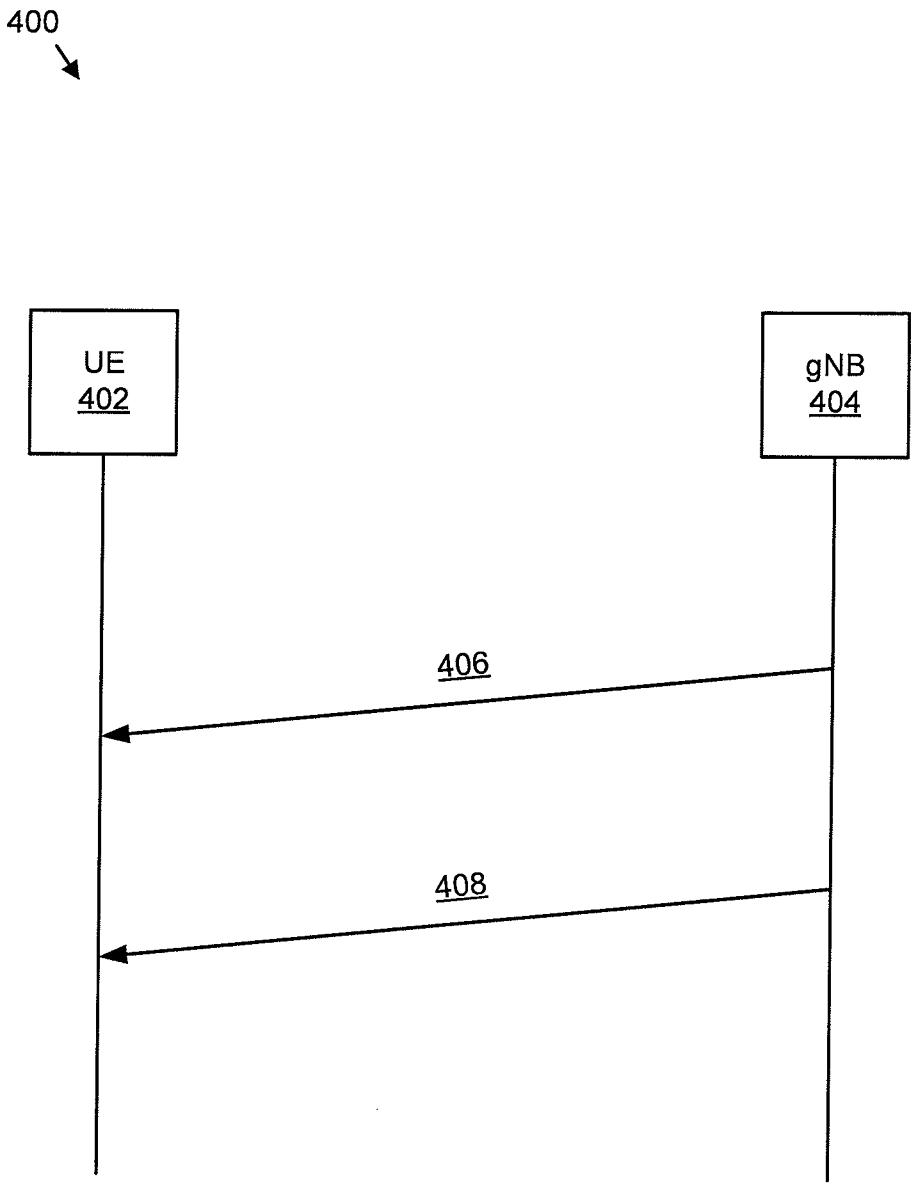


FIG. 4

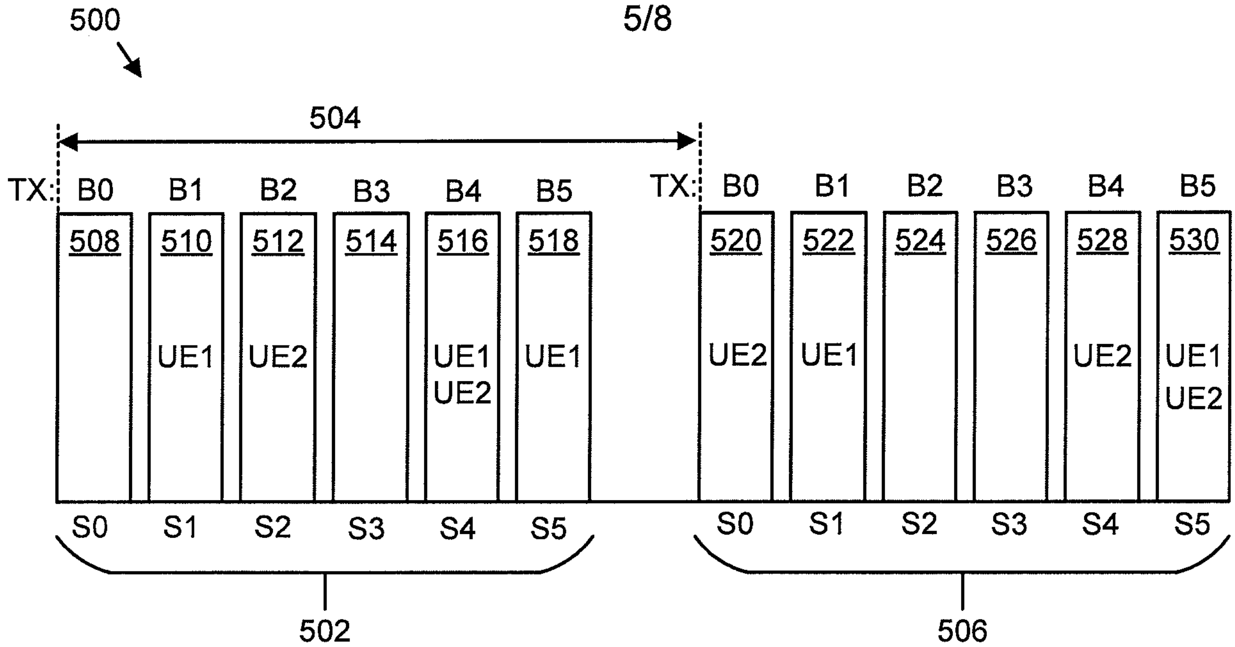


FIG. 5A

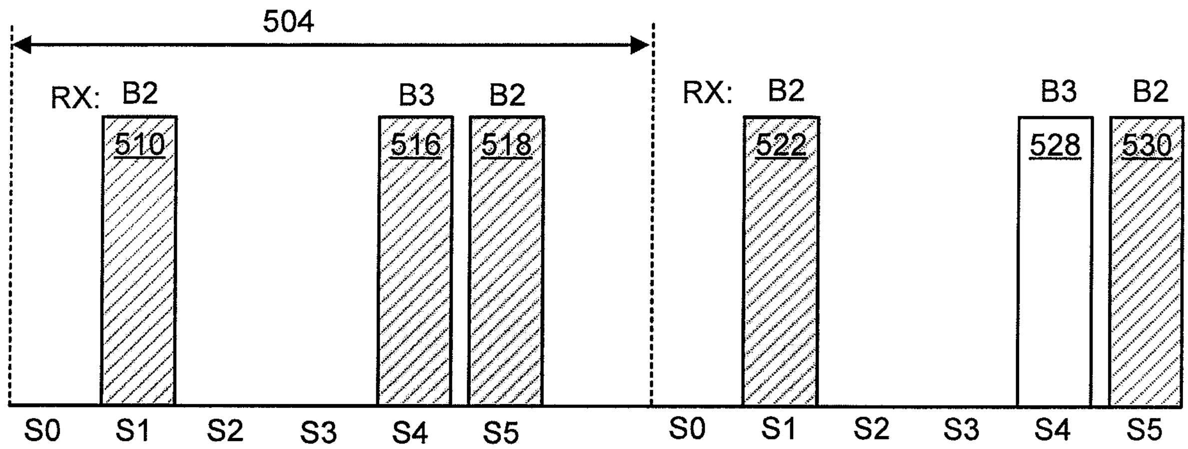


FIG. 5B

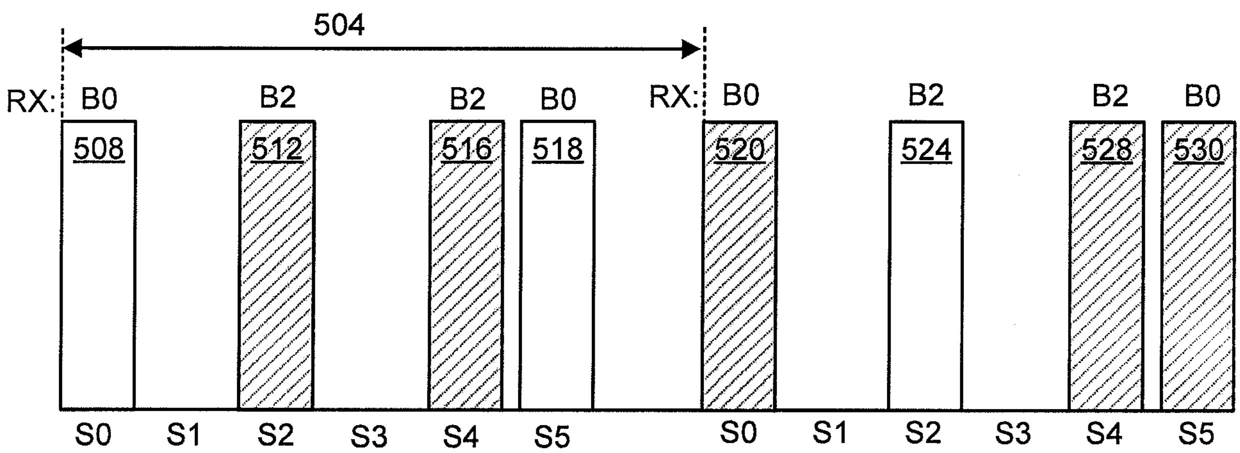


FIG. 5C

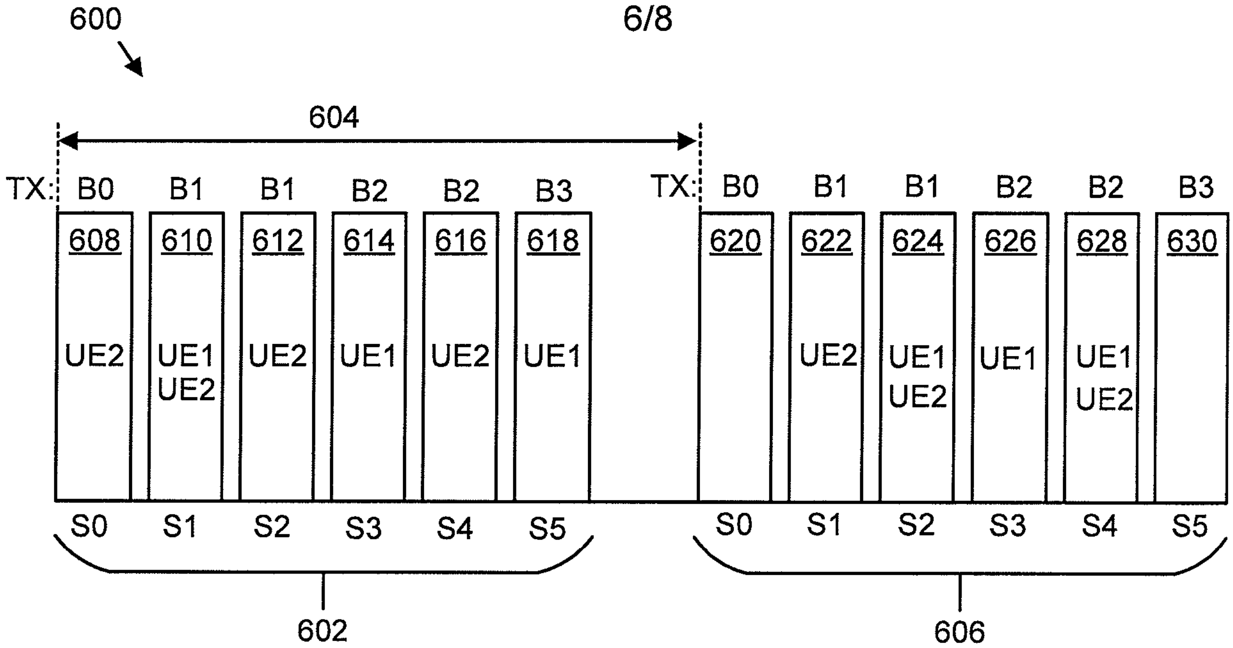


FIG. 6A

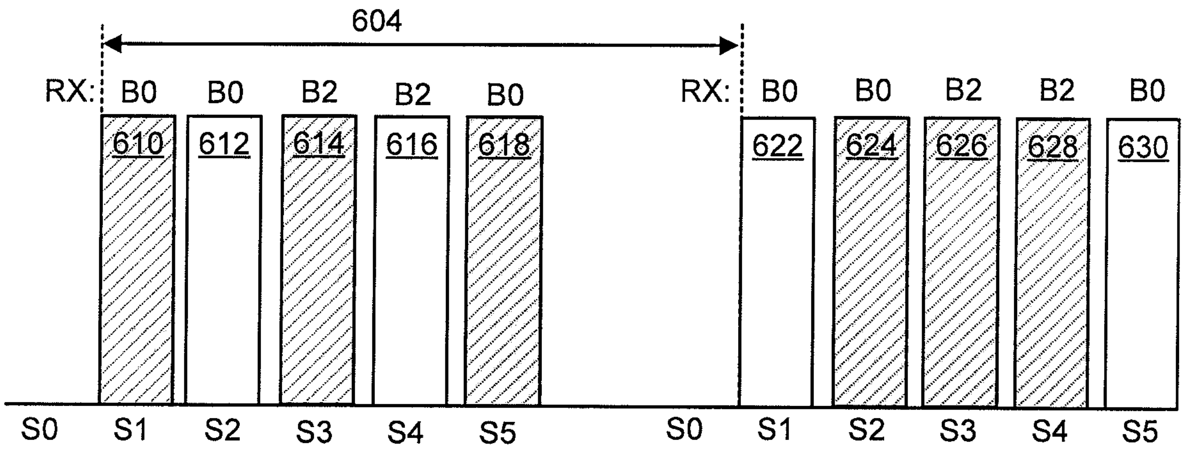


FIG. 6B

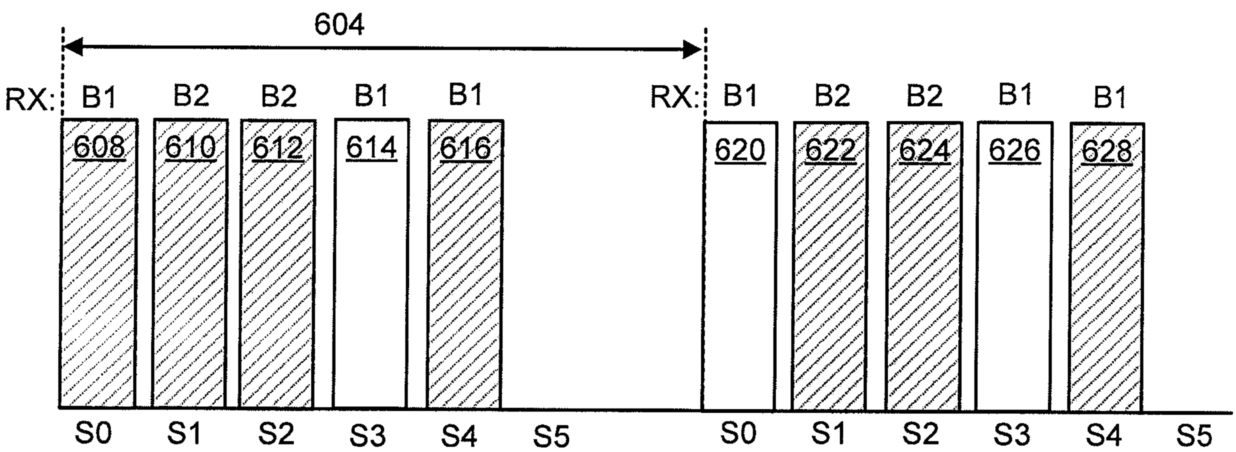


FIG. 6C

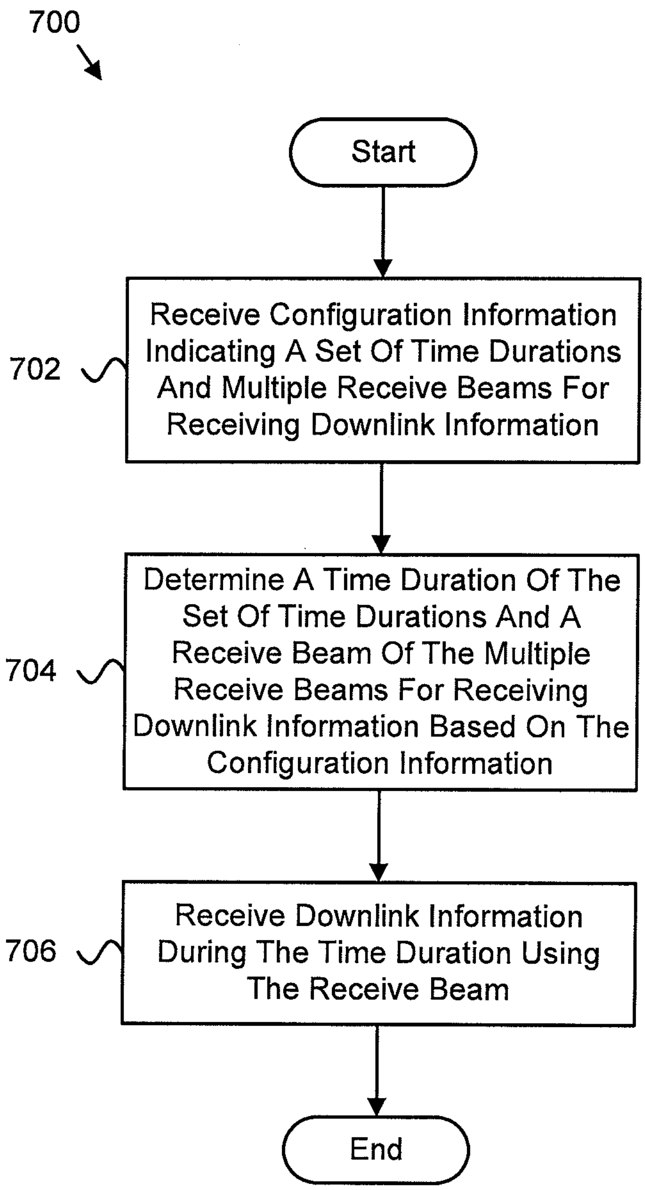
700
Start
702
Receive Configuration Information Indicating A Set Of Time Durations And Multiple Receive Beams For Receiving Downlink Information
704
Determine A Time Duration Of The Set Of Time Durations And A Receive Beam Of The Multiple Receive Beams For Receiving Downlink Information Based On The Configuration Information
706
Receive Downlink Information During The Time Duration Using The Receive Beam
End

FIG. 7

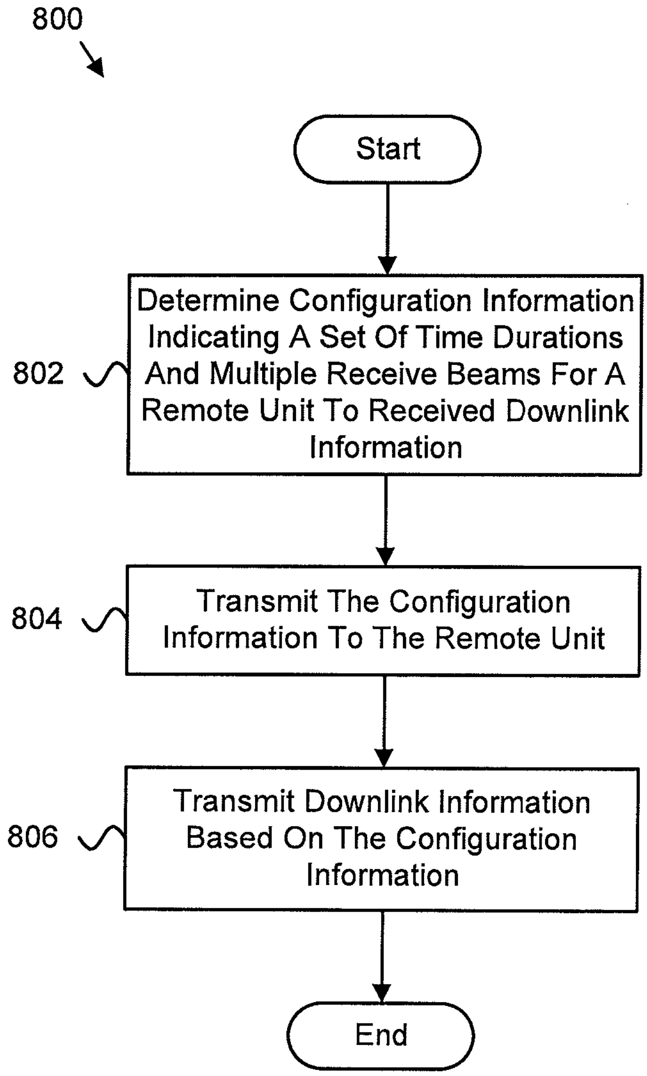
800
Start
802
Determine Configuration Information Indicating A Set Of Time Durations And Multiple Receive Beams For A Remote Unit To Received Downlink Information
804
Transmit The Configuration Information To The Remote Unit
806
Transmit Downlink Information Based On The Configuration Information
End

FIG. 8

## INTERNATIONAL SEARCH REPORT

International application No.
**PCT/CN2017/070965**

### A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/02(2009.01)i

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

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W; H04B

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

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

CNPAT, WPI, EPODOC, CNKI, 3GPP： beam, beamforming, multiple, antenna, time, duration, TTI, configuration, indicate, resource, position, terminal, UE, base station, eNB, eNodeB, access point

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | CN 105744591 A (ZTE CORP.) 06 July 2016 (2016-07-06)<br>description, paragraphs [0007]-[0041] | 1-40 |
| A | WO 2016023227 A1 (FUJITSU LIMITED ET AL.) 18 February 2016 (2016-02-18)<br>the whole document | 1-40 |
| A | CN 103688474 A (HUAWEI TECH. CO., LTD.) 26 March 2014 (2014-03-26)<br>the whole document | 1-40 |
| A | CN 101873670 A (ZTE CORP.) 27 October 2010 (2010-10-27)<br>the whole document | 1-40 |

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

* Special categories of cited documents:

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|---|---|
| **16 September 2017** | **27 September 2017** |

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

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