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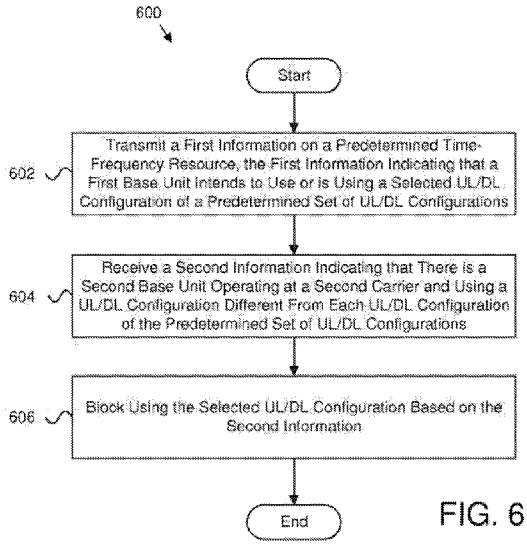

FIG. 6

(57) Abstract: Apparatuses, methods, and systems are disclosed for interference reduction. One apparatus includes a transmitter that transmits a first information on a predetermined time-frequency resource from a first base unit on a first carrier. In certain embodiments, the first information indicates that the first base unit intends to use or is using a selected uplink/downlink ("UL/DL") configuration of a predetermined set of UL/DL configurations. In various embodiments, the apparatus includes a receiver that receives a second information indicating that there is a second base unit operating at a second carrier and using a UL/DL eonfiguration different from each UL/DL configuration of the predetermined set of UL/DL configurations. In such embodiments, the second carrier may be within a predetermined frequency range from the first carrier. In certain embodiments, the apparatus includes a processor that blocks using the selected UL/DL configuration based on the second information.

INTERFERENCE REDUCTION IN A WIRELESS COMMUNICATION SYSTEM

FIELD

[0001] The subject matter disclosed herein relates generally to wireless communications and more particularly relates to interference reduction in a wireless communication system.

BACKGROUND

[0002] The following abbreviations are herewith defined, at least some of which are referred to within the following description.

[0003] 3GPP Third Generation Partnership Project

[0004] BPSK Binary Phase Shift Keying

[0005] CCE Control Channel Element

[0006] CP Cyclic Prefix

[0007] CRS Cell-Specific Reference Signal

[0008] CSI Channel State Information

[0009] CSI-RS Channel State Information Reference Signal

[0010] CSS Common Search Space

[0011] DCI Downlink Control Information

[0012] DL Downlink

[0013] DMRS Demodulation Reference Signal

[0014] DwPTS Downlink Pilot Time Slot

[0015] eNB Evolved Node B

[0016] ETSI European Telecommunications Standards Institute

[0017] EPDCCH Enhanced Physical Downlink Control Channel

[0018] FBE Frame Based Equipment

[0019] FDD Frequency Division Duplex

[0020] FDMA Frequency Division Multiple Access

[0021] FEC Forward Error Correction

[0022] GP Guard Period

[0023] LBE Load Based Equipment

[0024] LTE Long Term Evolution

[0025] MCL Minimum Coupling Loss

[0026] MCS Modulation and Coding Scheme

[0027] MU-MIMO Multi-User, Multiple-Input, Multiple-Output

[0028] OFDM Orthogonal Frequency Division Multiplexing

[0029] PCell Primary Cell

[0030] PBCH Physical Broadcast Channel

[0031] PCFICH Physical Control Format Indicator Channel

[0032] PDCCH Physical Downlink Control Channel

[0033] PDSCH Physical Downlink Shared Channel

[0034] PHICH Physical Hybrid ARQ Indicator Channel

[0035] PMCH Physical Multicast Channel

[0036] PRACH Physical Random Access Channel

[0037] PRB Physical Resource Block

[0038] PRS Positioning Reference Signal

[0039] PUCCH Physical Uplink Control Channel

[0040] PUSCH Physical Uplink Shared Channel

[0041] QoS Quality of Service

[0042] QPSK Quadrature Phase Shift Keying

[0043] RAR Random Access Response

[0044] RRC Radio Resource Control

[0045] RX Receive

[0046] SC-FDMA Single Carrier Frequency Division Multiple Access

[0047] SCell Secondary Cell

[0048] SCH Shared Channel

[0049] SIB System Information Block

[0050] SR Scheduling Request

[0051] SRS Sounding Reference Signals

[0052] TBS Transport Block Size

[0053] TDD Time-Division Duplex

[0054] TDM Time Division Multiplex

[0055] TX Transmit

[0056] UCI Uplink Control Information

[0057] UE User Entity/Equipment (Mobile Terminal)

[0058] UL Uplink

[0059] UMTS Universal Mobile Telecommunications System

[0060] UpPTS Uplink Pilot Time Slot

[0061] WiMAX Worldwide Interoperability for Microwave Access

[0062] In the 3GPP LTE specification there are seven UL/DL configurations as defined in Table 1.*See* 3GPP TS36.211 v12.6.0, Table 4.2-2. In Table 1, "D" represents a DL subframe, "U" represents an UL subframe, and "S" represents a special subframe. Within the various UL/DL configurations, the number the subframes out of a radio frame that may be used for DL transmission ranges from approximately 40% to approximately 90%. The special subframe may contain three fields sequentially in time (e.g., DwPTS, GP, and UpPTS). DwPTS may be used to transmit DL control information and data; GP may be used to create a guard period for DL-to-UL switching; and UpPTS may be used to transmit SRS and/or PRACH. The total length of DwPTS, GP, and UpPTS may equal the duration of a subframe, which is 1 millisecond ("ms") in 3GPP LTE. The length of DwPTS and UpPTS may be set according to a special subframe configuration found in 3GPP TS36.211 v12.6.0, Table 4.2-1. In certain configurations, the UL/DL configuration and the special subframe configuration may be provided in the system information block 1 ("SIB1") of a base unit (e.g., serving cell).

Table 1: Existing LTE TDD UL/DL Configurations

UL/DL Configuration	DL-to-UL Switch-Point Periodicity	Subframe Number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

[0063] Among the existing UL/DL configurations illustrated in Table 1, the DL heaviest configuration is UL/DL configuration 5 in which nine subframes (e.g., eight DL subframes and one special subframe) may be used for DL transmission. In many configurations, the amount of DL and UL data traffic is asymmetric, with more traffic generally in DL. Accordingly, two additional TDD configurations may be added to the existing UL/DL configurations, as illustrated in Table 2.

Table 2: Additional LTE TDD UL/DL Configurations

UL/DL Configuration	DL-to-UL Switch-Point Periodicity	Subframe Number									
		0	1	2	3	4	5	6	7	8	9
7	N/A	D	D	D	D	D	D	D	D	D	D
8	10 ms	D	S	D	D	D	D	D	D	D	D

[0064] A commonality of UL/DL configurations 7 and 8 is that all subframes may be used for DL transmission. As may be appreciated, configuration 7 may be referred to as the 10:0:0 configuration and configuration 8 may be referred to as the 9:1:0 configuration, in terms of DL, special, and UL subframes. Configuration 7 may also be called a DL only configuration. Because there is no subframe available for UL data transmission in configurations 7 and 8, a base unit (e.g., carrier or cell) using either configuration 7 or 8 may not be a standalone carrier. Such a base unit is to be accompanied by another carrier of the same operator and is to be used as a secondary cell for UEs (e.g., remote units). Furthermore, UEs incapable of carrier aggregation may not be able to connect to the base unit that uses either of configurations 7 or 8.

[0065] In certain configurations, when multiple operators deployTDD networks on frequencies that are near one another, the same UL/DL configuration is used among the operators (e.g., through negotiation). If the operators' TDD networks on frequencies that are near one another do not use the same UL/DL configuration, there may be significant interference to UL reception at a base unit (e.g., eNB). Such interference may be called DL-to-UL interference or eNB-to-eNB interference. To reduce DL-to-UL interference, the subframe timing among the operators on frequencies near one another may be aligned.

[0066] A commonality among the existing UL/DL configurations 0-6 is that at least one UL subframe exists per radio frame, where a radio frame includes ten consecutive subframes in 3GPP LTE. The UL subframe may be used to transmit UL data and UL control information, thereby facilitating standalone operation (e.g., UEs incapable of carrier aggregation may connect to a serving cell). It should be noted that if one operator (e.g., operator A) deploys a network on a carrier frequency F1 using UL/DL configurations 7 and 8, another operator (e.g., operator B) is not able to deploy a standalone carrier using any of the UL/DL configurations 0-6 in a carrier frequency F2 that is near carrier frequency F1. This is due to the fact that all subframes are used for DL transmission in operator A's carrier F1, which affects the UL reception in all UL subframes of operator B's carrier F2.

[0067] Various mitigation schemes may be used to reduce interference. For example, adjacent carriers may be sensed to determine what UL/DL configurations are being used by frequencies that are near one another. The sensing may be performed by UEs and/or by base units. To ensure that the sensing is performed, certain implementations may have the UEs perform the sensing. For UE based sensing, the UE may be configured by a base unit to perform the sensing. Such base unit configuration may typically be done via RRC signaling. However, it may be difficult to test mandatory implementation that a base unit configures such RRC signaling to the UE because it is generally up to the base unit's decision whether and when to configure the UE to perform sensing.

BRIEF SUMMARY

[0068] Apparatuses for interference reduction are disclosed. Methods and systems also perform the functions of the apparatus. In one embodiment, the apparatus includes a transmitter that transmits a first information on a predetermined time-frequency resource from a first base unit on a first carrier. In certain embodiments, the first information indicates that the first base unit intends to use or is using a selected uplink/downlink ("UL/DL") configuration of a predetermined set of UL/DL configurations. In various embodiments, the apparatus includes a receiver that receives a second information indicating that there is a second base unit operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of the predetermined set of UL/DL configurations. In such embodiments, the second carrier may be within a predetermined frequency range from the first carrier. In certain embodiments, the apparatus includes a processor that blocks using the selected UL/DL configuration based on the second information.

[0069] In a further embodiment, the first information is transmitted using a physical broadcast channel ("PBCH") and one or more bits in the PBCH indicate that the first base unit intends to use or is using the selected UL/DL configuration. In some embodiments, the first information is transmitted periodically in time. In certain embodiments, the predetermined time-frequency resource is dedicated to indicate that the first base unit intends to use or is using the selected UL/DL configuration.

[0070] In another embodiment, a presence pattern of a physical signal on the predetermined time-frequency resource is used to indicate that the first base unit intends to use or is using the selected UL/DL configuration and each individual instance of the physical signal includes a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration. In various embodiments, the predetermined set of UL/DL configurations includes a first UL/DL configuration having ten DL subframes within a radio

frame of ten subframes. In one embodiment, the predetermined set of UL/DL configurations includes a second UL/DL configuration having nine DL subframes and one special subframe within a radio frame of ten subframes.

[0071] A method for interference reduction, in one embodiment, includes transmitting a first information on a predetermined time-frequency resource from a first base unit on a first carrier. In such an embodiment, the first information may indicate that the first base unit intends to use or is using a selected uplink/downlink ("UL/DL") configuration of a predetermined set of UL/DL configurations. In some embodiments, the method includes receiving a second information indicating that there is a second base unit operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of the predetermined set of UL/DL configurations. In various embodiments, the second carrier is within a predetermined frequency range from the first carrier. In a further embodiment, the method includes blocking using the selected UL/DL configuration based on the second information.

[0072] In some embodiments, the first information is transmitted using a physical broadcast channel ("PBCH") and one or more bits in the PBCH indicate that the first base unit intends to use or is using the selected UL/DL configuration. In one embodiment, the first information is transmitted periodically in time. In certain embodiments, the predetermined time-frequency resource is dedicated to indicate that the first base unit intends to use or is using the selected UL/DL configuration.

[0073] In some embodiments, a presence pattern of a physical signal on the predetermined time-frequency resource is used to indicate that the first base unit intends to use or is using the selected UL/DL configuration and each individual instance of the physical signal includes a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration. In various embodiments, the predetermined set of UL/DL configurations includes a first UL/DL configuration having ten DL subframes within a radio frame of ten subframes. In one embodiment, the predetermined set of UL/DL configurations includes a second UL/DL configuration having nine DL subframes and one special subframe within a radio frame of ten subframes.

[0074] In one embodiment, an apparatus includes a receiver that receives a first information on a predetermined time-frequency resource transmitted from a first base unit on a first carrier. In certain embodiments, the first information indicates that the first base unit intends to use or is using a selected uplink/downlink ("UL/DL") configuration from a predetermined set of UL/DL configurations. In some embodiments, the apparatus includes a transmitter that transmits a second information to the first base unit. In various embodiments,

the second information indicates that there is a second base unit operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of the predetermined set of UL/DL configurations, and the second carrier is within a predetermined frequency range from the first carrier.

[0075] In various embodiments, the receiver receives a third information transmitted from the second base unit on the second carrier, and the third information indicates the UL/DL configuration used by the second based unit on the second carrier. In one embodiment, the first information is received on a physical broadcast channel ("PBCH") and one or more bits in the PBCH indicate that the first base unit intends to use or is using the selected UL/DL configuration. In certain embodiments, the predetermined time-frequency resource occurs periodically in time. In some embodiments, the predetermined time-frequency resource is dedicated to indicate that the first base unit intends to use or is using the selected UL/DL configuration.

[0076] In various embodiments, a presence pattern of a physical signal on the predetermined time-frequency resource is used to indicate that the first base unit intends to use or is using the selected UL/DL configuration and each individual instance of the physical signal includes a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration. In one embodiment, the predetermined set of UL/DL configurations comprises a first UL/DL configuration having ten DL subframes within a radio frame of ten subframes. In certain embodiments, the predetermined set of UL/DL configurations comprises a second UL/DL configuration having nine DL subframes and one special subframe within a radio frame of ten subframes.

[0077] Another method for interference reduction, in one embodiment, includes receiving a first information on a predetermined time-frequency resource transmitted from a first base unit on a first carrier. In various embodiments, the first information indicates that the first base unit intends to use or is using a selected uplink/downlink ("UL/DL") configuration of a predetermined set of UL/DL configurations. In some embodiments, the method includes transmitting a second information to the first base unit. In such embodiments, the second information may indicate that there is a second base unit operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of the predetermined set of UL/DL configurations, and the second carrier is within a predetermined frequency range from the first carrier.

[0078] In some embodiments, the method includes receiving a third information transmitted from the second base unit on the second carrier. In such embodiments, the third information may indicate the UL/DL configuration used by the second base unit on the second

carrier. In one embodiment, the first information is received on a physical broadcast channel ("PBCH") and one or more bits in the PBCH indicate that the first base unit intends to use or is using the selected UL/DL configuration. In certain embodiments, the predetermined time-frequency resource occurs periodically in time. In various embodiments, the predetermined time-frequency resource is dedicated to indicate that the first base unit intends to use or is using the selected UL/DL configuration.

[0079] In certain embodiments, a presence pattern of a physical signal on the pre-determined time-frequency resource is used to indicate that the first base unit intends to use or is using the selected UL/DL configuration and each individual instance of the physical signal includes a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration. In one embodiment, the predetermined set of UL/DL configurations includes a first UL/DL configuration having ten DL subframes within a radio frame of ten subframes. In some embodiments, the predetermined set of UL/DL configurations includes a second UL/DL configuration having nine DL subframes and one special subframe within a radio frame of ten subframes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0080] 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:

[0081] Figure 1 is a schematic block diagram illustrating one embodiment of a wireless communication system for interference reduction;

[0082] Figure 2 is a schematic block diagram illustrating one embodiment of an apparatus that may be used for interference reduction;

[0083] Figure 3 is a schematic block diagram illustrating another embodiment of an apparatus that may be used for interference reduction;

[0084] Figure 4 isa diagram illustrating one embodiment of wireless communication for interference reduction;

[0085] Figure 5Aillustrates one embodiment of a time-frequency resource for transmitting information;

[0086] Figure 5B illustrates another embodiment of a time-frequency resource for transmitting information;

[0087] Figure 5C illustrates a further embodiment of a time-frequency resource for transmitting information;

[0088] Figure 6 is a schematic flow chart diagram illustrating one embodiment of a method for interference reduction; and

[0089] Figure 7 is a schematic flow chart diagram illustrating another embodiment of a method for interference reduction.

DETAILED DESCRIPTION

[0090] 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.

[0091] 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.

[0092] 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.

[0093] 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.

[0094] Any combination of one or more computer readable medium may be utilized. The computer readable mediummay 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.

[0095] 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.

[0096] 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).

[0097] 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.

[0098] 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.

[0099] 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.

[00100] 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.

[00101] 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.

[00102] 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).

[00103] 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.

[00104] 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.

[00105] 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.

[00106] Figure 1 depicts an embodiment of a wireless communication system 100 for interference reduction. 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.

[00107] 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.

[00108] 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 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.

[00109] 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. 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.

[00110] 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.

[00111] In one embodiment, afirst base unit 104 maytransmit a first information on a predetermined time-frequency resource on a first carrier to a remote unit 102. The first information indicates that the first base unit 104 intends to use or is using a selected UL/DL configuration of a predetermined set of UL/DL configurations. The remote unit102 may receivethe first information from the first base unit 104. Moreover, the remote unit 102may transmit a second information to the first base unit 104. The second information may indicate

that there is a second base unit 104 operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of the predetermined set of UL/DL configurations. Furthermore, the second carrier may be within a predetermined frequency range from the first carrier. In addition, the first base unit 104 may receive the second information. The first base unit 104 may block using the selected UL/DL configuration based on the second information.

[00112] Figure 2 depicts one embodiment of an apparatus 200 that may be used for interference reduction. 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 such 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.

[00113] Theprocessor 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 is communicatively coupled to the memory 204, the input device 206, the display 208, the transmitter 210, and the receiver 212.

[00114] 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 information to be transmitted or information that is received. 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.

[00115] 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 206includes 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 206includes two or more different devices, such as a keyboard and a touch panel.

[00116] The display 208, in one embodiment, may include any known electronically controllable display or display device. The display 208 may bedesigned 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.

[00117] 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.

[00118] 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 one embodiment, the transmitter 210 is used to transmit information to a first base unit 104 that indicates there is a second base unit 104 operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of a predetermined set of UL/DL configurations. In another embodiment, the receiver 212 may receive information on a predetermined time-frequency resource transmitted from the first base unit 104 on a first carrier that indicates that the first base unit 104 intends to use or is using a selected UL/DL configuration of the predetermined set of UL/DL configurations. 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.

[00119] The predetermined time-frequency resource may be any suitable time-frequency resource, such as a physical signal or a physical channel. Moreover, the first and second carriers may be any suitable carriers, such as frequencies, channels, and so forth.The predetermined set of UL/DL configurations may be any suitable set of UL/DL configurations. In one embodiment, the predetermined set of UL/DL configurations may include one or more of the additional LTE TDD UL/DL configurations listed in Table 2 (i.e., configurations 7 and 8, the 10:0:0 configuration and the 9:1:0 configuration). Accordingly, the selected UL/DL configuration may be one of the 10:0:0 configuration and the 9:1:0 configuration. The predetermined set of UL/DL configurations may be hard coded, defined in a specification, or otherwise determined. As may be appreciated, if the UL/DL configuration used by the second base unit 104 is different from each UL/DL configuration of the predetermined set of UL/DL configurations, the UL/DL configuration used by the second base unit 104 would be one of configurations 0-6 illustrated in Table 1. The predetermined frequency range may be any suitable frequency range, such as frequencies within a range that may cause interference with the first carrier.

[00120] Figure 3 depicts another embodiment of an apparatus 300 that may be used for interference reduction. 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, and the display 308 may be substantially similar to the processor 202, the memory 204, the input device 206, and the display 208 of the remote unit 102, respectively.

[00121] The transmitter 310 is used to provide DL communication signals to the remote unit 102 and the receiver 312 is used to receive UL communication signals from the remote unit 102. In one embodiment, the transmitter 310 is used to transmit a first information on a predetermined time-frequency resource from a first base unit 104 on a first carrier. The first information may indicate that the first base unit 104 intends to use or is using a selected UL/DL configuration of a predetermined set of UL/DL configurations. In another embodiment, the receiver 312 is used to receive a second information indicating that there is a second base unit 104 operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of the predetermined set of UL/DL configurations. In such an embodiment, the

second carrier may be within a predetermined frequency range from the first carrier. The processor 302, in various embodiments, may block using the selected UL/DL configuration based on the second information.

[00122] 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.

[00123] The predetermined time-frequency resource may be any suitable time-frequency resource, such as a physical signal or a physical channel. Moreover, the first and second carriers may be any suitable carriers, such as frequencies, channels, and so forth. The predetermined set of UL/DL configurations may be any suitable set of UL/DL configurations. In one embodiment, the predetermined set of UL/DL configurations may include one or more of the additional LTE TDD UL/DL configurations listed in Table 2 (i.e., configurations 7 and 8, the 10:0:0 configuration and the 9:1:0 configuration). Accordingly, the selected UL/DL configuration may be one of the 10:0:0 configuration and the 9:1:0 configuration. The predetermined set of UL/DL configurations may be hard coded, defined in a specification, or otherwise determined. As may be appreciated, if the UL/DL configuration used by the second base unit 104 is different from each UL/DL configuration of the predetermined set of UL/DL configurations, the UL/DL configuration used by the second base unit 104 would be one of configurations 0-6 illustrated in Table 1. The predetermined frequency range may be any suitable frequency range, such as frequencies within a range that may cause interference with the first carrier.

[00124] Figure 4 is a diagram illustrating one embodiment of wireless communication 400 for interference reduction. As illustrated, a first base unit 104 may transmit information including its UL/DL configuration 402. The information including the first base unit's 104 UL/DL configuration 402 may be received by the remote unit 102. Moreover, a second base unit 104 may transmit information including its UL/DL configuration 404. The information including the second base unit's 104 UL/DL configuration 404 may be received by the remote unit 102. The remote unit 102 may determine whether there is a conflict between the UL/DL configurations of the first and second base units 104 (e.g., the UL/DL configurations are expected to interfere with one another). If there is a conflict between the UL/DL configurations of the first and second base units 104, the remote unit 102 may transmit conflict information 406 to the first base unit 104. The first base unit 104 may use the conflict information to determine an updated UL/DL configuration. Moreover, the first base unit 104 may transmit information

including its updated UL/DL configuration 408 to the remote unit 102, thereby facilitating interference reduction.

[00125] Figure 5Aillustrates one embodiment of a time-frequency resource 500 for transmitting information. The time-frequency resource 500 includes a PBCH 502 used to transmit the information. However, as may be appreciated, in other embodiments, the time-frequency resource 500 may include any suitable physical channel or physical signal. The PBCH 502 includes one or more bits 504 that indicate a selected UL/DL configuration that a base unit 104 intends to use or is using. In some embodiments, the one or more bits 504 may be transmitted periodically in time, such as at predetermined intervals (e.g., every 1 millisecond ("ms"), 1 second, and so forth). In certain embodiments, the PBCH 502 may include a maximum of 24 information bits, of which 10 bits may be reserved. The one or more bits 504 may use any suitable information bits of the PBCH 502, such as one or more of the reserved bits. In some embodiments, there may be multiple UL/DL configurations in a predetermined set of UL/DL configurations. In such embodiments, multiple bits in the PBCH 502 may be used to indicate which UL/DL configurations are within the predetermined set used by a base unit 104.

[00126] Figure 5B illustrates another embodiment of a time-frequency resource 506 for transmitting information. The time-frequency resource 506 includes a dedicated time-frequency resource 508 that is used only to indicate that a base unit 104 intends to use or is using a selected UL/DL configuration. As may be appreciated, the dedicated time-frequency resource 508 may includeany suitable new physical signal or physical channel that is different from existing physical signals(e.g., reference signal, synchronization signal, discovery signal) or existing physical channels (e.g., PDSCH, PBCH, PMCH, PCFICH, PDCCH, PHICH, EPDCCH). In some embodiments, the dedicated time-frequency resource 508 may be transmitted periodically in time, such as at predetermined intervals (e.g., every 1 millisecond ("ms"), 1 second, and so forth). In certain embodiments, the new physical signal or physical channel may be transmitted in the PDSCH region of an LTE subframe and may not collide with any existing reference signals (e.g., CRS, CSI-RS, PRS, DMRS, etc.).

[00127] If the new physical channel or physical signal carries only one bit of information (i.e., indicating that either the base unit 104 is using one of the configuration in the predetermined set of UL/DL configurations or not), the new physical channel or physical signal may use BPSK modulation, or ON-OFF keying (i.e., in the known time-frequency resource, if the base unit 104 transmits the new physical channel or physical signal, then it indicates the base unit's 104 intention to use the new UL/DL configuration; otherwise, it indicates that the base unit 104 does not intend to use the new UL/DL configuration). As may be appreciated, there may be

more than one time-frequency resource element for transmission of the new physical channel or physical signal to improve the reception reliability of the new physical channel or physical signal. Furthermore, in certain embodiments, the time-frequency resource elements for transmission of the new physical channel or physical signal may be evenly spread in the frequency domain, the time domain, or,in various embodiments, a resource element may be defined by a 15 kilohertz ("kHz") frequency and one OFDM symbol in time.

[00128] Figure 5C illustrates a further embodiment of a time-frequency resource 510 for transmitting information. In this embodiment, a presence pattern of a physical signal on a time-frequency resource is used to indicate that a base unit 104 intends to use or is using the selected UL/DL configuration and each individual instance of the physical signal includes a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration. For example, a physical signal with a first presence pattern 512 includes a reference signal 514 that is repeated at a first time interval 516. In contrast, a physical signal with a second presence pattern 518 includes the reference signal 514 repeated at a second time interval 520 different from the first time interval 516. The reference signal 514 on its own does not indicate a selected UL/DL configuration. Indeed, the reference signal 514 on its own may be any suitable communication transmitted from a base unit 104. However, the selected time interval between instances of the reference signal 514 is used by the base unit 104 to indicate a selected or unselected UL/DL configuration. For example, the first time interval 516 may indicate a first UL/DL configuration, while the second time interval 520 may indicate a second UL/DL configuration. It should be noted that any suitable number of time intervals may be used to indicate any suitable number of UL/DL configurations. In one embodiment, a first time interval may indicate use of one of a predetermined set of UL/DL configurations, and a second time may indicate not using one of the predetermined set of UL/DL configurations. As may be appreciated, the physical signals with the first and second presence patterns 512 and 518 may be any suitable physical signal (e.g., reference signal, synchronization signal, discovery signal).

[00129] Figure 6is a schematic flow chart diagram illustrating one embodiment of a method 600 for interference reduction. In some embodiments, the method 600 is performed by an apparatus, such as the base unit 104. In certain embodiments, the method 600 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.

[00130] The method 600 may include transmitting 602 a first information on a predetermined time-frequency resource (e.g., physical channel, physical signal) from a first base

unit (e.g., base unit 104) on a first carrier (e.g., frequency, channel). In some embodiments, the first information may indicate that the first base unit intends to use or is using a selected UL/DL configuration of a predetermined set of UL/DL configurations (e.g., 10:0:0, 9:1:0). In certain embodiments, the base unit 104 may transmit 602the first information on the predetermined time-frequency resourceon the first carrier. In one embodiment, the first information may be transmitted using a PBCH and one or more bits in the PBCH may indicate that the first base unit intends to use or is using the selected UL/DL configuration.

[00131] In various embodiments, the first information may be transmitted periodically in time. In certain embodiments, the predetermined time-frequency resource is dedicated to indicate that the first base unit intends to use or is using the selected UL/DL configuration. In one embodiment, a presence pattern of a physical signal on the predetermined time-frequency resource is used to indicate that the first base unit intends to use or is using the selected UL/DL configuration and each individual instance of the physical signal includes a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration. In certain embodiments, the predetermined set of UL/DL configurations includes a first UL/DL configuration having ten DL subframes within a radio frame of ten subframes. In some embodiments, the predetermined set of UL/DL configurations comprises a second UL/DL configuration having nine DL subframes and one special subframe within a radio frame of ten subframes.

[00132] The method 600 may also include receiving 604a second information indicating that there is a second base unit (e.g., base unit 104) operating at a second carrier (e.g., frequency, channel) and using a UL/DL configuration (e.g., configurations 0-6 from Table 1) different from each UL/DL configuration of the predetermined set of UL/DL configurations. In certain embodiments, the second carrier is within a predetermined frequency range from the first carrier. The predetermined frequency range may be a range of frequencies that are expected to be subject to theinterference fromthe first carrier. In certain embodiments, the base unit 104 may receive 604 the second information indicating that there is a second base unit operating at the second carrier and using the UL/DL configurationdifferent from each UL/DL configuration of the predetermined set of UL/DL configurations.

[00133] The method 600 may include blocking606using the selected UL/DL configuration based on the second information. Then the method 600may end. In some embodiments, the base unit 104 may block606using the selected UL/DL configuration based on the second information.For example, the base unit 104 may block 606 using the selected UL/DL configuration if the second information indicates that the second base unit operating at the

second carrier and using the UL/DL configuration may be interferedbyuse of the selected UL/DL configuration on the first carrier.

[00134] Figure 7is a schematic flow chart diagram illustrating another embodiment of a method 700 for interference reduction. 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.

[00135] The method 700 may include receiving 702 a first information on a predetermined time-frequency resource (e.g., physical channel, physical signal)transmitted from a first base unit (e.g., base unit 104) on a first carrier (e.g., frequency, channel). In some embodiments, the first information may indicate that the first base unit intends to use or is using a selected UL/DL configuration of a predetermined set of UL/DL configurations (e.g., 10:0:0, 9:1:0). In certain embodiments, the remote unit 102 may receive 702 the first information on the predetermined time-frequency resourceon the first carrier. In one embodiment, the first information may bereceived using a PBCH and one or more bits in the PBCH may indicate that the first base unit intends to use or is using the selected UL/DL configuration.

[00136] In various embodiments, the first information may be received periodically in time. In some embodiments, the predetermined time-frequency resource may occur periodically in time. In certain embodiments, the predetermined time-frequency resource is dedicated to indicate that the first base unit intends to use or is using the selected UL/DL configuration. In one embodiment, a presence pattern of a physical signal on the predetermined time-frequency resource is used to indicate that the first base unit intends to use or is using the selected UL/DL configuration and each individual instance of the physical signal includes a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration. In certain embodiments, the predetermined set of UL/DL configurations includes a first UL/DL configuration having ten DL subframes within a radio frame of ten subframes. In some embodiments, the predetermined set of UL/DL configurations comprises a second UL/DL configuration having nine DL subframes and one special subframe within a radio frame of ten subframes.

[00137] The method 700 may also include transmitting 704 a second information to the first base unit. The second information mayindicate that there is a second base unit (e.g., base unit 104) operating at a second carrier (e.g., frequency, channel) and using a UL/DL configuration (e.g., configurations 0-6 from Table 1) different from each UL/DL configuration of the predetermined set of UL/DL configurations. In certain embodiments, the second carrier is

within a predetermined frequency range from the first carrier. The predetermined frequency range may be a range of frequencies that are expected to be subject to the interference fromthe first carrier. In certain embodiments, the remote unit 102 may transmit 704 the second information to the first base unit.

[00138] The method 700 may include receiving 706 a third information transmitted from the second base unit on the second carrier. Then the method 700 may end. In certain embodiments, the third information indicates the UL/DL configuration used by the second base unit on the second carrier. In various embodiments, the remote unit 102 may receive 706 the third information transmitted from the second base unit on the second carrier.

[00139] 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 transmitter that transmits a first information on a predetermined time-frequency resource from a first base unit on a first carrier, wherein the first information indicates that the first base unit intends to use or is using a selected uplink/downlink ("UL/DL") configuration of a predetermined set of UL/DL configurations;

a receiver that receives a second information indicating that there is a second base unit operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of the predetermined set of UL/DL configurations, wherein the second carrier is within a predetermined frequency range from the first carrier; and

a processor that blocks using the selected UL/DL configuration based on the second information.

2. The apparatus of claim 1, wherein the first information is transmitted using a physical broadcast channel ("PBCH") and one or more bits in the PBCH indicate that the first base unit intends to use or is using the selected UL/DL configuration.

3. The apparatus of claim 1, wherein the first information is transmitted periodically in time.

4. The apparatus of claim 1, wherein the predetermined time-frequency resource is dedicated to indicate that the first base unit intends to use or is using the selected UL/DL configuration.

5. The apparatus of claim 1, wherein a presence pattern of a physical signal on the predetermined time-frequency resource is used to indicate that the first base unit intends to use or is using the selected UL/DL configuration and each individual instance of the physical signal comprises a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration.

6. The apparatus of claim 1, wherein the predetermined set of UL/DL configurations comprises a first UL/DL configuration having ten DL subframes within a radio frame of ten subframes.

7. The apparatus of claim 1, wherein the predetermined set of UL/DL configurations comprises a second UL/DL configuration having nine DL subframes and one special subframe within a radio frame of ten subframes.

8. A method comprising:

transmitting a first information on a predetermined time-frequency resource from a first base unit on a first carrier, wherein the first information indicates that the first base unit intends to use or is using a selected uplink/downlink ("UL/DL") configuration of a predetermined set of UL/DL configurations;

receiving a second information indicating that there is a second base unit operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of the predetermined set of UL/DL configurations, wherein the second carrier is within a predetermined frequency range from the first carrier; and

blocking using the selected UL/DL configuration based on the second information.

9. The method of claim 8, wherein the first information is transmitted using a physical broadcast channel ("PBCH") and one or more bits in the PBCH indicate that the first base unit intends to use or is using the selected UL/DL configuration.

10. The method of claim 8, wherein the first information is transmitted periodically in time.

11. The method of claim 8, wherein the predetermined time-frequency resource is dedicated to indicate that the first base unit intends to use or is using the selected UL/DL configuration.

12. The method of claim 8, wherein a presence pattern of a physical signal on the predetermined time-frequency resource is used to indicate that the first base unit intends to use or is using the selected UL/DL configuration and each individual instance of the

physical signal comprises a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration.

13. The method of claim 8, wherein the predetermined set of UL/DL configurations comprises a first UL/DL configuration having ten DL subframes within a radio frame of ten subframes.

14. The method of claim 8, wherein the predetermined set of UL/DL configurations comprises a second UL/DL configuration having nine DL subframes and one special subframe within a radio frame of ten subframes.

15. An apparatus comprising:

a receiver that receives a first information on a predetermined time-frequency resource transmitted from a first base unit on a first carrier, wherein the first information indicates that the first base unit intends to use or is using a selected uplink/downlink ("UL/DL") configuration from a predetermined set of UL/DL configurations; and

a transmitter that transmits a second information to the first base unit, wherein the second information indicates that there is a second base unit operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of the predetermined set of UL/DL configurations, and the second carrier is within a predetermined frequency range from the first carrier.

16. The apparatus of claim 15, wherein the receiver receives a third information transmitted from the second base unit on the second carrier, and the third information indicates the UL/DL configuration used by the second based unit on the second carrier.

17. The apparatus of claim 15, wherein the first information is received on a physical broadcast channel ("PBCH") and one or more bits in the PBCH indicate that the first base unit intends to use or is using the selected UL/DL configuration.

18. The apparatus of claim 15, wherein the predetermined time-frequency resource occurs periodically in time.

19. The apparatus of claim 15, wherein the predetermined time-frequency resource is dedicated to indicate that the first base unit intends to use or is using the selected UL/DL configuration.

20. The apparatus of claim 15, wherein a presence pattern of a physical signal on the predetermined time-frequency resource is used to indicate that the first base unit intends to use or is using the selected UL/DL configuration and each individual instance of the physical signal comprises a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration.

21. The apparatus of claim 15, wherein the predetermined set of UL/DL configurations comprises a first UL/DL configuration having ten DL subframes within a radio frame of ten subframes.

22. The apparatus of claim 15, wherein the predetermined set of UL/DL configurations comprises a second UL/DL configuration having nine DL subframes and one special subframe within a radio frame of ten subframes.

23. A method comprising:

receiving a first information on a predetermined time-frequency resource transmitted from a first base unit on a first carrier, wherein the first information indicates that the first base unit intends to use or is using a selected uplink/downlink ("UL/DL") configuration of a predetermined set of UL/DL configurations; and

transmitting a second information to the first base unit, wherein the second information indicates that there is a second base unit operating at a second carrier and using a UL/DL configuration different from each UL/DL configuration of the predetermined set of UL/DL configurations, and the second carrier is within a predetermined frequency range from the first carrier.

24. The method of claim 23, further comprising receiving a third information transmitted from the second base unit on the second carrier, wherein the third information indicates the UL/DL configuration used by the second base unit on the second carrier.

25. The method of claim 23, wherein the first information is received on a physical broadcast channel ("PBCH") and one or more bits in the PBCH indicate that the first base unit intends to use or is using the selected UL/DL configuration.

26. The method of claim 23, wherein the predetermined time-frequency resource occurs periodically in time.

27. The method of claim 23, wherein the predetermined time-frequency resource is dedicated to indicate that the first base unit intends to use or is using the selected UL/DL configuration.

28. The method of claim 23, wherein a presence pattern of a physical signal on the predetermined time-frequency resource is used to indicate that the first base unit intends to use or is using the selected UL/DL configuration and each individual instance of the physical signal comprises a reference signal that does not indicate that the first base unit intends to use or is using the selected UL/DL configuration.

29. The method of claim 23, wherein the predetermined set of UL/DL configurations comprises a first UL/DL configuration having ten DL subframes within a radio frame of ten subframes.

30. The method of claim 23, wherein the predetermined set of UL/DL configurations comprises a second UL/DL configuration having nine DL subframes and one special subframe within a radio frame of ten subframes.

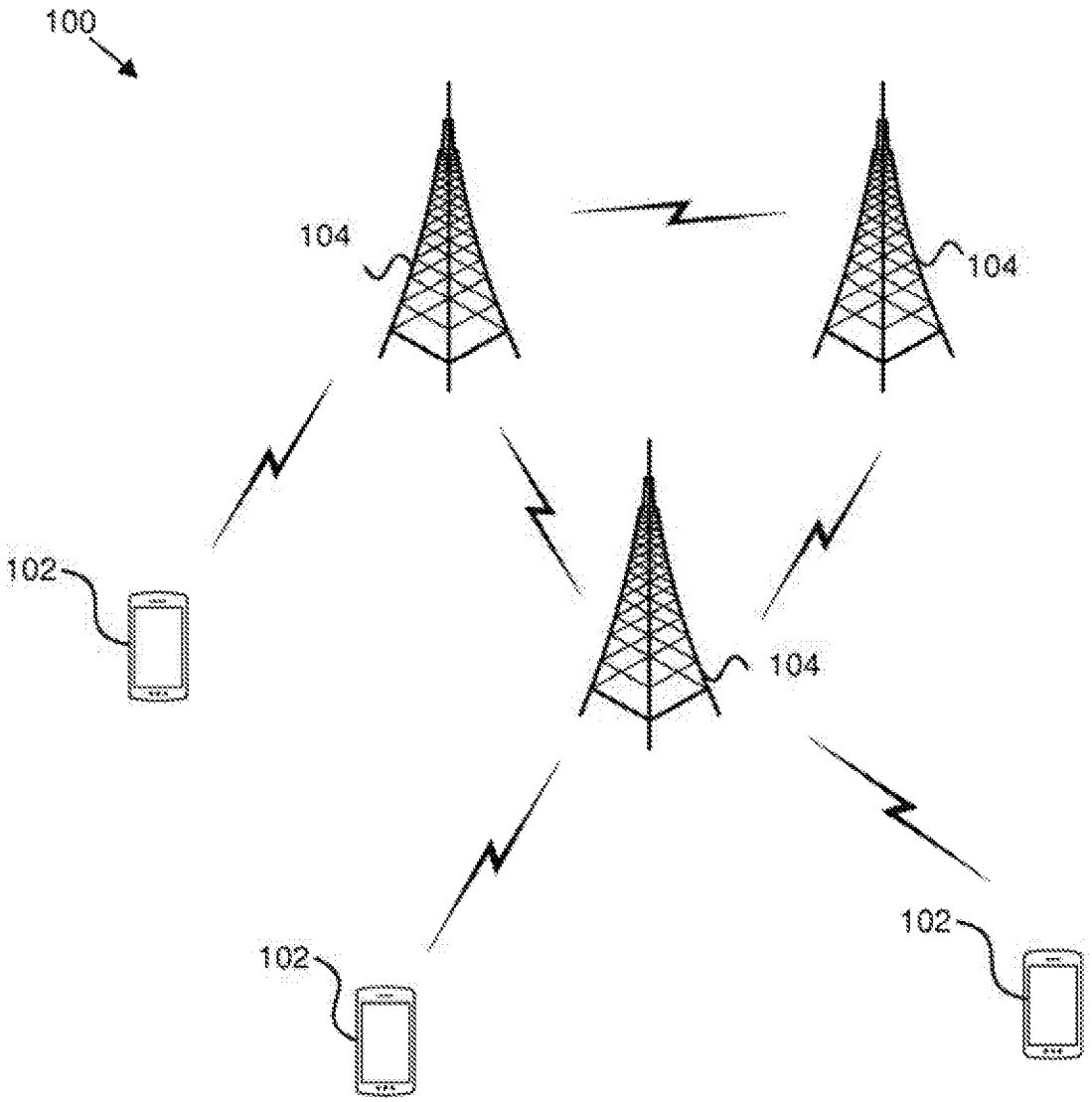

FIG. 1

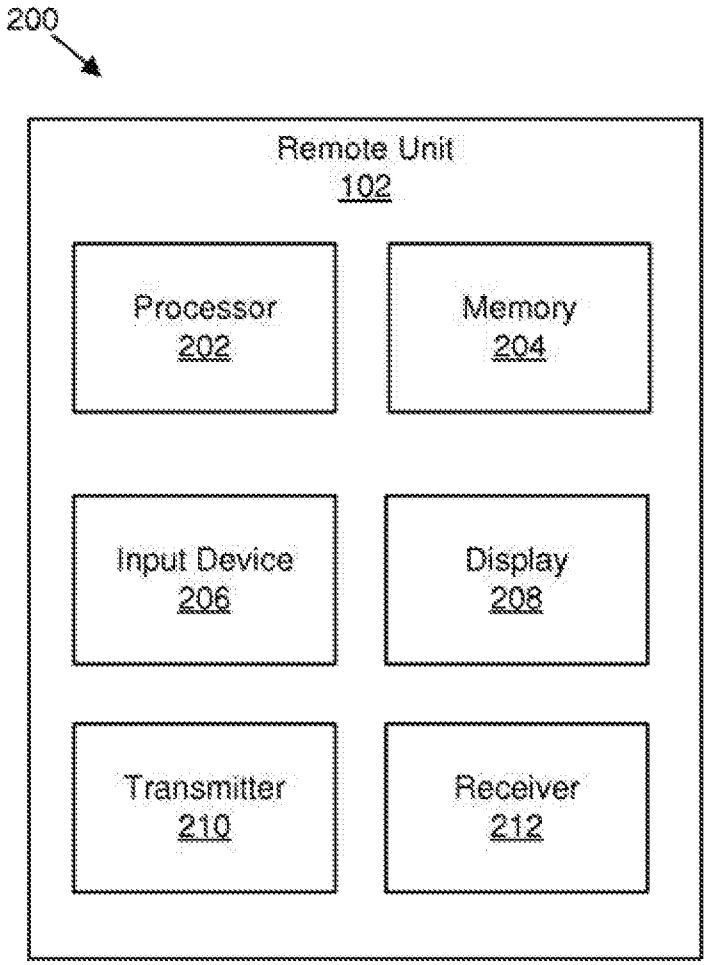
200
Remote Unit
102
Processor
202
Memory
204
Input Device
206
Display
208
Transmitter
210
Receiver
212

FIG. 2

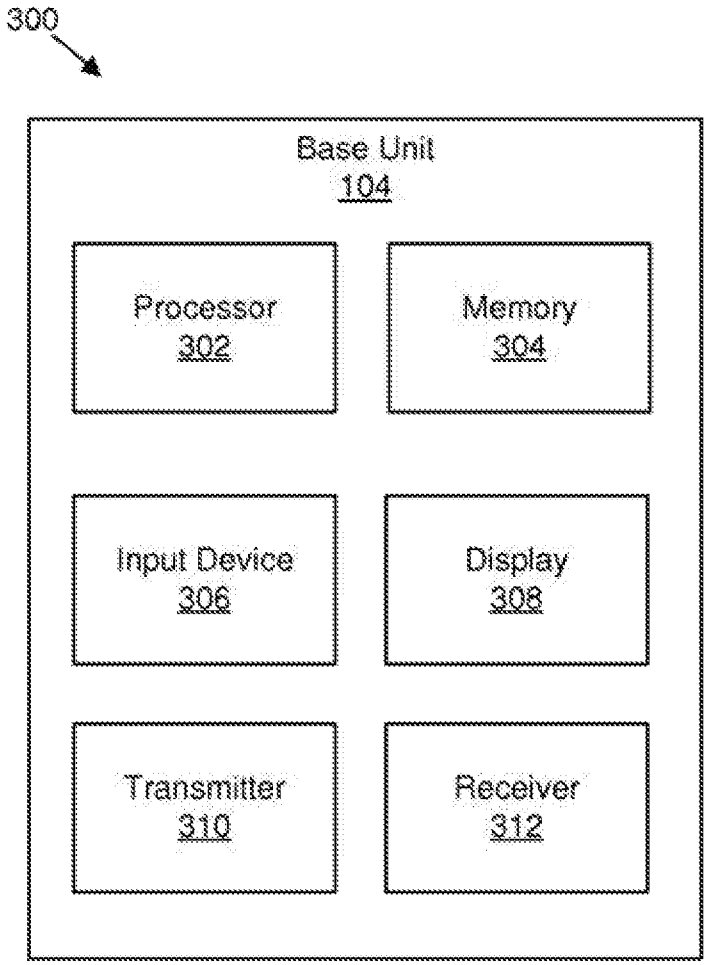
300
Base Unit
104
Processor
302
Memory
304
Input Device
306
Display
308
Transmitter
310
Receiver
312

FIG. 3

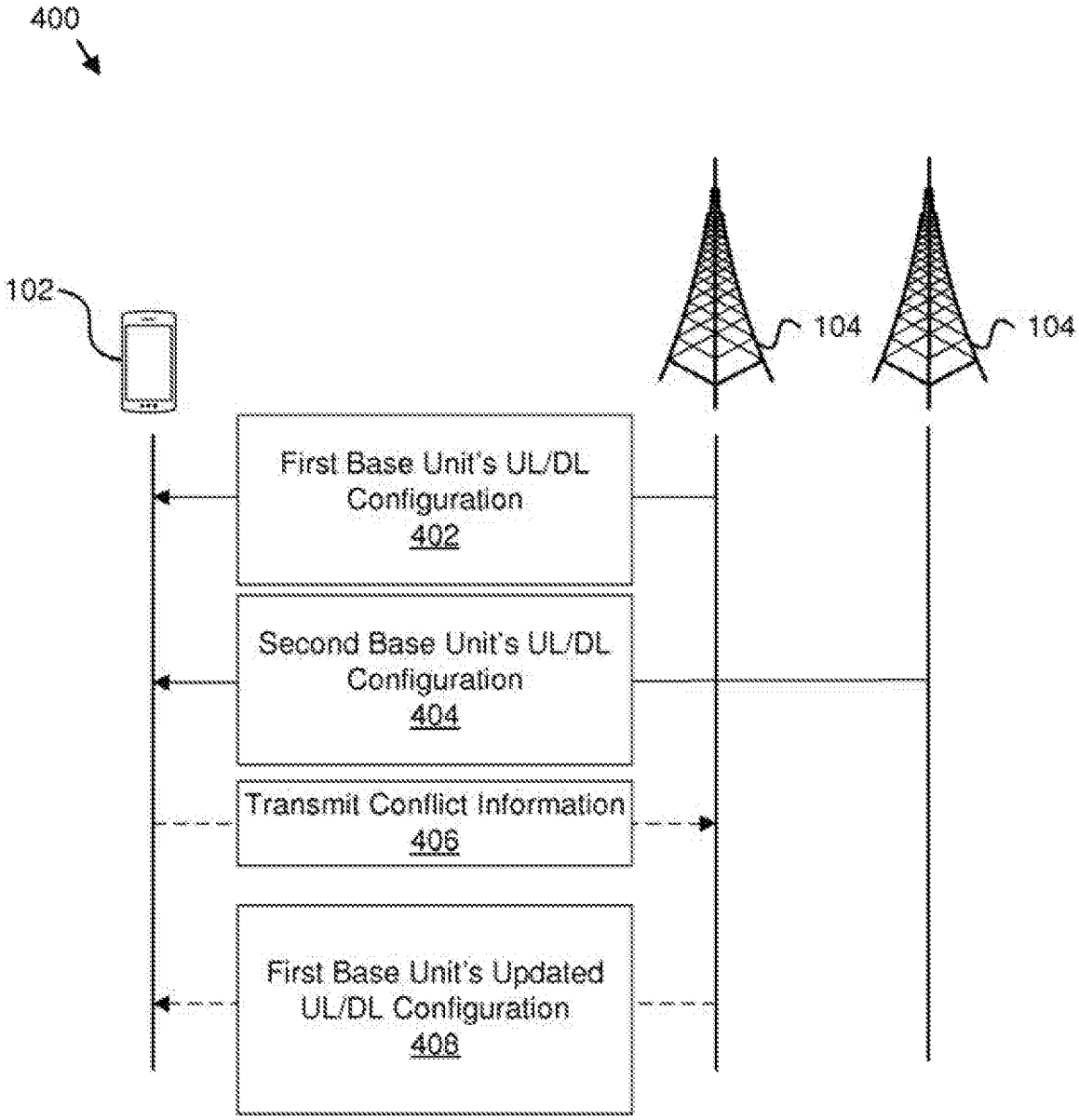
400
102
104
104
First Base Unit's UL/DL Configuration
402
Second Base Unit's UL/DL Configuration
404
Transmit Conflict Information
406
First Base Unit's Updated UL/DL Configuration
408

FIG. 4

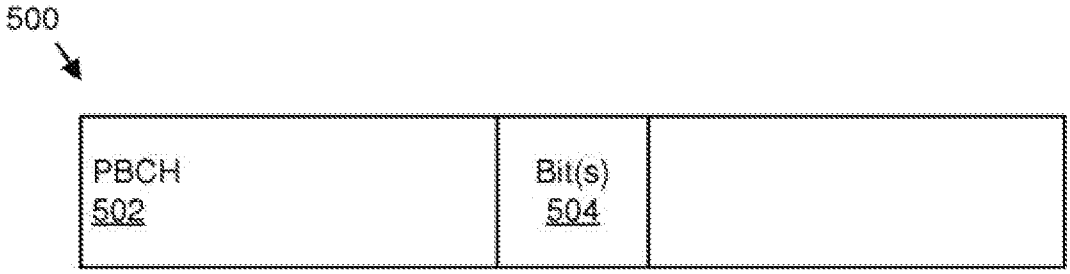

FIG. 5A

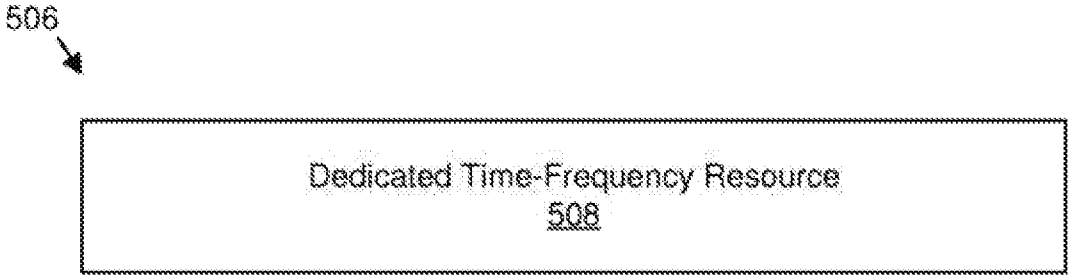

FIG. 5B

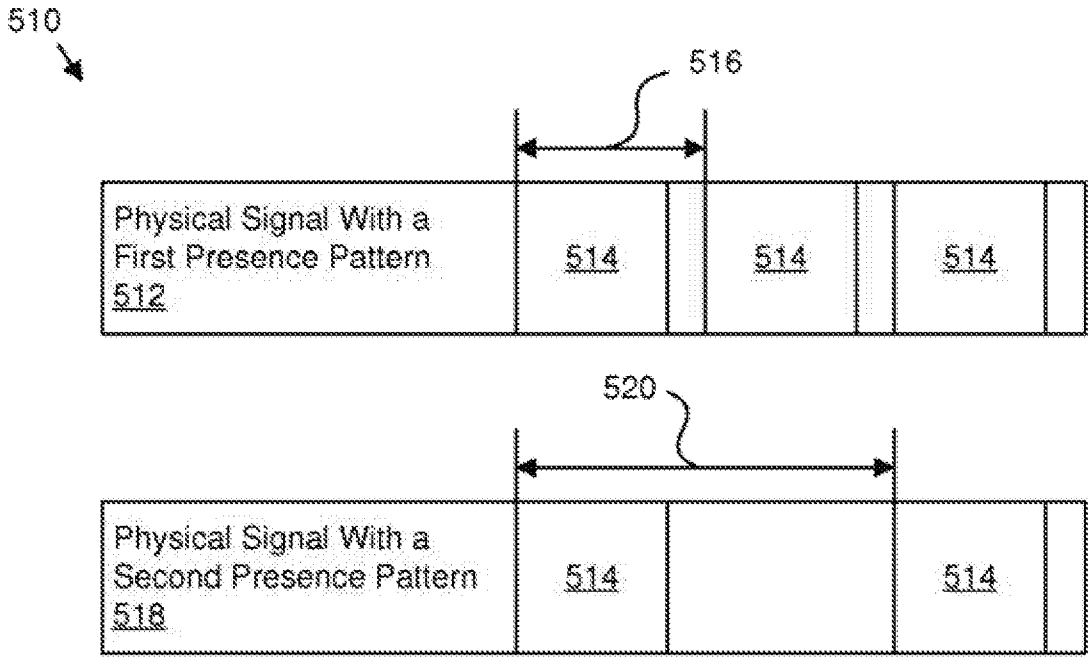

FIG. 5C

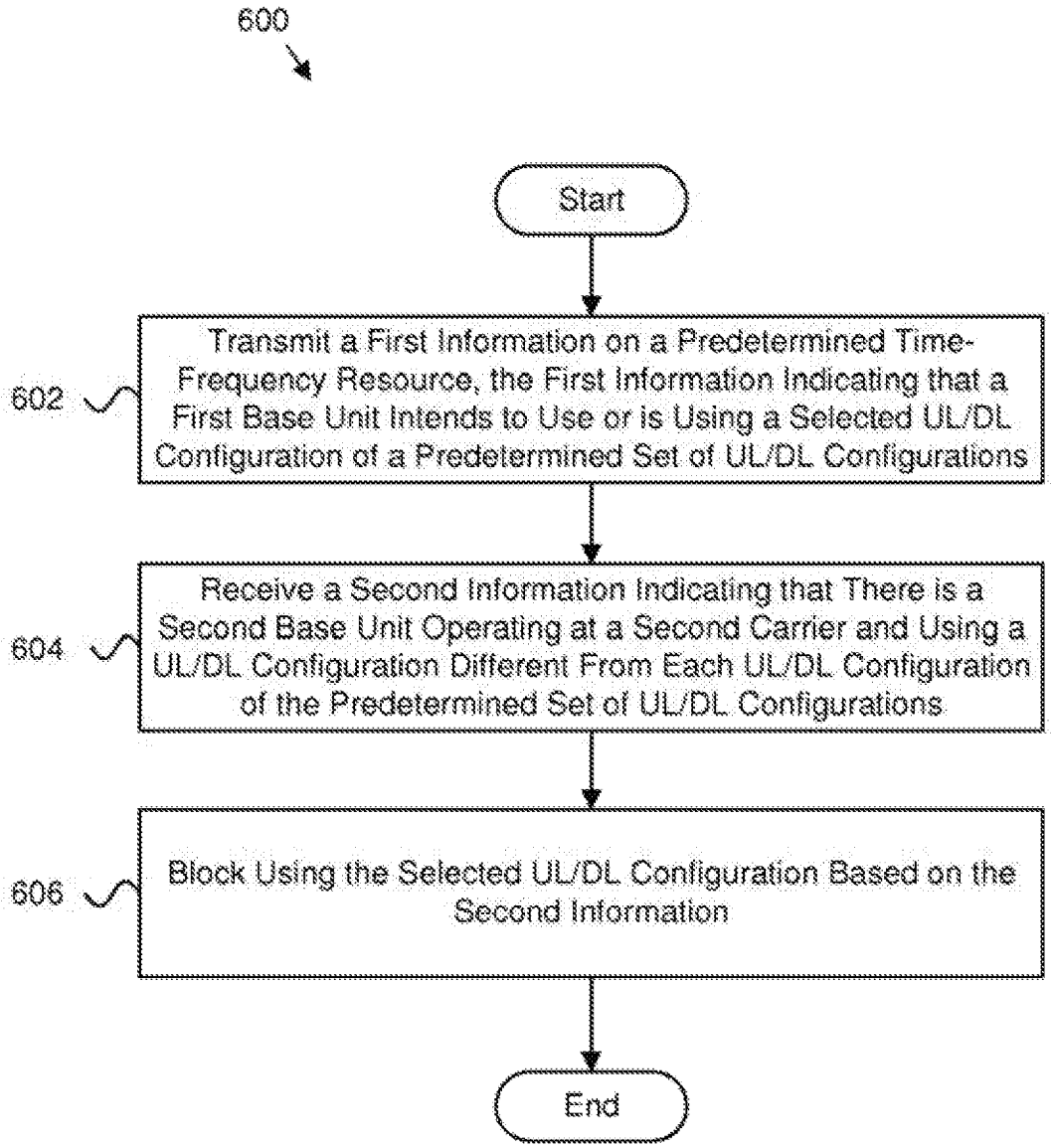
600
Start
Transmit a First Information on a Predetermined Time-Frequency Resource, the First Information Indicating that a First Base Unit Intends to Use or is Using a Selected UL/DL Configuration of a Predetermined Set of UL/DL Configurations
602
Receive a Second Information Indicating that There is a Second Base Unit Operating at a Second Carrier and Using a UL/DL Configuration Different From Each UL/DL Configuration of the Predetermined Set of UL/DL Configurations
604
Block Using the Selected UL/DL Configuration Based on the Second Information
606
End

FIG. 6

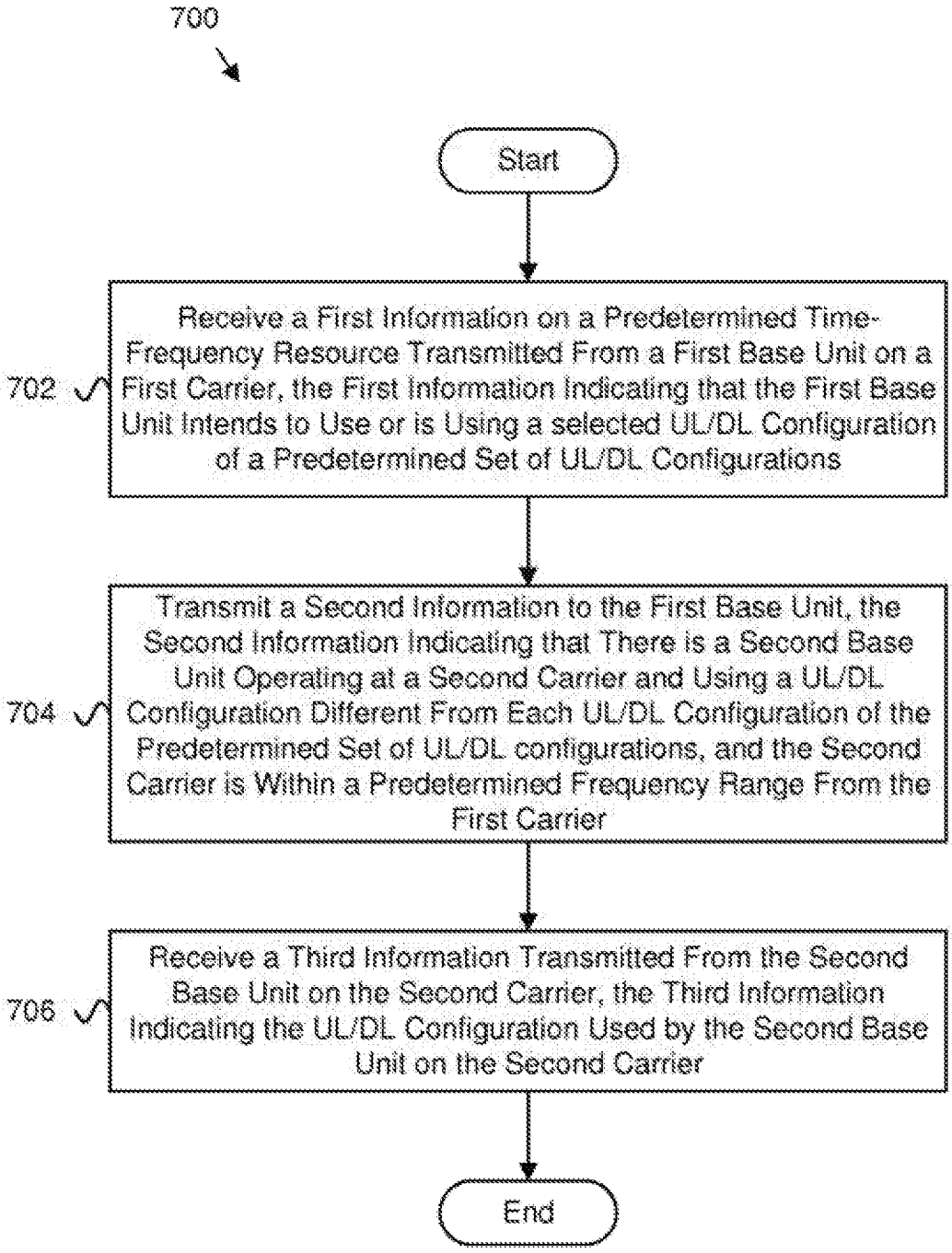
700
Start
Receive a First Information on a Predetermined Time-Frequency Resource Transmitted From a First Base Unit on a First Carrier, the First Information Indicating that the First Base Unit Intends to Use or is Using a selected UL/DL Configuration of a Predetermined Set of UL/DL Configurations
702
Transmit a Second Information to the First Base Unit, the Second Information Indicating that There is a Second Base Unit Operating at a Second Carrier and Using a UL/DL Configuration Different From Each UL/DL Configuration of the Predetermined Set of UL/DL configurations, and the Second Carrier is Within a Predetermined Frequency Range From the First Carrier
704
Receive a Third Information Transmitted From the Second Base Unit on the Second Carrier, the Third Information Indicating the UL/DL Configuration Used by the Second Base Unit on the Second Carrier
706
End

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/089541

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W; H04Q

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, CNKI, WPI, EPODOC, 3GPP: downlink, DL, uplink, UL, carrier, frequency, subframe, interference, configuration, block

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 103391584 A (INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE) 13 November 2013 (2013-11-13) the whole document	1-30
A	CN 104284426 A (POTEVIO INSTITUTE OF TECHNOLOGY CO., LTD.) 14 January 2015 (2015-01-14) the whole document	1-30
A	CN 104811955 A (HTC CORP.) 29 July 2015 (2015-07-29) the whole document	1-30
A	US 2014092789 A1 (NOKIA SOLUTIONS AND NETWORKS OY) 03 April 2014 (2014-04-03) the whole document	1-30

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 June 2016	**21 June 2016**
Name and mailing address of the ISA/CN **STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer **ZHANG,Qi** Telephone No. **(86-10)62413262**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2015/089541

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	103391584	A	13 November 2013	TW	201347434	A	16 November 2013
				EP	2663147	A2	13 November 2013
				US	2013303177	A1	14 November 2013
CN	104284426	A	14 January 2015		None		
CN	104811955	A	29 July 2015	US	2015215094	A1	30 July 2015
US	2014092789	A1	03 April 2014		None		