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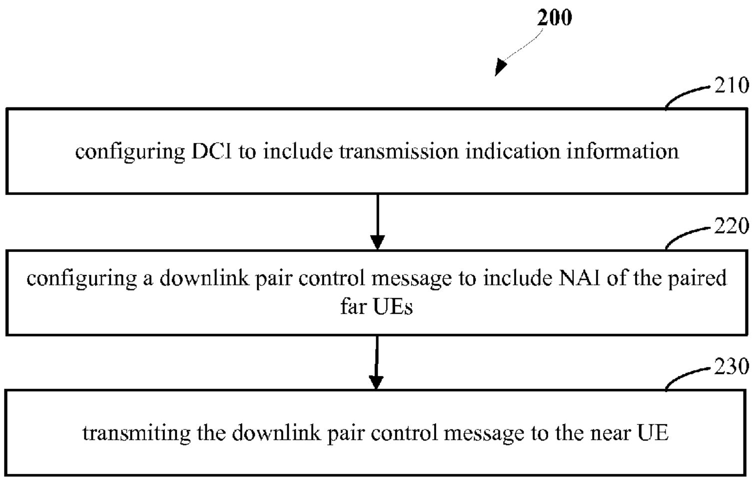

FIG. 2

(57) Abstract: The disclosure provides methods and devices for supporting a MUST in a communication System in which a base station of the communication pairs a near User Equipment (UE) with one or more far UEs for the MUST. The method comprises: configuring DCI to include transmission indication information indicating whether a transmission of a subframe is a MUST; in response to the transmission indication information indicating that the transmission of the subframe is a MUST, configuring a downlink pair control message to include NAI of the far UEs which are paired with the near UE, wherein the NAI includes at least superposed constellation information indicating power allocation information between the near UE and the far UEs in spatial layers; and transmitting the downlink pair control message to the near UE.

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COMMUNICATION METHOD, BASE STATION DEVICE AND COMMUNICATION DEVICE IN A COMMUNICAITON SYSTEM

FIELD

[0001] The present disclosure relates to the field of wireless communication, and more specifically, to a communication method implemented by a base station or a near user equipment (UE) in a communication system, a base station device and a communication device.

BACKGROUND

[0002] Recently, the third generation partnership project (3GPP) has approved the working item of Downlink (DL) Multiuser Superposition Transmission (MUST), whose objective is to specify necessary mechanisms to enable DL intra-cell MUST for Physical Downlink Shared Channel (PDSCH) with assistance information from the serving base station to the UE regarding its experienced intra-cell interference. The following cases are considered for DL MUST: superposed PDSCHs being transmitted using the same transmission scheme and the same spatial precoding vector; superposed PDSCHs being transmitted using the same transmit diversity scheme; and superposed PDSCHs being transmitted using the same transmission scheme with their spatial precoding vectors being different.

[0003] It has been proved that the MUST is generally more beneficial when the network experiences higher traffic load. In this case, more UEs could be paired for the MUST, which may bring more system capacity increase. Therefore, dynamic pairing of MUST-near UEs and MUST-far UEs from subframe to subframe and over different spatial layers and subbands should be supported in MUST, e.g. pairing one MUST-near UE with multiple MUST-far UEs on different spatial layers or in different subbands to increase the possibility of MUST pairing for the MUST.

SUMMARY

[0004] However, the dynamic pairing between the near UEs and the far UEs in the MUST and the dynamic switching between MUST and non-MUST will cause huge signaling overhead and decoding complexity. In order to solve the above and other potential problems, embodiments of this disclosure propose a method and apparatus for supporting a MUST in a communication system.

[0005] According to a first aspect of this disclosure, there is provided a method for supporting a MUST in a communication system in which a base station of the communication system pairs a near UE with one or more far UEs to perform the MUST. The method includes configuring DCI to include transmission indication information indicating whether a transmission in a subframe is the MUST; in response to the transmission indication information indicating that the transmission of the subframe is the MUST, configuring a downlink pair control message to include NAI of the far UEs which are paired with the near UE, wherein the NAI includes at least superposed constellation information indicating power allocation information of the near UE and the far UEs in spatial layers; and transmitting the downlink pair control message to the near UE.

[0006] According to a second aspect of this disclosure, there is provided a method for supporting a MUST in a communication system in which a base station of communication system pairs a near UE with one or more far UEs to perform the MUST. The method includes, at the near UE, receiving a transmission on a subband or a PRB from the base station; determining whether the transmission on the subband or the PRB is a MUST by determining whether there is any interference on the subband or the PRB; and in response to determining that the transmission on the subband or the PRB is a MUST, acquiring, from a search space, a downlink pair control message including NAI of at least one far UE, the NAI including at least superposed constellation information indicating power allocation information of the near UE and the at least one far UE in each spatial layer.

[0007] According to a third aspect of this disclosure, there is provided a base station device for pairing a near UE with one or more far UEs to perform a MUST. The base station device includes a processor and a memory including instructions executable by the processor, wherein the processor is configured to enable the base station device to implement the method according to the first aspect of this disclosure.

[0008] According to a fourth aspect of this disclosure, there is provided a communication device paired with one or more far UEs by a base station in a communication system so as to function as a near UE in a MUST. The communication device includes a processor and a memory including instructions executable by the processor, wherein the processor is configured to enable the communication device to implement the method according to the second aspect of this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] This disclosure will be better understood and other features, objectives and advantages of the present disclosure will become more apparent from the following detailed description of the embodiments of the disclosure in conjunction with the accompanying drawings, wherein:

[0010] FIG. 1 illustrates a schematic diagram of a scenario in which a MUST is performed in a communication system;

[0011] FIG. 2 illustrates a flow chart of a method for supporting a MUST in a communication system according to an embodiment of this disclosure;

[0012] FIG. 3 illustrates a schematic diagram of the pairing scenarios of near UEs and far UEs according to an embodiment of this disclosure;

[0013] FIG. 4 illustrates a flow chart of a method for supporting a MUST in a communication system according to an embodiment of this disclosure;

[0014] FIGS. 5A and 5B illustrate a schematic diagram of exemplary candidate far UEs to be blindly detected according to an embodiment of this disclosure;

[0015] FIG. 6 illustrates a block diagram of an apparatus for supporting a MUST in a communication system according to an embodiment of this disclosure;

[0016] FIG. 7 illustrates a block diagram of an apparatus for supporting a MUST in a communication system according to an embodiment of this disclosure; and

[0017] FIG. 8 illustrates a block diagram of a device suitable for implementing embodiments of this disclosure.

DETAILED DESCRIPTION

[0018] Preferred embodiments of this disclosure will be described below in conjunction with accompanying drawings. Although preferred embodiments are shown in accompanying drawings, it should be understood that this disclosure may be implemented in various forms but not be limited by the embodiments described herein. On the contrary, these embodiments are provided to make the disclosure more thorough and complete and to make the scope of this disclosure delivered to those skilled in this art completely.

[0019] FIG. 1 illustrates a schematic diagram of a scenario in which a MUST is performed in a communication system 100. As shown in FIG. 1, the communication system 100 includes a UE 120, a UE 130 and a base station (eNB) 110 which pairs the UE 120 with the UE 130 to perform a MUST. Herein, in operation of the MUST, in the pair of UEs, the UE near the base station is called as a near UE or a MUST-near UE such as the UE 120 in FIG.1, while the UE far from the base station is called as a far UE or a MUST-far UE such as the UE 130 in FIG. 1.

[0020] During the MUST, the base station allocates a relatively large transmitting power to the far UE 130 and allocates a relatively small transmitting power to the near UE 120. When receiving a DL MUST from the base station, the near UE 120 firstly decodes from the received transmission a signal for the far UE 130, then removes the signal for the far UE 130 from the received transmission, and finally decodes from the remaining transmission data directed to itself. Although FIG. 1 shows a MUST by paring only one near UE and one far UE as an example, it may be understood by those skilled in this art that paring scenarios of UEs in the MUST may further include one near UE paired with multiple far UEs, multiple near UEs paired with one far UE, and multiple near UEs paired with multiple far UEs, etc..

[0021] The dynamic pairing of MUST-near UEs and MUST-far UEs over different spatial layers and subbands on basis of subframe increases the possibility of MUST pairing. However, the dynamic pairing, as well as dynamic switching between MUST and non-MUST over different subframes makes it more difficult to detect signal for the paired MUST-far UE at the MUST-near UE, especially when multiple MUST-far UEs are paired to a MUST-near UE and the pairing changes from subframe to subframe. Although it has been proposed to help decoding the signal of the MUST-far UE at the MUST-near UE by identifying some candidate parameters of assistance information and blindly detecting other parameters, signaling the identified candidate parameters with long time intervals via higher layer could not provide the necessary assistance information of the MUST-far UEs that is updated every subframe.

[0022] Meanwhile, blind detection of the full parameters of the paired MUST-far UEs in each subframe could involve too much decoding complexity and be time consuming to support the dynamic pairing/switching in MUST. Also, signalling the full Downlink Control Information (DCI) of the paired MUST-far UE to the MUST-near UE would bring too much signalling overhead, which would become even worse if multiple MUST-far UEs are paired to the same MUST-near UE.

[0023] Embodiments of the disclosure provide an enhanced DCI format design and the corresponding decoding signaling to support dynamic pairing with either wideband scheduling or subband scheduling in DL MUST. For example, one MUST-near UE paired with multiple MUST-far UEs or one MUST-far UE paired with multiple MUST-near UEs is supported. And dynamic switching between MUST and non-MUST from one subframe to another is supported,.

[0024] FIG. 2 illustrates a flow chart of a method 200 for supporting the MUST in a communication system according to an embodiment of this disclosure. The method 200 may be implemented at the base station (the base station 110 in FIG. 1, for example) side of the communication system with respect to the near UE 120.

[0025] In Step 210, the base station 110 configures DCI to include transmission indication information. The transmission indication information indicates whether a transmission of a subframe is a MUST.

[0026] As aforementioned, dynamic signaling is required at the MUST-near UE to indicate its receiver whether to detect the received signal as a single transmission (non-MUST) or a superposed transmission (MUST). Therefore, additional transmission indication information is added into the DCI to indicate to the near UE whether the received transmission of each DL subframe is a MUST.

[0027] In some implementations, the transmission indication information may be one additional bit attached to the current DCI formats. For example the bit being 0 indicates that the transmission of the subframe is the non-MUST (i.e., a single transmission), and the bit being 1 indicates that the transmission of the subframe is the MUST, or vice versa. Of course, any other forms of indication are possible and this disclosure is not limited in this aspect.

[0028] In Step 220, in case that the transmission indication information indicates that the transmission of the subframe is the MUST, the base station 110 configures a downlink pair control message to include Necessary Assistance Information (NAI) of one or more far UEs which are paired with the near UE 120. The NAI of each far UE may be indicated using any number of bits such as 5-8 bits.

[0029] By including only the NAI of the paired far UEs rather than the full DCI of the far UEs, the near UE is enabled to detect signals for the far UEs without decoding full DCI of the far UEs. In this way, the signaling overhead of the system and the decoding overhead of the near UE are both reduced.

[0030] In particular, according to an embodiment of this disclosure, the NAI of the paired far

UEs at least includes a superposed constellation information indicating the power allocation information of the near UE and its paired far UEs in spatial layers. For example, in some embodiments, the constellation information may indicate power allocation of the near UE and the far UEs in each spatial layer.

[0031] FIG. 3 illustrates a schematic diagram of the pairing scenarios of near UEs and far UEs according to an embodiment of this disclosure. As shown in FIG. 3, the near UE #1 is paired with the far UE #1 and the far UE #2 (referred to as the MUST pair 1); the near UE #2 and the near UE #3 are paired with the far UE #3 (referred to as the MUST pair 2); and the near UE #4 is paired with the far UE #4 (referred to as the MUST pair 3). Power allocations of paired near UEs and far UEs are shown by the vertical axis of FIG. 3 indicating by the superposed constellation information included in the NAI.

[0032] In some implementations, in response to a far UE supporting a modulation scheme other than the Quadrature Phase Shift Keying (QPSK), configuring the downlink pair control message in the step 220 further includes including a modulation order in the NAI to indicate the modulation scheme of the paired far UE. In this way, the technical solution of this disclosure may be flexibly applicable to different conditions in which the near UE and the far UEs use the same or different modulation schemes.

[0033] Alternatively or additionally, in some implementations, if a far UE uses a different decoder from that of the near UE, then configuring the downlink pair control message in the step 220 further includes including a Precoding Matrix Indicator (PMI) index in the NAI. The PMI index is used for indicating the precoding scheme of a paired far UE. As an example, for a code book based precoding scheme such as the transmission mode (TM) 4, The PMI index may include 2 or 4 bits.

[0034] In another aspect, according to embodiments of this disclosure, the downlink pair control message may be configured as a separate control message independent from the current DCI or as a part of the current DCI.

[0035] In some implementations, if one far UE is paired with multiple near UEs in one subframe (as shown by the MUST pair 2 in FIG. 3), the base station 110 configures the downlink pair control message as a separate control message independent from the current DCI, and the separate control message includes NAI of all far UEs paired with the near UE in a subframe. In some implementations, the format of the formed separate control message may be similar to the current DCI Format 3/3A. For example, the format of the separate control message may be:

NAI 1, NAI 2, ... , NAI N

where N indicates total number of far UEs having pair relationships with multiple near UEs in the scheduled subframes.

[0036] In some other implementations, in one subframe, one far UE may be paired with only one near UE. This includes the case in which one near UE is paired with only one far UE such as the MUST pair 3 shown in FIG.3 and the case in which one near UE is paired with multiple far UEs such as the MUST pair 1 shown in FIG.3. In these cases, the base station 110 may configure the downlink pair control message to include only the NAI of the far UEs paired with one near UE. In this case, the downlink pair control message may be included into the current DCI as a part of it. In this way, the near UE receiving the DCI including the downlink pair control message may detect the signals for the paired far UEs after decoding the near UE's own DCI.

[0037] In Step 230, the base station 110 transmits the downlink pair control message to the UE 120. In some implementations, if the downlink pair control message is configured as a separate control message, the downlink pair control message is transmitted to the near UE 120 in a Physical Downlink Control Channel (PDCCH). In this case, the near UE 120 may acquire the NAI of the far UEs by monitoring the Common Search Space (CSS).

[0038] In some other implementations, if the downlink pair control message is configured as a part of the current DCI, the downlink pair control message is transmitted to the near UE 120 in a PDCCH or an enhanced PDCCH. In this case, the near UE 120 may acquire the NAI of the far UEs paired with the near UE 120 by monitoring the UE-specific Search Space (USS).

[0039] FIG. 4 illustrates a flow chart of a method 400 for supporting the MUST in a communication system according to an embodiment of this disclosure. The method 400 may be implemented at the near UE (UE 120 in FIG. 1, for example) side of the communication system. That is to say, the base station and the near UE in the communication system may cooperate with each other to implement the method 200 and the method 400 to implement various embodiments of this disclosure.

[0040] In Step 410, the near UE 120 receives a transmission on a subband or a Physical Resource Block (PRB) from the base station 110. Next, in Step 420, the near UE 120 determines whether the transmission on the subband or the PRB is a MUST by determining whether there is any interference on the subband or the PRB.

[0041] If the interference level on the subband or the PRB is relative high, for example, higher than a specific threshold, then the near UE 120 may determine that the transmission on the subband or the PRB is a MUST. On the contrary, if the interference level on the subband or the PRB is relative low, for example, lower than the specific threshold, then the near UE 120 may determine that the transmission on the subband or the PRB is a non-MUST. This is because, as mentioned above, a MUST includes data for both paired near UEs and far UEs and also because the transmitting powers of the far UEs are usually higher. Therefore, data for far UEs will become interferences to the near UE at a usually high level. It may be understood by those skilled in this art that the specific threshold may be configured according to channel conditions or traffic conditions without impacting the scope of this disclosure.

[0042] In Step 430, if the near UE 120 determines that the transmission on the subband or the PRB is a MUST, then the near UE 120 acquires from a search space (CSS and/or USS, for example) a downlink pair control message. The downlink pair control message includes Necessary Assistance Information (NAI) of at least one far UE. As stated above, the NAI includes at least a superposed constellation information indicating the power allocation information of the near UE 120 and the at least one far UE in each spatial layer.

[0043] If one far UE is paired with multiple near UEs, then each near UE may acquire the NAI of the far UE by monitoring the Common Search Space (CSS). Given the blind detection principles regulated in current 3GPP standards, blind detection of the far UE's NAI through monitoring the CSS corresponds to that the downlink pair control message is only carried in the PDCCH region. That is to say, if one far UE is paired with multiple near UEs, then the NAI of the far UE is included is a separate control message and transmitted through a PDCCH, and the receiver may acquire the NAI of the far UE by blind detection of the CSS. In this case, in addition to monitoring its own DCI in the CSS, the near UE 120 also monitors the downlink pair control message with aggregation level 4 and level 8.

[0044] If one near UE is paired with multiple far UEs or one far UE is only paired with one near UE, then each near UE may acquire the NAI of its paired far UE(s) by monitoring the CSS. Given the blind detection principles regulated in current 3GPP standards, blind detection of the far UEs' NAI through monitoring USS corresponds to that the downlink pair control message is carried in the PDCCH or EPDCCH region. That is to say, if one near UE is paired with one or more far UEs, then NAI of the one or more far UEs is transmitted through the PDCCH or EPDCCH as an additional part of the current DCI, and the receiver acquires the NAI of the one or more far UEs by blindly detecting the USS.

[0045] In some implementations, the downlink pair control message is carried in the PDCCH, and NAI of the one or more far UEs paired with the near UE is added to the current content of the near UE's own DCI.

[0046] In other implementations, if the near UE is configured with the EPDCCH in its Physical Downlink Shared Channel (PDSCH) region, the downlink pair control message may be carried in the EPDCCH, and NAI of the one or more far UEs paired with the near UE is added to the current content of the near UE's own DCI.

[0047] The near UE may monitor the USS and perform a Cyclic Redundancy Check (CRC) scramble in the PDCCH/EPDCCH region with a Cell Radio Network Temporary Identifier (C-RNTI), for example, to determine the NAI of the paired far UEs. In this implementation, since the DCI includes the NAI of the paired far UEs (the NAI of each far UE is represented by 5-8 bits, for example) such that the size of the DCI is larger than that defined in current standards, therefore, more candidate Channel Control Elements (CCEs) will be needed in the blind detection of the near UE. Even so, the additional complexity of decoding only the far UEs' NAI is much smaller than that of decoding the far UEs' full DCI.

[0048] Once the NAI of the paired far UEs is decoded in the PDCCH/EPDCCH region, although the resource allocations of the far UEs are not available at the near UE, the number of candidate far UEs has been greatly reduced. Therefore, only very limited decoding attempts are needed to blind detect the far UEs' control information, and fast blind detection could be realized and the decoding complexity is greatly reduced.

[0049] FIGS. 5A and 5B illustrate a schematic diagram of exemplary candidate far UEs to be blindly detected according to an embodiment of this disclosure. Refers again to FIG.3 from which it may be seen that a far UE#3 is paired with multiple near UEs (MUST pair 2 in FIG. 3), therefore the far UE#3's NAI along with other candidate far UEs paired with multiple near UEs forms a separate downlink pair control message. The far UE #1 and the far UE #2 are only paired with the near UE #1, therefore, the downlink pair control message formed by their NAI is added into the DCI of the near UE #1. The far UE #4 is only paired with the near UE #4, therefore, the downlink pair control message formed by its NAI is added into the DCI of the near UE #4.

[0050] Therefore, as shown in FIG. 5A, when the near UE #1 blindly detects the far UEs' control information, it monitors CSS with aggregation level 4 and level 8, for example, to obtain the NAI of the far UE #3, and monitors its own USS to obtain the NAI of the far UE #1 and far UE #2.

[0051] After the near UE #1 has obtained the NAI of the candidate far UE #1, #2 and #3 from the CSS and its own USS, when decoding the PDSCH of its paired far UEs, the near UE #1 only needs to perform decoding attempts among the far UE #1, the far UE #2 and the far UE #3.

[0052] For the near UE #2 and the near UE #3, since they are only paired with the same far UE #3, they only monitor the CSS to obtain the NAI of the far UE #3, and when decoding the PDSCH of their paired far UE, the decoding attempt is only needed with respect to the far UE #3.

[0053] Similar to the far UE #1, as shown in FIG. 5B, the near UE #4 blindly detects the NAI of the far UE #3 by monitoring the CSS, and monitors its own USS to obtain the NAI of the far UE #4. After the near UE #4 has obtained the NAI of candidate far UE #3 and UE #4 from the CSS and its own USS, when decoding the PDSCH of its paired far UEs, the near UE #4 only needs to perform decoding attempts among the far UE #3 and the far UE #4.

[0054] In some implementation, after the Step 420 and before the Step 430, the method 400 may further include acquiring, by the near UE 120, from the DCI transmitted by the base station 110 a transmission indication information indicating whether a transmission of a subframe is a MUST.

[0055] In this case, after the Step 430, the method 400 may further include the following actions (not shown in the figure). If the transmission of the subframe is a MUST, then the near UE 120 performs decoding attempts on the MUST only with respect to the bindly detected far UEs (i.e. the candidate far UEs) to decode the signals for the far UEs paired with the near UE 120 from the MUST. Next, the near UE 120 may remove the decoded signals for the paired far UEs from the MUST to obtain the signal for the near UE 120.

[0056] FIG. 6 illustrates a block diagram of an apparatus 600 for supporting a MUST in a communication system according to an embodiment of this disclosure. The apparatus 600 may be implemented in or by a base station (the base station 110 shown in FIG. 1, for example) in a communication system.

[0057] As shown in FIG. 6, the apparatus 600 includes a DCI configuring unit 610 configured to configure DCI to include transmission indication information indicating whether a transmission of a subframe is a MUST. The apparatus 600 further includes a NAI configuring unit 620 configured to, in response to the transmission indication information indicating that the transmission of the subframe is a MUST, configure a downlink pair control message to include NAI of the far UEs which are paired with the near UE, wherein the NAI includes at least superposed constellation information indicating the power allocation information of the near UE and the far UEs in spatial layers. The apparatus 600 further includes a transmitting unit 630 configured to transmit the downlink pair control message to the near UE.

[0058] In some implementations, the NAI configuring unit 620 is further configured to, in response to a far UE supporting a modulation scheme other than QPSK, include a modulation order in the NAI to indicate the modulation scheme of the far UE.

[0059] In some implementations, the NAI configuring unit 620 is further configured to, in response to the far UE using a precoder different from that of the near UE, include a PMI index in the NAI to indicate the precoding scheme of the far UE.

[0060] In some implementations, the NAI configuring unit 620 is further configured to, in response to one far UE being paired with multiple near UEs in the subframe, configure the downlink pair control message independently of the DCI to include the NAI of multiple far UEs paired with the multiple near UEs.

[0061] In some implementations, the transmitting unit 630 is further configured to transmit the downlink pair control message to the near UE in a PDCCH.

[0062] In some implementations, the NAI configuring unit 620 is further configured to, in response to one far UE being paired with only one near UE in the subframe, configure the downlink pair control message to include only NAI of the far UE paired with the one near UE, and to include the downlink pair control message into the DCI as a portion of it.

[0063] In some implementations, the transmitting unit 630 is further configured to transmit the downlink pair control message to the near UE in at least one of a PDCCH and an EPDCCH.

[0064] FIG. 7 illustrates a block diagram of an apparatus 700 for supporting a MUST in a communication system according to an embodiment of this disclosure. The apparatus 700 may be implemented in or by a near UE (the near UE 120 shown in FIG. 1, for example) in a communication system.

[0065] As shown in FIG. 7, the apparatus 700 includes a receiving unit 710 configured to receive a transmission on a subband or a PRB from the base station. The apparatus 700 further includes a transmission determining unit 720 configured to determine whether the transmission on the subband or the PRB is a MUST by determining whether there is any interference on the subband or the PRB. The apparatus 700 further includes a NAI acquiring unit 730 configured to, in response to determining that the transmission on the subband or the PRB is a MUST, acquire from a search space a downlink pair control message. The downlink pair control message include NAI of at least one far UE, wherein the NAI includes at least superposed constellation information indicating power allocation information of the near UE and the at least one far UE in each spatial layer.

[0066] In some implementations, the apparatus 700 further includes a DCI acquiring unit (not shown) configured to acquire, from DCI, transmission indication information indicating whether a transmission of a subframe is a MUST.

[0067] In some implementations, the apparatus 700 further includes a decoding unit (not shown) configured to, in response to the transmission indication information indicating that the transmission of the subframe is a MUST, perform decoding attempts on the MUST only with respect to the at least one far UE, so as to decode from the MUST signals for the far UEs paired with the near UE in the at least one far UE. The decoding unit is further configured to remove from the MUST the signals for the far UEs paired with the near UE to obtain a signal for the near UE.

[0068] It should be understood that each of apparatuses 600 and 700 may be partially or entirely implemented by software modules, hardware modules, firmware modules or any other suitable combination thereof. The scope of this disclosure is not limited thereto. For example, in an implementation based on hardware, Integrated Circuit (IC), Application Specific Integrated Circuits (ASIC), System-on-a-Chip (SOC), Field-Programmable Gate Array (FPGA), etc may be used to implement one or more of the above units.

[0069] FIG. 8 illustrates a block diagram of a device 800 suitable for implementing embodiments of this disclosure. The device 800 may be used to implement the base station device such as the base station 110 shown in FIG. 1, or to implement a user communication device acting as a near UE in a MUST such as the near UE 120 shown in FIG. 1.

[0070] As shown in FIG. 8, the device 800 includes a processor 810 and a memory 820 coupled to the processor 810. The memory 820 includes instructions 830 executable by the processor 810. The memory 820 may have any suitable type that is applicable to local technical background, and may be implemented by any suitable data storage technology which includes but not limit to a semiconductor-based storage device, a magnetic storage device and system, an optical storage device and system. Although only one memory is shown in FIG. 8, the device 800 may include more than one physically different memory.

[0071] The processor 810 may have any suitable type that is applicable to local technical background, and may include but not limit to a general computer, a specific computer, a microcomputer, a digital signal processor (DSP) and one or more of processor based multi-core processing architectures. The device 800 may include more than one processor 810. The processor 810 is configured to implement the method 200 or 400 as shown in FIG. 2 or FIG. 4.

[0072] This disclosure proposes an enhanced dynamic control signalling design to support the dynamic pairing/switching of MUST. Only necessary assistance information, rather than the full DCI, of the far UEs is included in the enhanced dynamic signalling so as to minimize the signalling overhead. Furthermore, it is also proposed to reduce the complexity of blind detection of the far UEs' control information by limiting the number of candidate far UEs in the blind detection process.

[0073] In one or more exemplary embodiments, the functions described by this application may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Computer-readable media includes both a computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium.

[0074] The various illustrative logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented within or performed by a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0075] Those of ordinal skill in this art would further appreciate that any of the various illustrative logical blocks, modules, processors, means, circuits, and algorithm steps described in connection with the aspects disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

[0076] The previous description of the disclosed aspects is provided to enable any person skilled in the art to make or use the present disclosure. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects without departing from the scope of the disclosure. Thus, the present disclosure is not intended to be limited to the examples and designs shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

I/We Claim:

1. A communication method implemented by a base station in a communication system, the base station pairing a near User Equipment (UE) with one or more far UEs to perform a Multiuser Superposition Transmission (MUST), the method comprising:

configuring Downlink Control Information (DCI) to include transmission indication information indicating whether a transmission in a subframe is the MUST;

in response to the transmission indication information indicating that the transmission of the subframe is the MUST, configuring a downlink pair control message to include Necessary Assistance Information (NAI) of the far UEs which are paired with the near UE, wherein the NAI includes at least superposed constellation information indicating power allocation information of the near UE and the far UEs in spatial layers; and

transmitting the downlink pair control message to the near UE.

2. The communication method of claim 1, wherein configuring the downlink pair control message comprises:

in response to a far UE supporting a modulation scheme other than Quadrature Phase Shift Keying (QPSK), including a modulation order in the NAI to indicate the modulation scheme of the far UE.

3. The communication method of claim 1, wherein configuring the downlink pair control message comprises:

in response to a far UE using a precoder different from that of the near UE, including a Precoding Matrix Indicator (PMI) index in the NAI to indicate the precoding scheme of the far UE.

4. The communication method of claim 1, wherein configuring the downlink pair control message comprises:

in response to a far UE being paired with multiple near UEs in the subframe, configuring the downlink pair control message independently of the DCI to include the NAI of multiple far UEs paired with the multiple near UEs.

5. The communication method of claim 4, wherein transmitting the downlink pair control message to the near UE comprises:

transmitting the downlink pair control message to the near UE in a Physical Downlink Control Channel (PDCCH).

6. The communication method of claim 1, wherein configuring the downlink pair control message comprises:

in response to a far UE being paired with only one near UE in the subframe, configuring the downlink pair control message to include only NAI of the far UE paired with the near UE; and

including the downlink pair control message into the DCI as a portion of the DCI.

7. The communication method of claim 6, wherein transmitting the downlink pair control message to the near UE comprises:

transmitting the downlink pair control message to the near UE in at least one of a Physical Downlink Control Channel (PDCCH) and an enhanced Physical Downlink Control Channel (EPDCCH).

8. A communication method implemented by a near User Equipment (UE) in a communication system in which a base station pairs the near UE with one or more far UEs to perform a Multiuser Superposition Transmission (MUST), comprising:

receiving a transmission on a subband or a Physical Resource Block (PRB) from the base station;

determining whether the transmission on the subband or the PRB is a MUST by determining whether there is interference on the subband or the PRB; and

in response to determining that the transmission on the subband or the PRB is a MUST, acquiring, from a search space, a downlink pair control message including Necessary Assistance Information (NAI) of at least one far UE, the NAI including at least superposed constellation information indicating power allocation information of the near UE and the at least one far UE in each spatial layer.

9. The communication method of claim 8, further comprising:

acquiring, from Downlink Control Information (DCI), transmission indication information indicating whether a transmission in a subframe is a MUST.

10. The communication method of claim 9, further comprising:

in response to the transmission indication information indicating that the transmission of the subframe is a MUST, performing decoding attempts on the MUST only with respect to the at least one far UE, so as to decode, from the MUST, a signal for a far UE paired with the near UE in the at least one far UE; and

removing, from the MUST, the signal for the far UE paired with the near UE to obtain a signal for the near UE.

11. A base station device for pairing a near User Equipment (UE) with one or more far UEs to perform a Multiuser Superposition Transmission (MUST), comprising:

a processor and a memory including instructions executable by the processor, wherein the processor is configured to enable the base station device to implement the communication method according to any one of claims 1-7.

12. A communication device paired with at least one far User Equipment (UE) by a base station in a communication system so as to function as a near UE in a Multiuser Superposition Transmission (MUST), comprising:

a processor and a memory including instructions executable by the processor, wherein the processor is configured to enable the communication device to implement the communication method according to any one of claims 8-10.

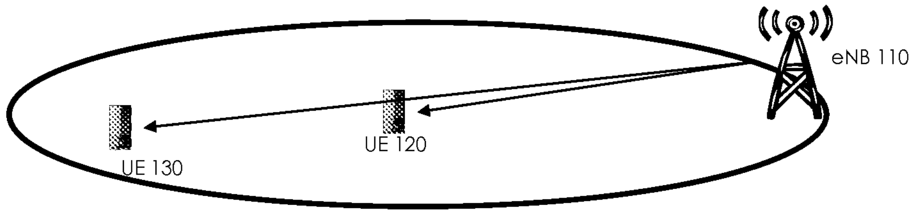
eNB 110
UE 120
UE 130

FIG. 1

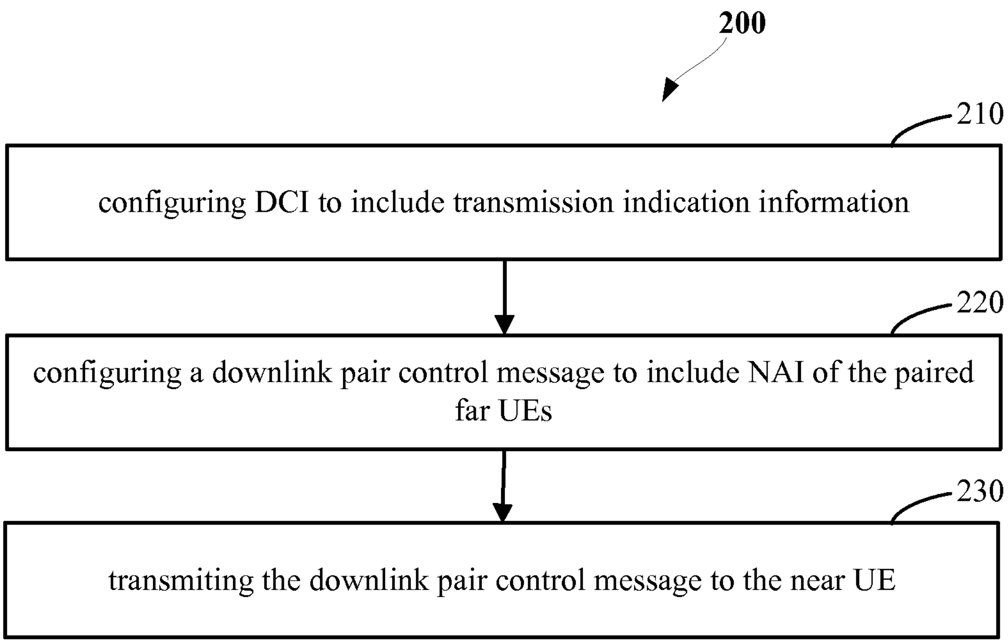
200
210
configuring DCI to include transmission indication information
220
configuring a downlink pair control message to include NAI of the paired far UEs
230
transmiting the downlink pair control message to the near UE

FIG. 2

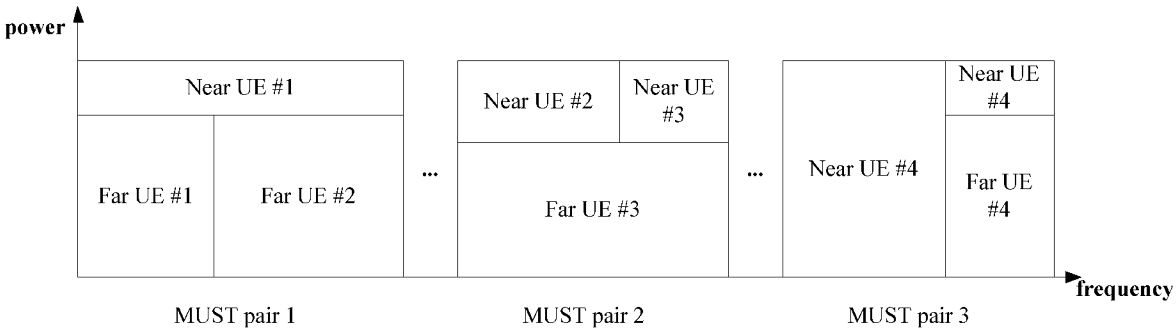
power
Near UE #1
Far UE #1
Far UE #2
...
Near UE #2
Near UE #3
Far UE #3
...
Near UE #4
Near UE #4
Far UE #4
frequency
MUST pair 1
MUST pair 2
MUST pair 3

FIG. 3

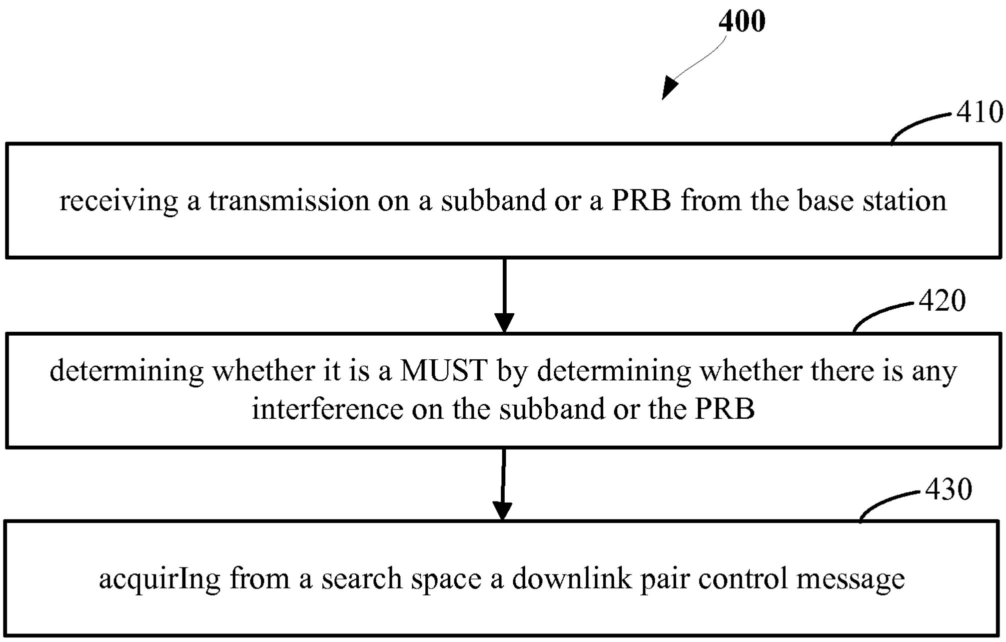
400
410
receiving a transmission on a subband or a PRB from the base station
420
determining whether it is a MUST by determining whether there is any interference on the subband or the PRB
430
acquirIng from a search space a downlink pair control message

FIG. 4

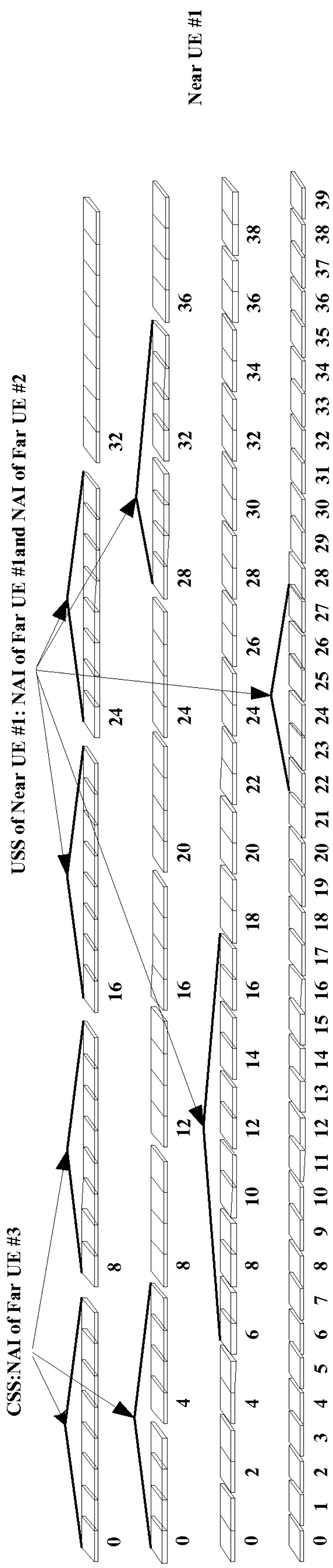
Near UE #1
USS of Near UE #1: NAI of Far UE #1and NAI of Far UE #2
CSS:NAI of Far UE #3

FIG. 5A

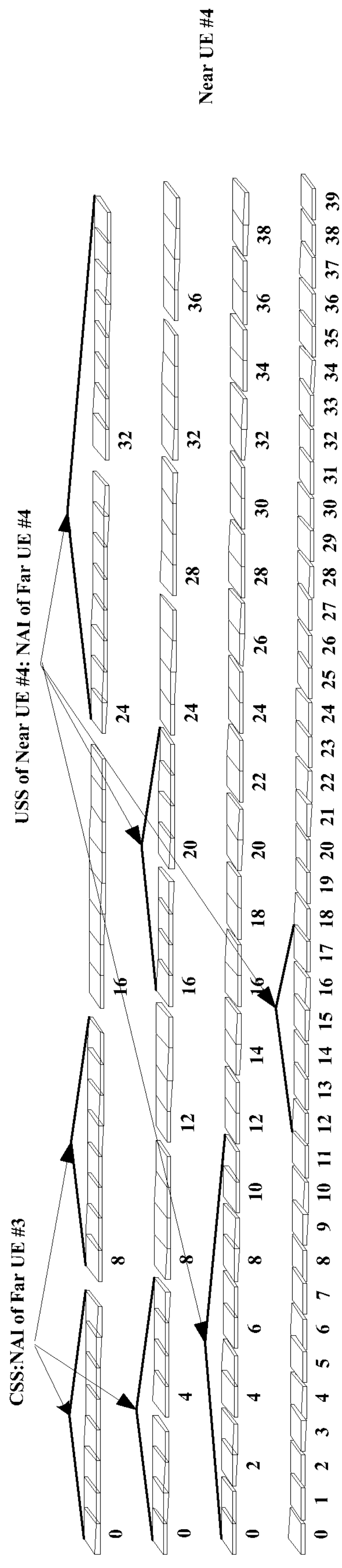
Near UE #4
USS of Near UE #4: NAI of Far UE #4
CSS:NAI of Far UE #3
0 8 16 24 32
0 4 8 12 16 20 24 28 32 36
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39

FIG. 5B

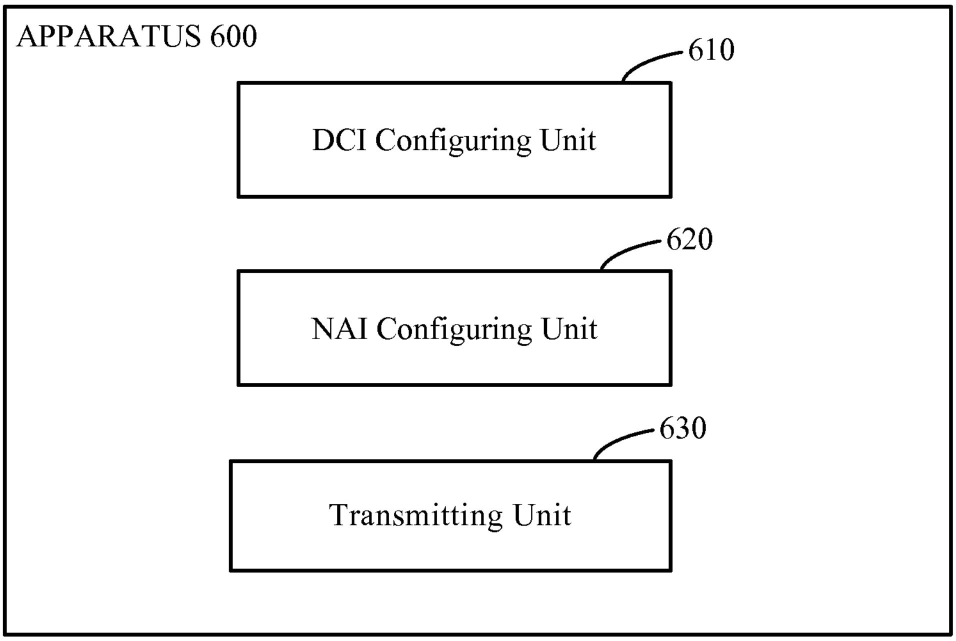
APPARATUS 600
610
DCI Configuring Unit
620
NAI Configuring Unit
630
Transmitting Unit

FIG. 6

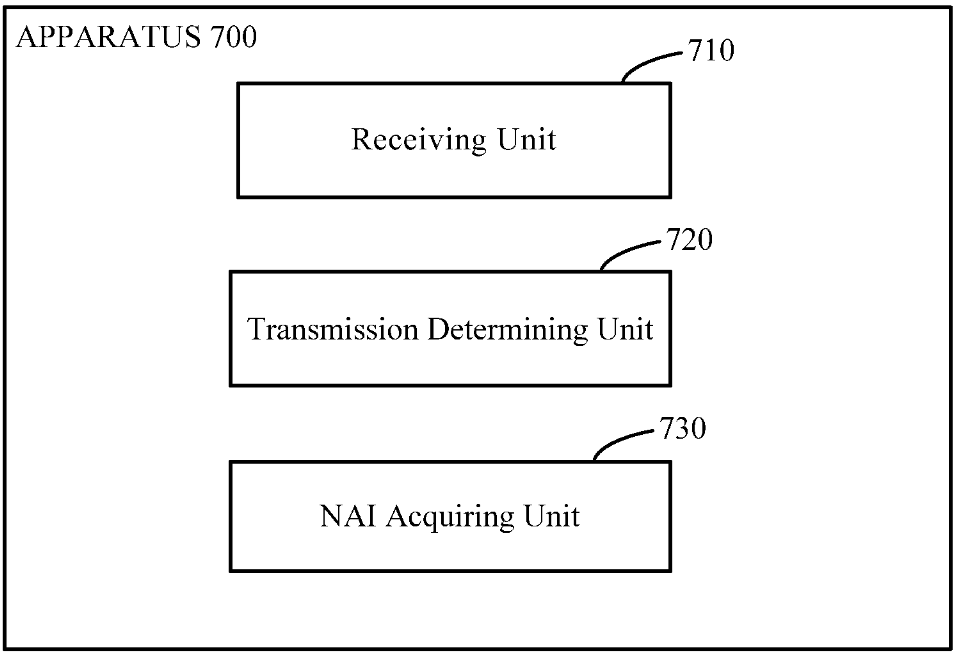
APPARATUS 700
710
Receiving Unit
720
Transmission Determining Unit
730
NAI Acquiring Unit

FIG. 7

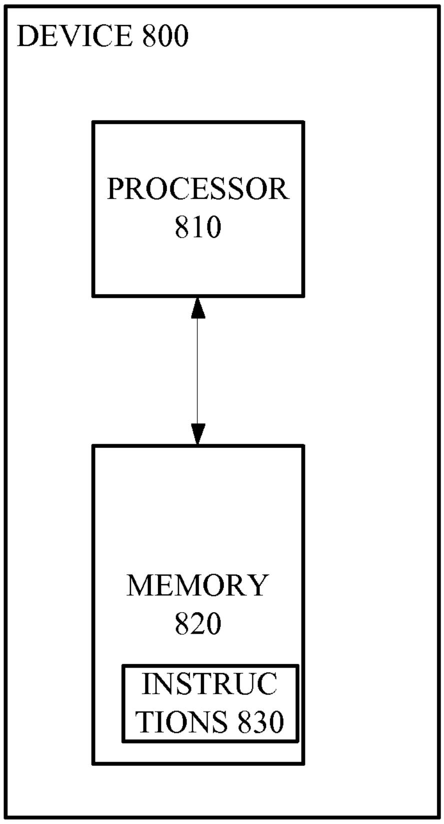

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/000719

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L5/00
ADD.

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)
H04L 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)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ASUSTEK: "Discussion on Downlink Control Signaling for MUST", 3GPP DRAFT; R1-157239, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. Anaheim, USA; 20151116 - 20151120 15 November 2015 (2015-11-15), XP051003460, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN1/Docs/ [retrieved on 2015-11-15] page First page second -----	1-12

-/--

[X] Further documents are listed in the continuation of Box C.

[ ] See patent family annex.

* Special categories of cited documents :

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

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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2017	21/08/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Fonseca dos Santos

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/000719

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	"Considerations of Efficient Control Signaling for MUST", 3GPP DRAFT; R1-162562, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. Busan, Korea; 20160411 - 20160415 1 April 2016 (2016-04-01), XP051079621, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_84b/Docs/ [retrieved on 2016-04-01] page second	1-12
X	LG ELECTRONICS: "Signaling schemes for MUST assistance information", 3GPP DRAFT; R1-162494 MUST SIGNAL, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. Busan, Korea; 20160411 - 20160415 2 April 2016 (2016-04-02), XP051080231, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_84b/Docs/ [retrieved on 2016-04-02]	1,8,11, 12
A	page third; figure 1	2-7,9,10
X	SEQUANS COMMUNICATIONS: "Sequans Communications", 3GPP DRAFT; R1-156488 EVALUATION OF SIGNALING POTENTIAL ASSISTANCE INFORMATION, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS , vol. RAN WG1, no. Anaheim, US; 20151116 - 20151120 15 November 2015 (2015-11-15), XP051039864, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN1/Docs/ [retrieved on 2015-11-15]	1,8,11, 12
A	tables 1-4	2-7,9,10