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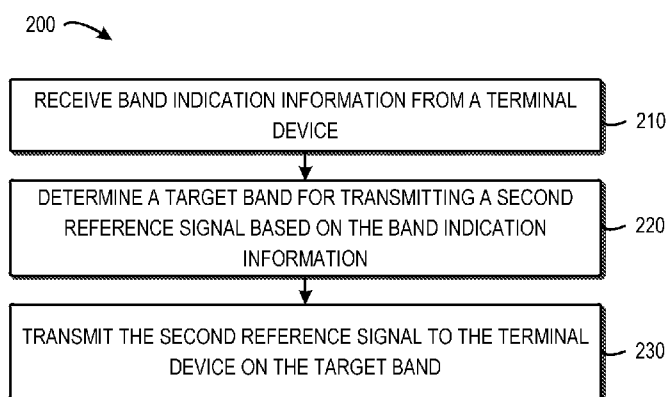


FIG. 2

(57) Abstract: Embodiments of the present disclosure relate to a communication method, a network device and a terminal device. There is provided a communication method implemented at a network device, comprising: receiving band indication information from a terminal device, the band indication information being obtained by the terminal device based on a first reference signal from the network device; determining, based on the band indication information, a target band for transmitting a second reference signal; and transmitting the second reference signal to the terminal device on the target band. There is further provided a communication method implemented at a terminal device, as well as the corresponding network device and terminal device.

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COMMUNICATION METHOD, NETWORK DEVICE AND TERMINAL DEVICE

FIELD

[0001] Embodiments of the present disclosure generally relate to communication technologies, and more particularly, to a communication method implemented at a network device and a terminal device, and the corresponding network device and terminal device.

BACKGROUND

[0002] In recent years, hybrid Channel State Information-Reference Signal (CSI-RS) transmission has been supported and enhanced in some CSI feedback frameworks such as (e)Full Dimension Multiple Input Multiple Output ((e)FD-MIMO) systems in Long Term Evolution (LTE) Release 14 and other appropriate systems. Generally these CSI frameworks build multiple levels of CSI feedback, wherein the first level of CSI feedback is obtained from a terminal device (e.g. UE) measuring a first reference signal (also referred to as “first CSI-RS”) hereafter) from a network device (e.g. base station) on full bandwidth and the second level of CSI feedback is obtained from the UE measuring a second reference signal generated according to the first level of CSI feedback. In other words, in multiple levels of CSI feedback, the first level of CSI feedback is used to generate the reference signal used for the second level of CSI feedback. Conventionally, the base station performs beamforming on the reference signal used in the second level of CSI feedback, and then transmits it to the UE.

[0003] In traditional hybrid CSI feedback frameworks, association between the first and second levels of CSI feedback is rather weak. Although the precoding matrix for beamforming the CSI-RS in the second level of CSI feedback is based on the first level of CSI feedback, UE does not need to know this, but only measures the beamformed CSI-RS and reports the CSI corresponding to the beamformed CSI-RS in the second level of CSI feedback.

[0004] It can be seen the association between the first and second levels of CSI feedback is rather weak in conventional frameworks, and thus the hybrid CSI feedback frameworks do not work well. In addition, both the first and second levels of CSI feedback occupy quite a lot of resources and overheads. These are the problems that need to be solved.

SUMMARY

[0005] Generally the embodiments of the present disclosure propose a communication method implemented at a network device and a terminal device, as well as a corresponding network device and terminal device.

5 [0006] In a first aspect, the embodiments of the present disclosure provide a communication method implemented at a network device. The method comprises: receiving band indication information from a terminal device, the band indication information being obtained by the terminal device based on a first reference signal from the network device; determining, based on the band indication information, a target band for transmitting a second reference signal;
10 and transmitting the second reference signal to the terminal device on the target band.

[0007] In this aspect, the embodiments of the present disclosure further provide a network device, comprising: a receiver configured to receive band indication information from a terminal device, the band indication information being obtained by the terminal device based on a first reference signal from the network device; a controller configured to determine,
15 based on the band indication information, a target band for transmitting a second reference signal; and a transmitter configured to transmit the second reference signal to the terminal device on the target band.

[0008] The embodiments of the present disclosure further comprise a network device. The network device comprises: a processor and a memory having instructions stored therein,
20 which, when executed by the processor, cause the network device to perform a method according to this aspect.

[0009] The embodiments of the present disclosure further comprise a device. The device comprises: means for receiving band indication information from a terminal device, the band indication information being obtained by the terminal device based on a first reference signal
25 from the network device; means for determining, based on the band indication information, a target band for transmitting a second reference signal; and means for transmitting the reference signal to the terminal device on the target band.

[0010] In a second aspect, the embodiments of the present disclosure provide a communication method implemented at a terminal device. The method comprises:
30 determining band indication information based on a first reference signal from a network device; transmitting the band indication information to the network device to enable the network device to determine, based on the band indication information, a target band for

transmitting a second reference signal; and receiving from the network device the second reference signal transmitted on the target band.

[0011] In this aspect, the embodiments of the present disclosure further provide a terminal device. The terminal device comprises: a controller configured to determine band indication information based on a first reference signal from a network device; a transmitter configured to transmit the band indication information to the network device to enable the network device to determine, based on the band indication information, a target band for transmitting a second reference signal; and a receiver configured to receive from the network device the second reference signal transmitted on the target band.

[0012] The embodiments of the present disclosure further comprise a terminal device. The terminal device comprises: a processor and a memory having instructions stored therein, which, when executed by the processor, cause the terminal device to perform a method according to this aspect.

[0013] The embodiments of the present disclosure further comprise a device. The device comprises: means for determining band indication information based on a first reference signal from a network device; means for transmitting the band indication information to the network device to enable the network device to determine, based on the band indication information, a target band for transmitting a second reference signal; and means for receiving from the network device the second reference signal transmitted on the target band.

[0014] As is to be understood from the following description, according to the embodiments of the present disclosure, the association between the first level of CSI feedback and the second level of CSI feedback is improved. In this way, the reference signal used in the second level of CSI feedback only needs to be sent on the target band instead of the full bandwidth, thereby reducing the reference signal overhead and increasing the resource utilization efficiency.

[0015] It should be appreciated contents as described in the summary are not intended to limit key or important features of the embodiments of the present disclosure or used to limit the scope of the present disclosure. Other features of the present disclosure will become easier to understand from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The above and other features, advantages and aspects of various embodiments of the

present disclosure will become apparent from the following detailed illustration, when taken in conjunction with the accompanying drawings in which the same or similar reference numerals denote the same or similar elements, wherein:

[0017] Fig. 1 shows an exemplary environment in which the embodiments of the present disclosure may be implemented;

[0018] Fig. 2 shows a flowchart of an exemplary communication method according to some embodiments in one aspect of the present disclosure;

[0019] Fig. 3 shows a flowchart of an exemplary communication method according to some embodiments in another aspect of the present disclosure;

[0020] Fig. 4 shows a block diagram of a network device according to some embodiments of the present disclosure;

[0021] Fig. 5 shows a block diagram of a terminal device according to some embodiments of the present disclosure; and

[0022] Fig. 6 shows a block diagram of a device according to some embodiments of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0023] Embodiments of the present disclosure will be described in more detail with reference to the accompanying drawings, in which some embodiments of the present disclosure have been illustrated. However, the present disclosure can be implemented in various manners, and thus should not be construed to be limited to the embodiments disclosed herein. On the contrary, those embodiments are provided for the thorough and complete understanding of the present disclosure. It should be understood that the accompanying drawings and embodiments of the present disclosure are merely for the illustration purpose, rather than limiting the protection scope of the present disclosure.

[0024] The term “network device” used here refers to a base station (BS), an access point or other appropriate network device. The base station may represent a node B (NodeB or NB), an Evolved Node B (eNodeB or eNB), or a low power node such as a Picocell, a Femto cell, a wireless access point and the like. Depending on the layout of antennas, one base station may be provided with one or more cells.

[0025] The term “terminal device” used here refers to any terminal device that can perform

wireless communication with the network device or one another. As an example, the terminal device may comprise a mobile terminal (MT), a subscriber station (SS), a portable subscriber station (PSS), a mobile station (MS) or an access terminal (AT), and on-board devices as above.

5 [0026] The terms “comprise”, “include” and their variants used here are to be read as open terms that mean “include, but is not limited to”. The term “based on” is to be read as “based at least in part on”. The term “one embodiment” is to be read as “at least one embodiment”; the term “another embodiment” is to be read as “at least one other embodiment”. Definitions of other terms will be presented in description below.

10 [0027] Fig. 1 shows an exemplary environment 100 in which the embodiments of the present disclosure may be implemented. The environment 100 may be one part of a communication network, comprising a base station 110 and a terminal device 120. In a conventional hybrid CSI feedback framework, the base station 110 transmits (101) a first reference signal (also referred to as “first CSI-RS” hereinafter) to the terminal device 120
15 which then measures the received first CSI-RS and transmits (102) the first level of CSI feedback to the base station 110 based on the measurement. According to the first level of CSI feedback, the base station 110 may determine long term characteristics of a channel between the base station 110 and the terminal device 120 and determine a precoding matrix for beamforming of a second CSI-RS. Next, the base station may obtain the second CSI-RS
20 by using the precoding matrix and transmit (103) the second CSI-RS to the terminal device 120, and notify the terminal device 120 of the transmission of the second CSI-RS by a relevant indicator in downlink control information (DCI). Afterwards, the terminal device 120 may measure the second CSI-RS and feed back a corresponding measurement result (i.e. the second level of CSI feedback).

25 [0028] However, the association between the first and second level of CSI feedback is rather weak in conventional frameworks, and hybrid CSI feedback frameworks are left to be fully utilized. In addition, both the first and second levels of CSI feedback occupy more resources and overheads.

[0029] To overcome the foregoing and potential technical problems, the embodiments of the
30 present disclosure propose a communication solution, in which the network device 110 transmits a first reference signal to the terminal device 120, and the terminal device 120 obtains band indication information based on the first reference signal from the network

device 110 and transmits the band indication information to the network device 110. Based on the band indication information received from the terminal device 120, the network device 110 determines a target band used for transmitting a second reference signal, and transmits the second reference signal to the terminal device 120 on the target band. Then, the terminal
5 device 120 measures the second reference signal received on the target band and feeds back to the network device 110.

[0030] According to the embodiments of the present disclosure, the association between the first level of CSI feedback and the second level of CSI feedback is increased. In this way, the reference signal used in the second level of CSI feedback only needs to be sent on the
10 target band rather than on the full band, thereby reducing the reference signal overhead and increasing the resource utilization efficiency.

[0031] It should be understood the number of base stations and the number of terminal devices as shown in Fig. 1 are merely for the illustration purpose and not intended to be limiting. The environment 100 may comprise any appropriate type and number of base
15 stations each of which may be provided with any appropriate number of cells, and the environment 100 may further comprise any appropriate number of terminal devices.

[0032] Communication between the base station 110 and the terminal device 120 may be implemented according to any appropriate communication protocol, including without limitation to, the first generation (1G), the second generation (2G), the third generation (3G),
20 the fourth generation (4G), the fifth generation (5G) and other cellular communication protocol, wireless local area network communication protocols such as Institute of Electrical and Electronics Engineers (IEEE) 802.11, and/or any other protocols that are currently known or to be developed later. Furthermore, the communication utilizes any appropriate wireless communication technology, including without limitation to, code division multiple access
25 (CDMA), frequency division multiple access (FDMA), time division multiple access (TDMA), frequency division duplexing (FDD), time division duplexing (TDD), multiple input multiple output (MIMO), orthogonal frequency division multiplexing (OFDM), and/or any other technology that is currently known or to be developed later. Note although the
30 embodiments of the present disclosure are described by taking a long term evolution (LTE) system as an example, this is merely exemplary and the technical solution of the present disclosure can absolutely be applied to other appropriate existing or to-be-developed systems.

[0033] With reference to Figs. 2 and 3, detailed description will be presented to the

embodiments of the present disclosure. Fig. 2 shows a flowchart of an exemplary communication method 200 according to some embodiments in one aspect of the present disclosure. It may be understood the method 200 may be executed by the network device 110 shown in Fig. 1. For the discussion purpose, the method 200 will be illustrated in conjunction with Fig. 1.

[0034] In step 210, band indication information from a terminal device is received. The band indication information is for determining a target band and is obtained by the terminal device based on a first reference signal from the network device and sent by the terminal device to the network device.

[0035] In the embodiments of the present disclosure, the target band is a frequency resource for transmitting a second CSI-RS from the network device to the terminal device. In one example, the target band may be determined by the terminal device and directly contained in the band indication information. Thereby, the network device can directly determine the target band from the band indication information. This however does not suggest any limitation. For example, in another embodiment, the band indication information may include channel quality information for determining the target band. Upon receipt of the band indication information, the network device may determine the target band according to the channel quality information.

[0036] According to the embodiments of the present disclosure, the band indication information may be carried in the first level of CSI feedback. For example, indicators for the target band may be added into the first level of CSI feedback to carry the band indication information. In some other embodiments, the channel quality information in the first level of CSI feedback may be sent as the band indication information. At this time, the network device may use the channel quality information in the first level of CSI feedback from the terminal device as the band indication information, extract the channel quality information from the first level of CSI feedback, obtain channel qualities corresponding to respective bands, and then determine the target band based on these channel qualities.

[0037] It is to be appreciated the foregoing embodiments are merely exemplary rather than limiting. In other embodiments, the band indication information may also be sent through other signaling than the first level of CSI feedback.

[0038] In step 220, a target band for transmitting a second reference signal is determined based on the band indication information. In the embodiments of the present disclosure, the

target band is one or more bands or subbands for transmitting the second reference signal. In other words, the target band may be one continuous band or a plurality of discontinuous bands or subbands.

[0039] According to the embodiments of the present disclosure, the target band may be determined based on the band indication information in various manners. In some embodiments, one or more bands indicated by the band indication information may be determined as target bands.

[0040] As an alternative, in some embodiments, channel qualities of a plurality of bands may be obtained from the band indication information, and the target band may be determined from the plurality of bands according to their channel qualities. The determination of the target band from the plurality of bands may be implemented in various manners. For example, the plurality of bands may be ranked based on their channel qualities; then, a predefined number of bands are selected from the plurality of bands as the target band according to the ranking based on the channel qualities. As an alternative solution, the plurality of bands may be ranked based on their channel qualities; then, a band with the best channel quality from the plurality of bands may be determined as the target band according to the ranking based on the channel qualities.

[0041] In step 230, the second reference signal (second CSI-RS) is sent to the terminal device on the target band. The network device may determine channel characteristics with the terminal device according to the first level of CSI feedback, and determine a precoding matrix for beamforming the second CSI-RS based on the channel characteristics. Then, the network device may obtain the second CSI-RS by using the precoding matrix and transmit the second CSI-RS to the terminal device on the target band determined in step 220. Thereby, the terminal device may measure the second CSI-RS and feed a measurement result back to the network device, thus completing the second level of CSI feedback.

[0042] According to the embodiments of the present disclosure, the network device transmitting the second CSI-RS may be either periodic or aperiodic. In one embodiment, the network device periodically transmits the second CSI-RS on the target band, and notifies, through a corresponding trigger message (e.g. corresponding indication in DCI) the terminal device to receive the second CSI-RS. Once receiving the trigger message, the terminal device receives the second CSI-RS on the target band.

[0043] With the above approach, the embodiments of the present disclosure increase the

association between the first level of CSI feedback and the second level of CSI feedback by using the target band. Therefore, the reference signal used in the second level of CSI feedback only needs to be sent on the target band instead of the full bandwidth, thus reducing the reference signal overhead and improving the resource utilization efficiency.

5 [0044] Operations performed on the network side, e.g. the network device 110 have been described above with reference to Fig. 2. According to the embodiments of the present disclosure, the terminal device 120 may perform matching operations, which will be elaborated with reference to Fig. 3 below. Fig. 3 shows a flowchart of an exemplary communication method 300 according to some embodiments in another aspect of the present disclosure. It will be appreciated the method 300 may be implemented by the terminal
10 device 120 as shown in Fig. 1. For the discussion purpose, the method 300 will be illustrated in conjunction with Fig. 1.

[0045] In step 310, band indication information is determined based on a first reference signal from a network device. According to the embodiments of the present disclosure, the
15 terminal device may measure the first reference signal on a plurality of bands, and determine channel qualities of the plurality of bands based on measurements on the plurality of bands. Then, the terminal device may determine the band indication information according to determined channel qualities.

[0046] In the embodiments of the present disclosure, the band indication information may be
20 determined in various manners. In some embodiments, channel qualities of a plurality of bands may be included in the band indication information. In this case, the mobile terminal may send to the network device the band indication information that includes channel qualities of the plurality of bands, and the network device, upon receipt of the band indication information, may determine a target band from the plurality of bands according to their
25 channel qualities. The number of target bands may be predefined. If the predefined number of target bands is 1, the network device may determine a band with the best channel quality from the plurality of bands as the target band. In other embodiments, if the predefined number of target bands is larger than 1, then a predefined number of bands may be selected from the plurality of bands as the target band according to the ranking based on the
30 channel qualities.

[0047] As an alternative solution, the band indication information may also directly include related information of the target band, such as the number of target bands, start frequency, end

frequency, length and/or other information. In this case, target band related information included in the band indication information may be determined by the terminal device. In some embodiments, the terminal device may rank a plurality of bands based on their channel qualities, and select a predefined number of bands from the plurality of bands as the target band(s) according to the ranking based on the channel qualities. Then, the terminal device may include the target band(s) in the band indication information so as to send it to the network device.

[0048] In some other embodiments, the terminal device may rank a plurality of bands by channel quality, and determine a band with the best channel quality from the plurality of bands as the target band according to the ranking based on the channel qualities. Then, the terminal device may include the target band into the band indication information so as to send it to the network device.

[0049] In step 320, the band indication information is sent to the network device so that the network device determines, based on the band indication information, a target band for transmitting a second reference signal. Determination of the target band by the network device may at least be implemented through step 220 in the embodiments as shown in Fig. 2, which is not detailed here.

[0050] In step 330, the second reference signal (a second CSI-RS) sent on the target band is received from the network device. The second CSI-RS may be sent to the terminal device on the target band after being beamformed by the network device. In some embodiments, where the terminal device has determined the target band in step 310, the terminal device may directly receive the second CSI-RS on the target band in step 330. Alternatively, in some other embodiments, where in step 310 the terminal device does not determine the target band but simply sends channel qualities associated with a plurality of bands to the network device, in step 330 the terminal device may determine the target band according to the ranking based on the channel qualities and receive the second CSI-RS on the target band. Subsequently, the terminal device may measure the second CSI-RS and feed a corresponding measurement result back to the network device, thereby completing the second level of CSI feedback.

[0051] Further embodiments of the present disclosure are discussed below by taking aperiodic CSI feedback mode 2-1, aperiodic CSI feedback mode 3-2 and periodic CSI feedback mode 2-0, which are defined in TS 36.213, as respective examples. In these embodiments, assuming that antennas of the base station have 16 transmit ports, the base

station does not precode the first CSI-RS but precodes the second CSI-RS so as to perform beamforming.

[0052] In some embodiments, the first level of CSI feedback may use the aperiodic CSI feedback mode 2-0 (e.g. as defined in 3GPP TS 36.213 version 12.3.0 (2014-10) Release 12, page 70). In this mode, the terminal device (e.g. UE) may measure the first CSI-RS from the base station, determine M bands (each of size k) as target bands based on the measurement result, and then send an indication of these target bands to the base station. In this embodiment, UE may not send the CQI feedback to the base station. And the base station may use the M bands for transmitting the second CSI-RS. While transmitting the second CSI-RS, the base station may use DCI to trigger aperiodic transmission of the second CSI-RS. After receiving the triggering message, the UE may measure the second CSI-RS on the M bands, thereby generating the second level of CSI feedback.

[0053] Alternatively, in some embodiments, the first level of CSI feedback may use the aperiodic CSI feedback mode 3-2 (e.g. as defined in 3GPP TS 36.213 version 12.3.0 (2014-10) Release 12, page 69). UE reports channel quality (e.g. channel quality indicator (CQI)) for each band from a plurality of bands to the base station in the first level of CSI feedback. According to these CQIs, the base station may determine a band with the best channel quality as the target band used for transmitting the second CSI-RS. When transmitting the second CSI-RS, the base station may use DCI to trigger aperiodic transmission of the second CSI-RS. After receiving the triggering message, UE may measure the second CSI-RS on the band with the best channel quality, thereby generating the second level CSI feedback.

[0054] Those skilled in the art should understand this is merely exemplary rather than suggesting any limitation. In some other embodiments, the base station may rank these CQIs reported by UE, and thus determine a plurality of bands with better channel qualities as target bands.

[0055] Alternatively, in some embodiments, the first level CSI feedback may use the periodic CSI feedback mode 2-0 (e.g. as defined in 3GPP TS 36.213 version 12.3.0 (2014-10) Release 12, page 82). In this mode, UE may report to the base station j target bands, which may be either continuous or discontinuous. For example, all bands may be divided into j groups of bands, each group of bands consisting of N_j subbands, and then the best subband may be selected from each group of bands as a target band. UE may report information of these target bands to the base station via periodic reports, and thus the base station may

determine target bands from the most recently received report and transmit the second CSI-RS to UE on the j target bands.

[0056] It is to be understood that the above CSI feedback modes are merely part of application scenarios of the embodiments of the present disclosure, which are only illustrative instead of suggesting any limitation. Those skilled in the art would appreciate that the embodiments of the present disclosure may be applied in various CSI feedback modes, including but not limited to, other CSI feedback modes specified in 3GPP TS 36.213 which is incorporated herein by reference.

[0057] Fig. 4 shows a block diagram of a network device 400 according to some embodiments of the present disclosure. It may be understood the network device 400 may be implemented as the base station 110 shown in Fig. 1.

[0058] As shown in Fig. 4, the network device 400 may comprise: a receiver 410 configured to receive from a terminal device band indication information, which is obtained by the terminal device based on a first reference signal from the network device; a controller 420 configured to determine, based on the band indication information, a target band for transmitting a second reference signal; and a transmitter 430 configured to transmit the second reference signal to the terminal device on the target band.

[0059] In one embodiment, the controller 420 may be further configured to determine one or more bands indicated by the band indication information as target bands.

[0060] In one embodiment, the controller 420 may be further configured to: obtain channel qualities of a plurality of bands from the band indication information; and determine the target band from the plurality of bands according to the channel qualities of the plurality of bands.

[0061] In one embodiment, the controller 420 may be further configured to: rank the plurality of bands based on the channel qualities of the plurality of bands; and select a predefined number of bands from the plurality of bands as the target bands according to the ranking based on the channel qualities.

[0062] In one embodiment, the controller 420 may be further configured to: rank the plurality of bands based on the channel qualities of the plurality of bands; and determine a band with the best channel quality from the plurality of bands as the target band according to the ranking based on the channel qualities.

[0063] The embodiments of the present disclosure further provide a device for feedback at

the network device side, the device comprising: means for receiving band indication information from a terminal device, the band indication information being obtained by the terminal device based on a first reference signal from the network device; means for determining, based on the band indication information, a target band for transmitting a second reference signal; and means for transmitting the second reference signal to the terminal device on the target band.

[0064] In one embodiment, the means for determining, based on the band indication information, a target band for transmitting a second reference signal may comprise: means for determining one or more bands indicated by the band indication information as target bands.

[0065] In one embodiment, the means for determining, based on the band indication information, a target band for transmitting a second reference signal may comprise: means for obtaining channel qualities of a plurality of bands from the band indication information; and means for determining the target band from the plurality of bands according to the channel qualities of the plurality of bands.

[0066] In one embodiment, the means for determining the target band from the plurality of bands according to the channel qualities of the plurality of bands may comprise: means for ranking the plurality of bands based on the channel qualities of the plurality of bands; and means for determining a predefined number of bands from the plurality of bands as the target bands according to the ranking based on the channel qualities.

[0067] In one embodiment, the means for determining the target band from the plurality of bands according to the channel qualities of the plurality of bands may comprise: means for ranking the plurality of bands based on the channel qualities of the plurality of bands; and means for determining a band with the best channel quality from the plurality of bands as the target band according to the ranking based on the channel qualities.

[0068] Fig. 5 shows a block diagram of a terminal device 500 according to some embodiments of the present disclosure. It may be understood the terminal device 500 may be implemented as the UE 120 shown in Fig. 1.

[0069] As shown in Fig. 5, the terminal device 500 may comprise: a controller 510 configured to determine band indication information based on a first reference signal from a network device; a transmitter 520 configured to transmit the band indication information to the network device to enable the network device to determine, based on the band indication information, a target band for transmitting a second reference signal; and a receiver 530

configured to receive from the network device the second reference signal transmitted on the target band.

[0070] In one embodiment, the controller 510 may be further configured to: measure the first reference signal on a plurality of bands; determine channel qualities of the plurality of bands based on the measurement; and determine the band indication information according to the channel qualities.

[0071] In one embodiment, the controller 510 may be further configured to: include the channel qualities of the plurality of bands into the band indication information.

[0072] In one embodiment, the controller 510 may be further configured to: rank the plurality of bands based on the channel qualities of the plurality of bands; select a predefined number of bands from the plurality of bands as target bands according to the ranking based on the channel qualities; and include the target bands into the band indication information.

[0073] In one embodiment, the controller 510 may be further configured to: rank the plurality of bands based on the channel qualities of the plurality of bands; determine a band with the best channel quality from the plurality of bands as the target band according to the ranking based on the channel qualities; and include the target band into the band indication information.

[0074] The embodiments of the present disclosure further provide a device for feedback at the terminal device side, the device comprising: means for determining band indication information based on a first reference signal from a network device; means for transmitting the band indication information to the network device to enable the network device to determine, based on the band indication information, a target band for transmitting a second reference signal; and means for receiving from the network device the second reference signal transmitted on the target band.

[0075] In one embodiment, the means for determining band indication information based on a first reference signal from a network device may comprise: means for measuring the first reference signal on a plurality of bands; means for determining channel qualities of the plurality of bands based on the measurement; and means for determining the band indication information according to the channel qualities.

[0076] In one embodiment, the means for determining the band indication information according to the channel qualities may comprise: means for including the channel qualities of the plurality of bands into the band indication information.

[0077] In one embodiment, the means for determining the band indication information according to the channel qualities may comprise: means for ranking the plurality of bands based on the channel qualities of the plurality of bands; means for selecting a predefined number of bands from the plurality of bands as target bands according to the ranking based on the channel qualities; and means for including the target bands into the band indication information.

[0078] In one embodiment, the means for determining the band indication information according to the channel qualities may comprise: means for ranking the plurality of bands based on the channel qualities of the plurality of bands; means for determining a band with the best channel quality from the plurality of bands as the target band according to the ranking based on the channel qualities; and means for including the target band into the band indication information.

[0079] It is to be understood that each unit of the network device 400 and the terminal device 500 corresponds to each step of the methods 200 and 300 described with reference to Figs. 2 and 3. Therefore, operations and features described above with reference to Figs. 2 and 3 are also applicable to the network device 400 and the terminal device 500 as well as units included therein and have the same effect, details of which are omitted here.

[0080] The units included in the network device 400 and the terminal device 500 may be implemented in various manners, including software, hardware, firmware, or any combination thereof. In one embodiment, one or more units may be implemented using software and/or firmware, for example, machine-executable instructions stored on the storage medium. In addition to or instead of machine-executable instructions, parts or all of the units in the network device 400 and the terminal device 500 may be implemented, at least in part, by one or more hardware logic components. For example, and without limitation, illustrative types of hardware logic components that can be used include Field-programmable Gate Arrays (FPGAs), Application-specific Integrated Circuits (ASICs), Application-specific Standard Products (ASSPs), System-on-a-chip systems (SOCs), Complex Programmable Logic Devices (CPLDs), etc.

[0081] The units shown in Figs. 4 and 5 may be implemented, partially or entirely, as hardware modules, software modules, firmware modules or any combination thereof. In particular, in some embodiments, the flows, methods or processes described above may be implemented by hardware in a base station or terminal device. For example, the base station

or terminal device may implement the methods 200 and 300 by means of its transmitter, receiver, transceiver and/or processor.

[0082] Fig. 6 shows a block diagram of a device 600 which is applicable to implement the embodiments of the present disclosure. The device 600 may be used for implementing a network device like the base station 110 shown in Fig. 1, or a terminal device like the terminal device 120 shown in Fig. 1.

[0083] As shown, the device 600 comprises a processor 610 and a memory 620 coupled to the processor 610. In the memory 620 there are stored instructions 630 which can be executed by the processor 610. The memory 620 may be of any appropriate type that is applicable to a local technical environment, and may be implemented using any appropriate data storage techniques, including without limitation to, semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems. Though only one memory unit is shown in Fig. 6, there may be a plurality of physically different memory units in the device 600.

[0084] The processor 610 may be of any appropriate type that is applicable to a local technical environment, and may include without limitation to, a general-purpose computer, a special-purpose computer, a microprocessor, a digital signal processor (DSP), as well as one or more processors in a processor based multi-core processor architecture. The device 600 may also comprise multiple processors 610, which are configured to execute the methods 200 and 300 as shown in Figs. 2 and 3.

[0085] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. While various aspects of embodiments of the present disclosure are illustrated and described as block diagrams, flowcharts, or using some other pictorial representation, it will be appreciated that the blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[0086] For example, embodiments of the present disclosure can be described in the general context of machine-executable instructions, such as those included in program modules, being

executed in a device on a target real or virtual processor. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data types. The functionality of the program modules may be combined or split between program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or distributed device. In a distributed device, program modules may be located in both local and remote storage media.

[0087] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. These program codes may be provided to a processor or controller of a general purpose computer, special purpose computer, or other programmable data processing apparatus, such that the program codes, when executed by the processor or controller, cause the functions/operations specified in the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on the machine and partly on a remote machine or entirely on the remote machine or server.

[0088] In the context of this disclosure, a machine readable medium may be any tangible medium that may contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device. The machine readable medium may be a machine readable signal medium or a machine readable storage medium. A machine readable medium may include but is not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the machine readable storage medium would include 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), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[0089] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, while several specific implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the present disclosure, but rather

as descriptions of features that may be specific to particular embodiments. Certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment may also be implemented in multiple embodiments separately or in any suitable sub-combination.

[0090] Although the subject matter has been described in a language that is specific to structural features and/or method actions, it is to be understood the subject matter defined in the appended claims is not limited to the specific features or actions described above. On the contrary, the above-described specific features and actions are disclosed as an example of implementing the claims.

I/We Claim:

1. A communication method implemented at a network device, comprising:
receiving band indication information from a terminal device, the band indication
information being obtained by the terminal device based on a first reference signal from the
5 network device;

determining, based on the band indication information, a target band for transmitting a
second reference signal; and

transmitting the second reference signal to the terminal device on the target band.

10 2. The method according to Claim 1, wherein determining the target band for
transmitting the second reference signal based on the band indication information comprises:

determining one or more bands indicated by the band indication information as target
bands.

15 3. The method according to Claim 1, wherein determining the target band for
transmitting the second reference signal based on the band indication information comprises:

obtaining channel qualities of a plurality of bands from the band indication
information; and

determining the target band from the plurality of bands according to the channel
20 qualities of the plurality of bands.

4. The method according to Claim 3, wherein determining the target band from the
plurality of bands according to the channel qualities of the plurality of bands comprises:

ranking the plurality of bands based on the channel qualities of the plurality of bands;

25 and

selecting a predefined number of bands from the plurality of bands as target bands
according to the ranking based on the channel qualities.

5. The method according to Claim 3, wherein determining the target band according to
30 the channel qualities comprises:

ranking the plurality of bands based on the channel qualities of the plurality of bands;

and

determining a band with the best channel quality from the plurality of bands as the

target band according to the ranking based on the channel qualities.

6. A communication method implemented at a terminal device, the method comprising:

5 determining band indication information based on a first reference signal from a network device;

 transmitting the band indication information to the network device to enable the network device to determine, based on the band indication information, a target band for transmitting a second reference signal; and

10 receiving from the network device the second reference signal transmitted on the target band.

7. The method according to Claim 6, wherein determining the band indication information based on the first reference signal from the network device comprises:

15 measuring the first reference signal on a plurality of bands;

 determining channel qualities of the plurality of bands based on the measurement; and
 determining the band indication information according to the channel qualities.

8. The method according to Claim 7, wherein determining the band indication
20 information according to the channel qualities comprises:

 including the channel qualities of the plurality of bands into the band indication information.

9. The method according to Claim 7, wherein determining the band indication
25 information according to the channel qualities comprises:

 ranking the plurality of bands based on the channel qualities of the plurality of bands;
 selecting a predefined number of bands from the plurality of bands as target bands according to the ranking based on the channel qualities; and
 including the target bands into the band indication information.

30

10. The method according to Claim 7, wherein determining the band indication information according to the channel qualities comprises:

 ranking the plurality of bands based on the channel qualities of the plurality of bands;
 determining a band with the best channel quality from the plurality of bands as the

target band according to the ranking based on the channel qualities; and
including the target band into the band indication information.

11. A network device, comprising:

5 a receiver configured to receive band indication information from a terminal device,
the band indication information being obtained by the terminal device based on a first
reference signal from the network device;

a controller configured to determine, based on the band indication information, a target
band for transmitting a second reference signal; and

10 a transmitter configured to transmit the second reference signal to the terminal device
on the target band.

12. The network device according to Claim 11, wherein the controller is further
configured to:

15 determine one or more bands indicated by the band indication information as target
bands.

13. The network device according to Claim 11, wherein the controller is further
configured to:

20 obtain channel qualities of a plurality of bands from the band indication information;
and

determine the target band from the plurality of bands according to the channel qualities
of the plurality of bands.

25 14. The network device according to Claim 13, wherein the controller is further
configured to:

rank the plurality of bands based on the channel qualities of the plurality of bands; and
select a predefined number of bands from the plurality of bands as target bands
according to the ranking based on the channel qualities.

30 15. The network device according to Claim 13, wherein the controller is further
configured to:

rank the plurality of bands based on the channel qualities of the plurality of bands; and
determine a band with the best channel quality from the plurality of bands as the target

band according to the ranking based on the channel qualities.

16. A terminal device, comprising:

- 5 a controller configured to determine band indication information based on a first reference signal from a network device;
- a transmitter configured to transmit the band indication information to the network device to enable the network device to determine, based on the band indication information, a target band for transmitting a second reference signal; and
- 10 a receiver configured to receive from the network device the second reference signal transmitted on the target band.

17. The terminal device according to Claim 16, wherein the controller is further configured to:

- 15 measure the first reference signal on a plurality of bands;
- determine channel qualities of the plurality of bands based on the measurement; and
- determine the band indication information according to the channel qualities.

18. The terminal device according to Claim 17, wherein the controller is further configured to:

- 20 include the channel qualities of the plurality of bands into the band indication information.

19. The terminal device according to Claim 17, wherein the controller is further configured to:

- 25 rank the plurality of bands based on the channel qualities of the plurality of bands;
- select a predefined number of bands from the plurality of bands as target bands according to the ranking based on the channel qualities; and
- include the target bands into the band indication information.

30 20. The terminal device according to Claim 17, wherein the controller is further configured to:

- rank the plurality of bands based on the channel qualities of the plurality of bands;
- determine a band with the best channel quality from the plurality of bands as the target band according to the ranking based on the channel qualities; and

include the target band into the band indication information.

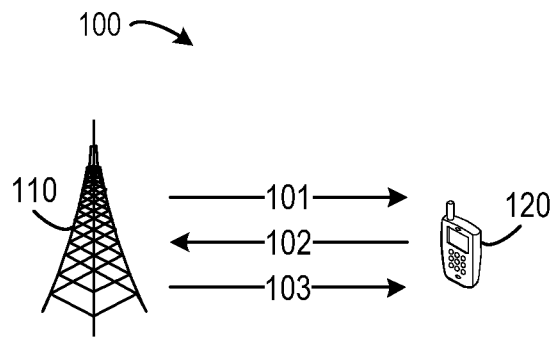


FIG. 1

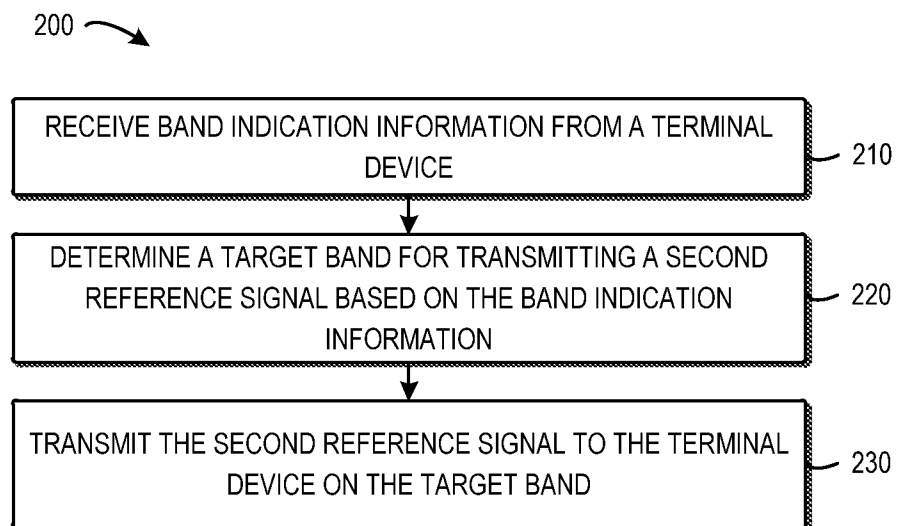


FIG. 2

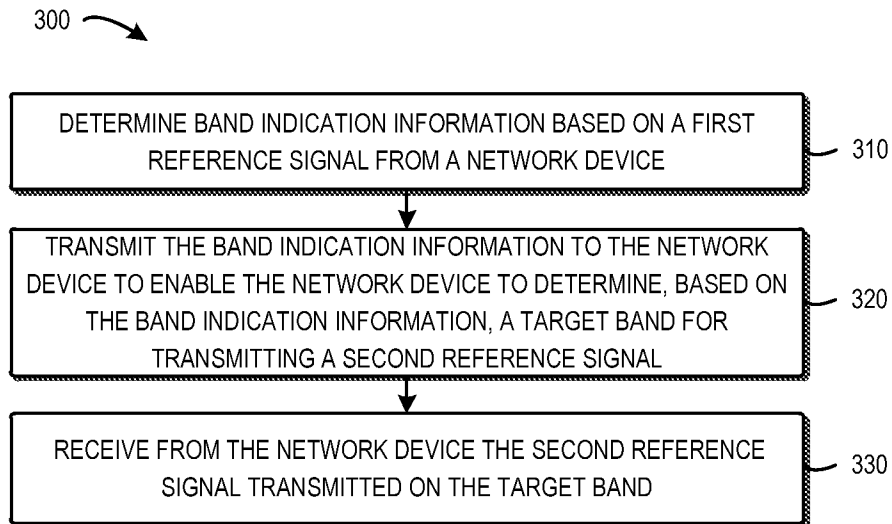


FIG. 3

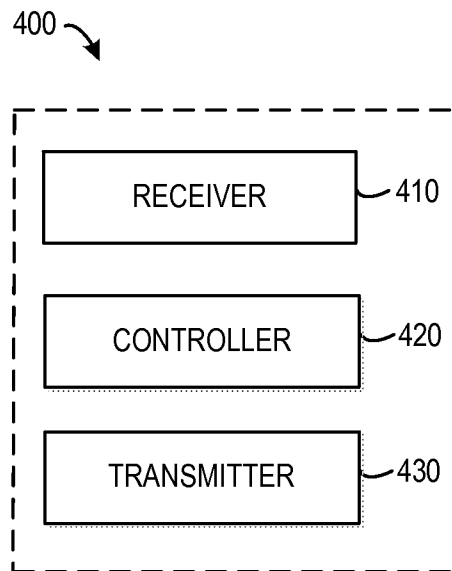


FIG. 4

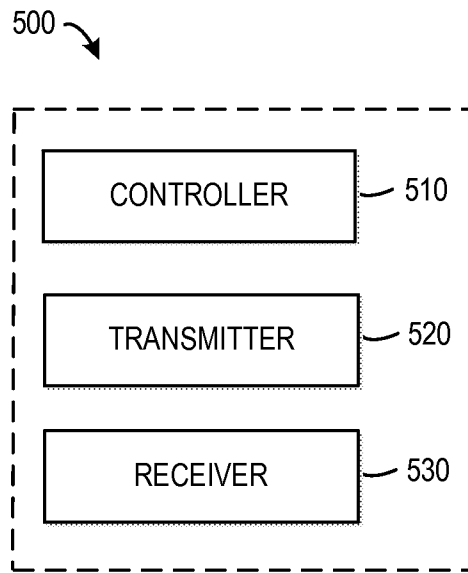


FIG. 5

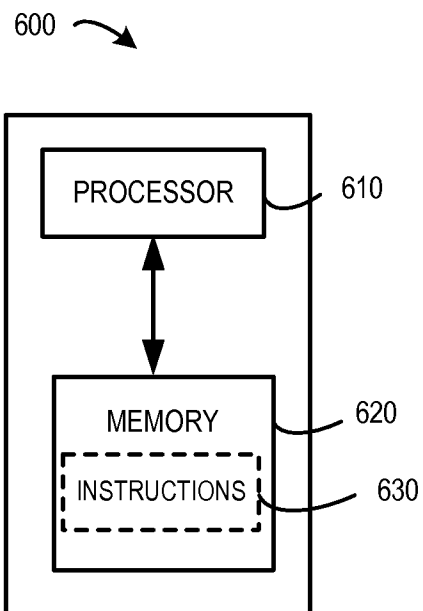


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/000721

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04B7/06 H04L25/02 H04L5/00 H04L1/00
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)

H04B H04L

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

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

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/341097 A1 (YANG WEIDONG [US] ET AL) 26 November 2015 (2015-11-26) paragraphs [0045], [0054] - [0057], [0086] - [0087]; figure 5 -----	1-20
X	ALESSANDRO CHIUMENTO ET AL: "Adaptive CSI and feedback estimation in LTE and beyond: a Gaussian process regression approach", EURASIP JOURNAL ON WIRELESS COMMUNICATIONS AND NETWORKING, vol. 2015, no. 1, 12 June 2015 (2015-06-12), XP055394485, DOI: 10.1186/s13638-015-0388-0 section 2.2.1 -----	1-3,6-8, 11-13, 16-18
X,P	US 2016/330004 A1 (KIM CHEULSOON [KR] ET AL) 10 November 2016 (2016-11-10) paragraphs [0118] - [0119]; figure 9 ----- -/--	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

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"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

1 August 2017

Date of mailing of the international search report

08/08/2017

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/000721

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Etsi: "3GPP TS 36.213 version 12.3.0 Release 12", 1 October 2014 (2014-10-01), pages 1-213, XP055394293, Retrieved from the Internet: URL:http://www.etsi.org/deliver/etsi_ts/136200_136299/136213/12.03.00_60/ts_136213v120300p.pdf [retrieved on 2017-07-27] pages 68-70 -----	1-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2017/000721

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015341097 A1	26-11-2015	US 2015341097 A1	26-11-2015
		WO 2014062195 A1	24-04-2014

US 2016330004 A1	10-11-2016	NONE	
