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CODEBOOK-BASED PRECODING DETERMINATION METHODS AND APPARATUSES, AND DEVICE AND STORAGE MEDIUM

Abstract

Codebook-based precoding determination methods and apparatuses, and a device and a storage medium, which relate to the field of mobile communications. A codebook-based precoding determination method comprises: according to determined channel information corresponding to each channel status information (CSI)-RS resource, and codebook parameter information, a terminal sending CSI to a network device, wherein the CSI comprises indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, and the CSI is used for determining precoding for the terminal on the basis vector of a codebook structure corresponding to the codebook parameter information.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application is a U.S. national phase of International Application No. PCT/CN2022/089672, filed Apr. 27, 2022, the entire content of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The disclosure relates to a field of mobile communication, in particular to a method and an apparatus for determining precoding based on a codebook, a device, and a storage medium.

BACKGROUND

[0003] In a mobile communication system, a network device and a terminal may communicate with each other. The terminal may feed channel status information (CSI) back to the network device, and the network device determines precoding of the terminal according to the received CSI and a corresponding codebook structure. However, when a plurality of network devices such as a plurality of transmission reception points (TRPs) jointly serve one terminal, it is necessary to determine precoding used by the plurality of TRPs to transmit data to the terminal. It becomes an urgent problem that needs to be solved how the network device determines precoding for collaboration of the plurality of TRPs based on a codebook.

SUMMARY

[0004] According to a first aspect of the disclosure, a method for determining precoding based on a codebook is provided, performed by a terminal. The method includes: determining, based on at least one channel status information reference signal (CSI-RS) resource, channel information corresponding to each CSI-RS resource; and sending, according to the channel information determined corresponding to each CSI-RS resource and codebook parameter information, CSI to a network device, in which the CSI includes indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or the CSI includes indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, the port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource; and the CSI is configured to determine precoding of the terminal based on a codebook structure corresponding to the codebook parameter information.

[0005] According to a second aspect of the disclosure, a method for determining precoding based on a codebook is provided, performed by a network device. The method includes: receiving CSI from a terminal, in which the CSI includes indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or the CSI includes indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, the port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource, and the CSI is determined by a terminal based on channel information corresponding to each CSI-RS resource in at least one CSI-RS resource and codebook parameter information; determining, according to the CSI and a codebook structure corresponding to the codebook parameter information, precoding of the terminal.

[0006] According to a third aspect of the disclosure, a terminal is provided, including a processor, a transceiver connected to the processor and a memory for storing instructions executable by the processor. The processor is configured to load and execute executable instructions, to implement the method for determining precoding based on a codebook according to the above-described first aspect.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] A brief description of the accompanying drawings is given below. The drawings in the following description are only example embodiments of the disclosure.

[0008] FIG. **1** illustrates a block diagram of a communication system according to an embodiment of the disclosure.

[0009] FIG. **2** illustrates a block diagram of another communication system according to an embodiment of the disclosure.

[0010] FIG. **3** illustrates a flowchart of a method for determining precoding based on a codebook according to an embodiment of the disclosure.

[0011] FIG. **4** illustrates a flowchart of a method for determining precoding based on a codebook according to an embodiment of the disclosure.

[0012] FIG. **5** illustrates a flowchart of a method for determining precoding based on a codebook according to an embodiment of the disclosure.

[0013] FIG. **6** illustrates a flowchart of a method for determining precoding based on a codebook according

to an embodiment of the disclosure.

[0014] FIG. **7** illustrates a flowchart of a method for determining precoding based on a codebook according to an embodiment of the disclosure.

[0015] FIG. **8** illustrates a block diagram of an apparatus for determining precoding based on a codebook according to an embodiment of the disclosure.

[0016] FIG. **9** illustrates a block diagram of another apparatus for determining precoding based on a codebook according to an embodiment of the disclosure.

[0017] FIG. **10** illustrates a block diagram of an apparatus for determining precoding based on a codebook according to an embodiment of the disclosure.

[0018] FIG. **11** illustrates a block diagram of another apparatus for determining precoding based on a codebook according to an embodiment of the disclosure.

[0019] FIG. **12** illustrates a structure diagram of a communication device according to an embodiment of the disclosure.

DETAILED DESCRIPTION

[0020] In order to make the objectives, technical solutions and advantages of the disclosure more clear, the implementations of the disclosure may be further described in detail below with reference to the accompanying drawings.

[0021] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings. When the following description refers to the drawings, unless otherwise indicated, the same numbers in different drawings represent the same or similar elements. The implementations described in the following embodiments do not represent all implementations consistent with the disclosure. Rather, they are merely examples of apparatuses and methods consistent with some aspects of the disclosure as detailed in the appended claims.

[0022] The terms used in the embodiments of the disclosure are only for the purpose of describing specific embodiments, and are not intended to limit the embodiments of the disclosure. The singular forms of "a/an" and "the/said" used in the disclosure and appended claims are also intended to include plural forms, unless the context clearly indicates other meanings. It should also be understood that the term "and/or" as used herein refers to and includes any or all possible combinations of one or more associated listed items.

[0023] It should be understood that although the terms "first", "second", and "third" may be used in the embodiments of the disclosure to describe various information, the information should not be limited to these terms. These terms are only used to distinguish the same type of information from each other. For example, without departing from the scope of the disclosure, first information may also be referred to as second information, and similarly, second information may also be referred to as first information. Depending on the context, the term "if" as used herein can be interpreted as "when", "while" or "in response to determining".

[0024] It should be noted that the information (including but not limited to user device information, user personal information, etc.), data (including but not limited to data used for analysis, stored data, displayed data, etc.) and signals involved in the disclosure are all authorized by users or fully authorized by all parties, and the collection, use and processing of relevant data must comply with relevant laws, regulations and standards of relevant countries and regions.

[0025] In the solutions according to the embodiments of the disclosure, after the terminal measures the CSI-RS corresponding to each CSI-RS resource, the indication information reported to the network device indicates the codebook parameter information corresponding to the plurality of CSI-RS resources and the codebook parameter information corresponding to each CSI-RS resource, or indicates the codebook parameter information corresponding to the plurality of port groups in one CSI-RS resource and the codebook parameter information corresponding to each port group. The plurality of CSI-RS resources or the plurality of port groups may be understood as corresponding to the plurality of TRPs. That is, the disclosure determines parameters shared by the plurality of TRPs and individual parameters for each TRP, so the network device may determine the precoding of the terminal according to the parameters reported by the terminal. The disclosure jointly utilizes channel information of the plurality of TRPs and proposes a method for reporting CSI, which not only reduces the feedback overhead, but also improves the determined precoding accuracy of the terminal.

[0026] The following is an explanation of application scenarios of the disclosure.

[0027] FIG. **1** illustrates a block diagram of a communication system according to an embodiment of the disclosure. The communication system may include a terminal **10** and a network device **20**.

[0028] There are usually a plurality of terminals **10**, and one or more terminals **10** may be distributed in a cell managed by each network device **20**. The terminal **10** may include various handheld devices with wireless communication functions, vehicle-mounted devices, wearable devices, computing devices or other processing devices connected to a wireless modem, as well as various forms of user equipment (UE), mobile stations (MS), etc. For the convenience of description, the above-mentioned devices in the embodiments of the disclosure are collectively referred to as terminals.

[0029] The network device **20** is a device deployed in an access network to provide a wireless communication function for the terminal **10**. For the convenience of description, the above- mentioned devices in the embodiments of the disclosure that provide the wireless communication function for the terminal **10** are collectively referred to as network devices. A connection may be established between the network device **20** and the terminal **10** via a radio interface, so that communication is performed via the connection, including the interactions of signaling and data. There may be a plurality of network devices **20**, and two adjacent network devices **20** may communicate with each other via wired or wireless means. The terminal **10** may switch between different network devices **20**, that is, establish connections with different network devices **20**.

[0030] The network device **20** may include various forms of macro base stations, micro base stations, relay stations, access points, transmission reception points (TRPs), etc. In systems using different radio access technologies, the names of devices with network device functions may be different. For example, in 5G new radio (NR) systems, they are called gNodeB or gNB. The name "network device" may varied with the evolution of the communication technology.

[0031] In some embodiments, a network device may include one or more TRPs, or a network device may include one or more antenna panels.

[0032] If the network device includes a plurality of TRPs, the network device may communicate with the terminal through each TRP in the plurality of TRPs. That is, the network device establishes a transmission channel with each TRP in the plurality of TRPs, and then communicates with the terminal based on the established transmission channel.

[0033] If the network device includes a plurality of antenna panels, the network device may communicate with the terminal through each of the plurality of antenna panels. That is, the network device establishes a transmission channel with each of the plurality of antenna panels, and then communicates with the terminal based on the established transmission channel.

[0034] For example, as illustrated in FIG. **2**, a network device is configured with four TRPs, namely TRP**1**, TRP**2**, TRP**3** and TRP**4**. The network device establishes communication connections with the terminal through the four TRPs, and then the network device can communicate with the terminal through the four TRPs.

[0035] In some embodiments, the plurality of TRPs included in the network device can collaborate with each other using coherent joint transmission (CJT) technology to complete data transmission between the network device and the terminal. The CJT technology means that each data stream will be mapped to a TRP participating in the collaboration through a weighted vector.

[0036] FIG. **3** illustrates a flowchart of a method for determining precoding based on a codebook according to an embodiment of the disclosure, which can be exemplarily applied to a terminal and a network device as illustrated in FIG. **1**, and the method includes at least part of the following contents.

[0037] At step **301**, the terminal determines channel information corresponding to each CSI- RS resource based on at least one CSI-RS resource.

[0038] The CSI-RS resources are used to transmit a CSI-RS. In addition, the CSI-RS resource is configured by the network device, and then the network device can send the CSI-RS to the terminal through the configured CSI-RS resources.

[0039] In embodiments of the disclosure, the terminal measures the CSI-RS based on at least one CSI-RS resource to obtain measured channel information corresponding to each CSI-RS resource.

[0040] In some embodiments, the CSI-RS resource is a channel measurement resource (CMR). That is, the CSI-RS resource in the embodiments of the disclosure is a CMR.

[0041] Optionally, different CMRs belong to a same CSI-RS resource set, or different CMRs belong to different CSI-RS resource sets.

[0042] In some embodiments, each CSI-RS resource in at least one CSI-RS resource corresponds to one TRP, and at least two TRPs are used for CJT.

[0043] In some other embodiments, each of a plurality of port groups in one CSI-RS resource corresponds to

one TRP, and at least two TRPs are used for CJT.

[0044] One CSI-RS resource corresponds to a plurality of CSI-RS ports, the plurality of CSI- RS ports are grouped to obtain a plurality of port groups, each port group includes at least one CSI-RS port, and each port group corresponds to one TRP.

[0045] At step **302**, the terminal sends CSI to a network device according to the channel information determined corresponding to each CSI-RS resource and codebook parameter information. The CSI includes indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or the CSI includes indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, the port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource. The CSI is configured to determine precoding of the terminal based on a codebook structure corresponding to the codebook parameter information.

[0046] The codebook parameter information is used by the terminal to report indication information so that the network device can determine the precoding of the terminal. In addition, the codebook parameter information corresponds to a codebook structure, which means that the precoding of the terminal can be determined according to the codebook structure corresponding to the codebook parameter information and the CSI. In addition, the CSI in the embodiments of the disclosure is configured to determine the precoding of the terminal based on the codebook structure corresponding to the codebook parameter information, and the CSI includes indication information. That is, the indication information included in the CSI is configured to determine the precoding of the terminal based on the codebook structure corresponding to the codebook parameter information.

[0047] The CSI includes indication information corresponding to the plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource. The indication information corresponding to the plurality of CSI-RS resources means that the indication information for determining the precoding of the terminal included in the CSI can be applied to each CSI-RS resource. That is, sending indication information can be applied to each CSI-RS resource. The indication information corresponding to each CSI-RS resource means that precoding parameters for the terminal included in the CSI are applied to one CSI-RS resource. That is, the indication information corresponding to each CSI-RS resource is applied to the corresponding CSI-RS resource, but not applied to other CSI-RS resources.

[0048] Alternatively, the CSI includes indication information corresponding to the plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, and the port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource. The indication information corresponding to the plurality of port groups means that the indication information for determining the precoding of the terminal included in the CSI can be applied to each port group. That is, sending indication information can be applied to each port group. The indication information corresponding to each port group means that the indication information for determining the precoding of the terminal included in the CSI is applied to one port group. That is, the parameters corresponding to each port group are applied to the corresponding port group, but not applied to other port groups.

[0049] In embodiments of the disclosure, after the terminal determines the channel information corresponding to each CSI-RS resource in at least one CSI-RS resource, indication information that the terminal needs to report to the network device is determined according to the acquired channel information and codebook parameter information. The terminal then sends CSI including the indication information to the network device, and the CSI is configured to determine the precoding parameters of the terminal.

[0050] If the at least one CSI-RS resource includes a plurality of CSI-RS resources, the terminal determines the channel information corresponding to each CSI-RS resource. If the at least one CSI-RS resource includes one CSI-RS resource, and the CSI-RS resource corresponds to a plurality of CSI-RS ports, the terminal determines the channel information corresponding to each of the plurality of port groups.

[0051] In some embodiments, the network device configures the codebook parameter information for the terminal through a radio resource control (RRC) signaling, or the network device configures the codebook parameter information for the terminal through other signaling.

[0052] At step **303**, the network device receives CSI from the terminal. The CSI includes indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or the CSI includes indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group. The port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource, and the CSI is determined by the

terminal based on channel information corresponding to each CSI-RS resource in at least one CSI-RS resource and codebook parameter information.

[0053] At step **304**, the network device determines precoding of the terminal according to the CSI and the codebook structure corresponding to the codebook parameter information.

[0054] The codebook parameter information corresponds to a codebook structure. If the codebook structure is different, the network device determines the precoding of the terminal based on the codebook structure in different ways.

[0055] In an embodiment of the disclosure, after the network device receives the CSI, the network device can determine, according to the CSI, the indication information corresponding to the plurality of CSI-RS resources and the indication information corresponding to each CSI-RS resource included in the CSI, or the indication information corresponding to the plurality of port groups in one CSI-RS resource and the indication information corresponding to each port group indicated by the CSI, and then determine the precoding of the terminal according to the determined CSI and the codebook structure corresponding to the codebook parameter information.

[0056] It should be noted that the steps executed by the network device can form an independent embodiment, and the steps executed by the terminal can also form an independent embodiment, which is not limited in the disclosure.

[0057] In the solution according to the embodiment of the disclosure, after the terminal measures the CSI-RS corresponding to each CSI-RS resource, the CSI reported to the network device includes the indication information corresponding to the plurality of CSI-RS resources and the indication information corresponding to each CSI-RS resource, or the indication information corresponding to the plurality of port groups in one CSI-RS resource and the indication information corresponding to each port group. The plurality of CSI-RS resources or the plurality of port groups may be understood as corresponding to the plurality of TRPs. That is, the disclosure determines parameters shared by the plurality of TRPs and individual parameters for each TRP, so the network device may determine the precoding of the terminal according to the parameters reported by the terminal. The disclosure jointly utilizes a plurality of TRP channel information and proposes a channel CSI reporting method, which not only reduces the feedback overhead, but also improves the accuracy of the determined terminal precoding.

[0058] Based on the embodiment illustrated in FIG. **3**, the CSI sent by the terminal includes types of information, and the included types of information includes different situations.

[0059] In the first type of information, the CSI includes at least one of following information (1)-(3).

[0060] (1) N pieces of spatial domain (SD) basis vector indication information or N pieces of port selection indication information, where N is the same as a number of CSI-RS resources and N is a positive integer greater than 1.

[0061] The SD basis vector indication information is represented by a SD basis vector. The SD basis vector indication information indicates L_i SD basis vectors selected by the terminal, where i belongs to $\{1, 2 \ldots, N\}$. In some embodiments, the SD basis vector indication information is a SD beam basis vector, which may be referred to as a beam basis vector, or as a SD basis vector, or as a beam. The port selection indication information indicates L_i CSI-RS ports selected by the terminal.

[0062] In addition, the CSI sent by the terminal to the network device includes N pieces of SD basis vector indication information or N pieces of port selection indication information, which actually correspond to the number of CSI-RS resources. It may also be understood as a one-to- one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to each TRP.

[0063] For example, the SD basis vector indication information is used for explanation. The SD basis vector indicated by the SD basis vector indication information is $W_{1,i}$, where $W_{1,i} \in$ custom-character$^{N_t \times 2L_i}$, or $W_{1,i} \in$ custom-character$^{P \times 2L_i}$. $W_{1,i}$ represents a matrix consisting of L_i SD basis vectors corresponding to an ith CSI-RS resource, N represents the number of the CSI-RS resources, N_t represents a number of transmitting antenna ports, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the ith CSI-RS resource, $i \in \{1, \ldots, N\}$, and P is a number of CSI-RS ports. custom-character$^{X \times Y}$ represents a complex matrix with dimensions of X rows and Y columns, for example, X is N_t and Y is $2L_i$, that

is, $\mathbb{C}^{N_t \times 2L_i}$. The complex matrix in the following embodiments is similar to $\mathbb{C}^{N_t \times 2L_i}$ in the embodiment of the disclosure, which is not repeated herein.

[0064] Optionally, if the number of CSI-RS resources is 2, the number of SD basis vectors corresponding to each CSI-RS resource is 4, and L_i is 4, then $W_{1,i} \in \mathbb{C}^{N_t \times 8}$.

[0065] It should be noted that the embodiment of the disclosure is described by taking N pieces of SD basis vector indication information or N pieces of port selection indication information corresponding to CSI-RS resources as an example. In another embodiment, the N pieces of SD basis vector indication information or the N pieces of port selection indication information may also correspond to the plurality of port groups in one CSI-RS resource.

[0066] The CSI includes N pieces of SD basis vector indication information or N pieces of port selection indication information, and N is the same as the number of port groups, and N is a positive integer greater than 1.

[0067] The CSI sent by the terminal to the network device includes N pieces of SD basis vector indication information or N pieces of port selection indication information, which actually correspond to the number of port groups. It may also be understood as a one-to-one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to each TRP.

[0068] For example, the SD basis vector indication information is used for explanation. The SD basis vector indicated by the SD basis vector indication information is $W_{1,i}$, where $W_{1,i} \in \mathbb{C}^{N_t \times 2L_i}$, or $W_{1,i} \in \mathbb{C}^{P \times 2L_i}$. $W_{1,i}$ represents a matrix consisting of L_i SD basis vectors corresponding to an ith port group, N represents the number of at least two port groups, N_t represents a number of transmitting antenna ports, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the ith port group, $i \in \{1, \ldots, N\}$, and P is a number of CSI-RS ports.

[0069] Optionally, if the number of port groups is 2, the number of SD basis vectors corresponding to each port group is 4, and L_i is 4, then $W_{1,i} \in \mathbb{C}^{N_t \times 8}$.

[0070] (2) combination coefficient indication information, and the combination coefficient indication information corresponds to the plurality of CSI-RS resources.

[0071] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes combination coefficient indication information, which is actually shared by the plurality of CSI-RS resources. It may also be understood as combination coefficient indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0072] For example, a combination coefficient matrix indicated by the combination coefficient indication information is $\tilde{W}_2$, where $\tilde{W}_2 \in \mathbb{C}^{\sum_{i=1}^{N} 2L_i \times M}$. N represents the number of CSI-RS resources, L_i represents a number of pieces of SD basis vector indication information or a number of CSI-RS ports corresponding to the ith CSI-RS resource, $i \in \{1, \ldots, N\}$, and M represents a number of frequency domain (FD) basis vectors corresponding to the CSI-RS resource.

[0073] Optionally, if the number of CSI-RS resources is 2, the number of SD basis vectors corresponding to each CSI-RS resource is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and $\tilde{W}_2 \in \mathbb{C}^{12 \times 4}$.

[0074] It should be noted that the embodiment of the disclosure is described by taking combination coefficient indication information corresponding to one CSI-RS resource as an example. In another embodiment, combination coefficient indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0075] The CSI includes combination coefficient indication information, and the combination coefficient indication information corresponds to the plurality of port groups.

[0076] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes combination coefficient indication information, which is actually shared by the plurality of port groups. It

may also be understood as combination coefficient indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0077] For example, a combination coefficient matrix indicated by the combination coefficient indication information is $\tilde{W}_2$, where $\tilde{W}_2 \in$ custom-character $^{\Sigma_{i=1}^{N} 2L_i \times M}$. N represents the number of port groups, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the ith port group, $i \in \{1, \ldots, N\}$, and M represents a number of FD basis vectors corresponding to the port group.

[0078] Optionally, if the number of port groups is 2, and the number of SD basis vectors corresponding to each port group is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and $\tilde{W}_2 \in$ custom-character $^{12 \times 4}$.

[0079] (3) FD basis vector indication information, and the FD basis vector indication information corresponds to the plurality of CSI-RS resources.

[0080] The FD basis vector indication information indicates M FD basis vectors selected by the terminal. The FD basis vector indication information is used to represent a change rule of the channel in the FD. Specifically, the FD basis vectors can be used to represent a change rule of a weighted coefficient of each SD basis vector in each FD unit. The change rule represented by the FD base is related to factors such as a multipath delay.

[0081] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes FD basis vector indication information, which is actually shared by the plurality of CSI-RS resources. It may also be understood as FD basis vector indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0082] For example, a FD basis vector indicated by the FD basis vector indication information is W_f, representing a FD basis vector matrix, where $W_f \in$ custom-character $^{N_3 \times M}$. N_3 represents a number of precoding matrix indication (PMI) subbands, and M represents a number of FD basis vectors corresponding to the CSI-RS resources.

[0083] Optionally, if the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and $W_f \in$ custom-character $^{N_3 \times 4}$.

[0084] It should be noted that the embodiment of the disclosure is described by taking FD basis vector indication information corresponding to one CSI-RS resource as an example. In another embodiment, FD basis vector indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0085] The CSI includes FD basis vector indication information, and the FD basis vector indication information corresponds to the plurality of port groups.

[0086] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes FD basis vector indication information, which is actually shared by the plurality of port groups. It may also be understood as FD basis vector indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0087] For example, a FD basis vector indicated by the FD basis vector indication information is W_f, representing a FD basis vector matrix, $W_f \in$ custom-character $^{N_3 \times M}$, N_3 represents a number of PMI subbands, and M represents a number of FD basis vectors corresponding to the port group.

[0088] Optionally, if the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and $W_f \in$ custom-character $^{N_3 \times 4}$.

[0089] It should be noted that the SD basis vector indication information, the combination coefficient indication information and the FD basis vector indication information indicated by the CSI in the embodiments of the disclosure correspond to the CSI-RS resources or the port groups at the same time.

[0090] In addition, it should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0091] The codebook parameter information configured by the network device for the terminal includes at

least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0092] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0093] It should be noted that, in the first situation, the codebook structure is expressed by following formulas:

[00001]

$$W = \begin{bmatrix} W_{1,1} & & \\ & \ddots & \\ & & W_{1,N} \end{bmatrix} \tilde{W}_2 W_f^H, \quad W_{1,i} \in \mathbb{C}^{N_t \times 2L_i}, \text{ or } W_{1,i} \in \mathbb{C}^{P \times 2L_i}, \quad \tilde{W}_2 \in \mathbb{C}^{.\text{Math.}_{i=1}^{N} 2L_i \times M}, \quad W_f \in \mathbb{C}^{N_3 \times M},$$

where W represents the codebook structure, N represents the number of the CSI-RS resources, N_t represents a number of transmitting antenna ports, P is a number of CSI-RS ports, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to an ith CSI-RS resource, $i \in \{1, \ldots, N\}$, M represents a number of FD basis vectors corresponding to the ith CSI-RS resource, or a number of FD basis vectors corresponding to the ith port group, N_3 represents a number of PMI subbands, $W_{1,i}$ represents a matrix consisting of L_i SD basis vectors or unit basis vectors for port selection corresponding to the ith CSI-RS resource, {tilde over (W)}.sub.2 represents a matrix consisting of the combination coefficient indication information, W_f represents a matrix consisting of M FD basis vectors, and custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

[0094] Alternatively, where the W represents the codebook structure, N represents the number of the port groups, N_t represents a number of transmitting antenna ports, P is a number of CSI-RS ports, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to an ith port group, $i \in \{1, \ldots, N\}$, M represents a number of FD basis vectors corresponding to the ith port group, N_3 represents a number of PMI subbands, $W_{1,i}$ represents a matrix consisting of L_i SD basis vectors or unit basis vectors for port selection corresponding to the ith port group, {tilde over (W)}.sub.2 represents a matrix consisting of the combination coefficient indication information, W_f represents a matrix consisting of M FD basis vectors, and custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

[0095] In some embodiments, if W_f is off, M=1. The terminal selects L_1=2, L_2=4 and L_3=8 ports respectively according to estimated valid information of each port, and calculates, based on the selected ports, a port combination coefficient as {tilde over (W)}.sub.2 ∈ custom-character.sup.28×1. The network device determines a calculation formula for the precoding of the terminal

[00002] $$W = \begin{bmatrix} W_{1,1} & & \\ & \ddots & \\ & & W_{1,3} \end{bmatrix} W_2 .$$

The UE reports indication information of $W_{1,1}$, $W_{1,2}$ and $W_{1,3}$, respectively and each quantization coefficient information in {tilde over (W)}.sub.2, so that the network device uses them to calculate the precoding of the terminal.

[0096] In the second type of information, the plurality of CSI-RS resources are grouped to obtain G CSI-RS resource groups, and the CSI indicates information corresponding to each of the G CSI-RS resource groups. G is the same as the number of CSI-RS resource groups in the plurality of CSI-RS resources, the CSI-RS resource group includes at least one CSI-RS resource, and G is a positive integer greater than 1. Alternatively, the plurality of port groups are grouped to obtain G first groups, and the CSI indicates information corresponding to each of the G first groups. G is the same as the number of first groups among the plurality of port groups, the first group includes at least one port group, and G is a positive integer greater than 1.

[0097] The CSI indicates at least one of following information:

[0098] (1) G pieces of SD basis vector indication information or G pieces of port selection indication information (1)-(3).

[0099] The SD basis vector indication information is represented by a SD basis vector. The SD basis vector indication information indicates L_g SD basis vectors selected by the terminal, where L_g represents a number of SD basis vectors corresponding to a gth CSI-RS resource group, $g \in \{1, \ldots, G\}$. L_g represents a number and a value of SD basis vectors corresponding to each CSI-RS resource in the gth CSI-RS resource group, Alternatively, the port selection indication information indicates L_g CSI-RS ports selected by the terminal, where L_g represents a number of CSI-RS ports corresponding to a gth first group, $g \in \{1, \ldots, G\}$. L_g represents a number and a value of CSI-RS ports corresponding to each port group in the gth first group.

[0100] In addition, the CSI sent by the terminal to the network device indicates G pieces of SD basis vector indication information or G pieces of port selection indication information, which actually correspond to the number of G CSI-RS resource groups. It may also be understood as a one-to-one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and CSI-RS resource groups. In addition, each CSI-RS resource group includes at least one CSI-RS resource, and each CSI-RS resource corresponds to one TRP, that is, the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to the CSI-RS resource in each CSI- RS resource group.

[0101] For example, the SD basis vector is used for explanation. The SD basis vector is $W_{1,g}$, where $W_{1,g} \in \mathbb{C}^{N_g N_t \times 2L_g}$. $W_{1,g}$ represents a matrix consisting of one or more SD basis vectors corresponding to the gth CSI-RS resource group, N_g represents a number of CSI-RS resources or a number of port groups in the gth group, N_t represents a number of transmitting antenna ports, L_g represents a number of SD basis vectors or a number of CSI-RS ports selected for the gth group, and $\mathbb{C}^{N_g N_t \times 2L_g}$ represents a complex matrix with dimensions of $N_g N_t \times 2L_g$.

[0102] Optionally, the embodiment of the disclosure includes 4 CSI-RS resources, where CSI-RS resource 1 and CSI-RS resource 2 are the 1st CSI-RS resource group, CSI-RS resource 3 and CSI-RS resource 4 are the 2nd CSI-RS resource group, and the CSI-RS resource 1, the CSI- RS resource 2, the CSI-RS resource 3 and the CSI-RS resource 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st CSI-RS resource group, TRP**3** and TRP**4** being the 2nd CSI-RS resource group. The number of SD basis vectors is $L_1 = L_2 = 4$, $L_3 = L_4 = 3$, then $W_{1,1} \in \mathbb{C}^{2N_t \times 16}$ and $W_{1,2} \in \mathbb{C}^{2N_t \times 12}$. $\mathbb{C}^{2N_t \times 16}$ represents a complex matrix with dimensions of $2N_t \times 16$, and $\mathbb{C}^{2N_t \times 12}$ represents a complex matrix with dimensions of $2N_t \times 12$.

[0103] It should be noted that the embodiment of the disclosure is described by taking grouping CSI-RS resources to obtain G CSI-RS resource groups as an example. In another embodiment, G first groups may be obtained by grouping a plurality of port groups in one CSI-RS resource.

[0104] In addition, the CSI sent by the terminal to the network device indicates G pieces of SD basis vector indication information or G pieces of port selection indication information, which actually correspond to the number of G first groups. It may also be understood as a one-to-one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and first groups. In addition, each first group includes at least one port group, and each port group corresponds to one TRP, that is, the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to the port group in each first group.

[0105] For example, the SD basis vector is used for explanation. The SD basis vector is $W_{1,g}$, where $W_{1,g} \in \mathbb{C}^{N_g N_t \times 2L_g}$. $W_{1,g}$ represents a matrix consisting of SD basis vectors corresponding to the gth first group, N_g represents a number of CSI-RS resources or a number of port groups in the gth group, N_t represents a number of transmitting antenna ports, L_g represents a number of SD basis vectors or a number of CSI-RS ports selected for the gth group, and $\mathbb{C}^{N_g N_t \times 2L_g}$ represents a complex matrix with dimensions of $N_g N_t \times 2L_g$.

[0106] Optionally, the embodiment of the disclosure includes 4 port groups, where port group 1 and port group 2 are the 1st first group, port group 3 and port group 4 are the 2nd first group, and the port

group 1, the port group 2, the port group 3 and the port group 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st first group, TRP**3** and TRP**4** being the 2nd first group. The number of SD basis vectors is $L_1=L_2=4$, $L_3=L_4=3$, then $W_{1,1} \in \mathbb{C}^{2N_t \times 16}$ and $W_{1,2} \in \mathbb{C}^{2N_t \times 12}$. $\mathbb{C}^{2N_t \times 16}$ represents a complex matrix with dimensions of $2N_t \times 16$, and $\mathbb{C}^{2N_t \times 12}$ represents a complex matrix with dimensions of $2N_t \times 12$.

[0107] (2) G pieces of combination coefficient indication information.

[0108] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G pieces of combination coefficient indication information, which actually correspond to the number of G CSI-RS resource groups. It may also be understood as a one-to-one correspondence between pieces of combination coefficient indication information and CSI-RS resource groups. In addition, each CSI-RS resource group includes at least one CSI-RS resource, and each CSI-RS resource corresponds to one TRP, that is, the terminal reports the piece of combination coefficient indication information corresponding to the CSI-RS resource in each CSI-RS resource group.

[0109] For example, the combination coefficient indication information is $\tilde{W}_{2,g}$, representing a combination coefficient matrix. In $\tilde{W}_{2,g} \in \mathbb{C}^{2L_g \times M_g}$, N_g represents a number of CSI-RS resources in the gth group, L_g represents a number of CSI-RS ports selected for the gth group, M_g represents a number of FD basis vectors selected for the gth group, and $\mathbb{C}^{2L_g \times M_g}$ represents a complex matrix with dimensions of $2L_g \times M_g$.

[0110] Optionally, the embodiment of the disclosure includes 4 CSI-RS resources, where CSI-RS resource 1 and CSI-RS resource 2 are the 1st CSI-RS resource group, CSI-RS resource 3 and CSI-RS resource 4 are the 2nd CSI-RS resource group, and the CSI-RS resource 1, the CSI-RS resource 2, the CSI-RS resource 3 and the CSI-RS resource 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st CSI-RS resource group, TRP**3** and TRP**4** being the 2nd CSI-RS resource group. The number of SD basis vectors is $L_1=L_2=4$, $L_3=L_4=3$. The number of FD basis vectors corresponding to one of the two groups is $M_1=4$, the number of FD basis vectors corresponding to the other of the two groups is $M_2=7$, $\tilde{W}_{2,1} \in \mathbb{C}^{16 \times 4}$, and $\tilde{W}_{2,2} \in \mathbb{C}^{12 \times 3}$.

[0111] It should be noted that the embodiment of the disclosure is described by taking grouping CSI-RS resources to obtain G CSI-RS resource groups as an example. In another embodiment, G first groups may be obtained by grouping a plurality of port groups in one CSI-RS resource.

[0112] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G pieces of combination coefficient indication information, which actually correspond to the number of G first groups. It may also be understood as a one-to-one correspondence between pieces of combination coefficient indication information and first groups. In addition, each first group includes at least one port group, and each port group corresponds to one TRP, that is, the terminal reports combination coefficient indication information corresponding to the port group in each first group.

[0113] For example, the combination coefficient indication information is $\tilde{W}_{2,g}$, representing a combination coefficient matrix. In $\tilde{W}_{2,g} \in \mathbb{C}^{2L_g \times M_g}$, N_g represents a number of port groups in the gth group, L_g represents a number of CSI-RS ports selected for the gth group, M_g represents a number of FD basis vectors selected for the gth group, and $\mathbb{C}^{2L_g \times M_g}$ represents a complex matrix with dimensions of $2L_g \times M_g$.

[0114] Optionally, the embodiment of the disclosure includes 4 port groups, where port group 1 and port group 2 are the 1st first group, port group 3 and port group 4 are the 2nd first group, and the port group 1, the port group 2, the port group 3 and the port group 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st first group, TRP**3** and TRP**4** being the 2nd first group. The number of SD basis vectors is $L_1=L_2=4$, $L_3=L_4=3$. The number of FD basis vectors corresponding to one of the two groups is $M_1=4$, the number of FD basis vectors corresponding to the other of the two groups is $M_2=7$, $\tilde{W}_{2,1} \in \mathbb{C}^{16 \times 4}$, and $\tilde{W}_{2,2} \in \mathbb{C}^{12 \times 3}$.

[0115] (3) G pieces of FD basis vector indication information.

[0116] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G pieces of FD basis vectors, which actually correspond to the number of G CSI-RS resource groups. It may also be understood as a one-to-one correspondence between pieces of FD basis vector indication information and CSI-RS resource groups. In addition, each CSI-RS resource group includes at least one CSI-RS resource, and each CSI-RS resource corresponds to one TRP, that is, the terminal reports the FD basis vector corresponding to the CSI-RS resource in each CSI-RS resource group.

[0117] For example, the FD basis vector is $W_{f,g}^{H}$, representing a FD basis vector matrix. In $W_{f,g}^{H} \in \mathbb{C}^{N_3 \times M_g}$, N represents a number of CSI-RS resources, M_g represents a number of FD basis vectors selected for the gth group, H is a conjugate transpose, and $\mathbb{C}^{N_3 \times M_g}$ represents a complex matrix with dimensions of $N_3 \times M_g$.

[0118] Optionally, the embodiment of the disclosure includes 4 CSI-RS resources, where CSI-RS resource 1 and CSI-RS resource 2 are the 1st CSI-RS resource group, CSI-RS resource 3 and CSI-RS resource 4 are the 2nd CSI-RS resource group, and the CSI-RS resource 1, the CSI-RS resource 2, the CSI-RS resource 3 and the CSI-RS resource 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st CSI-RS resource group, TRP**3** and TRP**4** being the 2nd CSI-RS resource group. The number of SD basis vectors is $L_1 = L_2 = 4$, $L_3 = L_4 = 3$. The number of FD basis vectors corresponding to one of the two groups is $M_1 = 4$, the number of FD basis vectors corresponding to the other of the two groups is $M_2 = 7$, $W_{f,1} \in \mathbb{C}^{N_3 \times 4}$, and $W_{f,2} \in \mathbb{C}^{N_3 \times 7}$.

[0119] It should be noted that the embodiment of the disclosure is described by taking grouping CSI-RS resources to obtain G CSI-RS resource groups as an example. In another embodiment, G first groups may be obtained by grouping a plurality of port groups in one CSI-RS resource.

[0120] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G FD basis vectors. The G pieces of FD basis vector indication information actually corresponds to the number of G first groups, which may also be understood as a one-to-one correspondence between pieces of FD basis vector indication information and first groups. In addition, each first group includes at least one port group, and each port group corresponds to one TRP, that is, the terminal reports the FD basis vector corresponding to the port group in each first group.

[0121] For example, the FD basis vector is $W_{f,g}^{H}$, representing a FD basis vector matrix. In $W_{f,g}^{H} \in \mathbb{C}^{N_3 \times M_g}$, H is a conjugate transpose, N_g represents a number of CSI-RS resources or a number of port groups in the gth group, H is the conjugate transpose, N_3 represents a number of PMI subbands, M_g represents a number of FD basis vectors selected for the gth group, and $\mathbb{C}^{N_3 \times M_g}$ represents a complex matrix with dimensions of $N_3 \times M_g$.

[0122] Optionally, the embodiment of the disclosure includes 4 port groups, where port group 1 and port group 2 are the 1st first group, port group 3 and port group 4 are the 2nd first group, and the port group 1, the port group 2, the port group 3 and the port group 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st first group, TRP**3** and TRP**4** being the 2nd first group. The number of SD basis vectors is $L_1 = L_2 = 4$, $L_3 = L_4 = 3$. The number of FD basis vectors corresponding to one of the two groups is $M_1 = 4$, the number of FD basis vectors corresponding to the other of the two groups is $M_2 = 7$, $W_{f,1} \in \mathbb{C}^{N_3 \times 4}$, and $W_{f,1} \in \mathbb{C}^{N_3 \times 7}$.

[0123] It should be noted that the SD basis vector indication information, the combination coefficient indication information and the FD basis vector indication information indicated by the CSI in the embodiment of the disclosure correspond to the CSI-RS resource group or the first group in the port group at the same time.

[0124] It should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0125] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting

antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0126] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0127] It should be noted that, in the second situation, the codebook structure is expressed by following formulas:

$$[00003] W = \begin{bmatrix} W_{1,1}\, \tilde{W}_{2,1}\, W_{f,1}^H \\ .\text{Math.} \\ W_{1,g}\, \tilde{W}_{2,g}\, W_{f,g}^H \end{bmatrix}, W_{1,g} \in \mathbb{C}^{N_g N_t \times 2L_g}, \tilde{W}_{2,g}\, \mathbb{C}^{2L_g \times M_g}, W_{f,g}^H \in \mathbb{C}^{N_3 \times M_g}$$

where W represents the codebook structure, $W_{1,g}$ represents a matrix consisting of SD basis vectors or unit basis vectors for port selection corresponding to CSI-RS resources in the gth group, N_g represents a number of CSI-RS resources in the gth group, N_t represents a number of transmitting antenna ports, $W_{f,g}$ represents a matrix consisting of M_g FD basis vectors corresponding to the CSI-RS resource in the gth group, M_g represents a number of FD basis vectors selected for the gth group, $\tilde{W}_{2,g}$ represents a matrix consisting of combination coefficients corresponding to CSI-RS resources in the gth group, L_g represents a number of SD basis vectors or a number of CSI-RS ports selected for the gth group, G represents being the same as the number of CSI-RS resource groups in the plurality of CSI-RS resources, G is a positive integer greater than 1, H is a conjugate transpose, N_3 represents a number of PMI subbands, custom-character$^{X \times Y}$ represents a complex matrix with dimensions of X rows and Y columns.

[0128] Alternatively, where W represents the codebook structure, $W_{1,g}$ represents a matrix consisting of SD basis vectors or unit basis vectors for port selection corresponding to port groups in the gth group, N_g represents a number of port groups in the gth group, N_t represents a number of transmitting antenna ports, $W_{f,g}$ represents a matrix consisting of M_g FD basis vectors corresponding to port groups in the gth group, M_g represents a number of FD basis vectors selected for the gth group, $\tilde{W}_{2,g}$ represents a matrix consisting of combination coefficients corresponding to port groups in the gth group, L_g represents a number of SD basis vectors or a number of CSI-RS ports selected for the gth group, G represents being the same as the number of first groups among the port groups, G is a positive integer greater than 1, H is a conjugate transpose, N_3 represents a number of PMI subbands, and custom-character$^{X \times Y}$ represents a complex matrix with dimensions of X rows and Y columns.

[0129] In the third type of information, the CSI indicates at least one of following information (1)-(3).

[0130] (1) SD basis vector indication information or port selection indication information, and the SD basis vector indication information or the port selection indication information corresponds to a plurality of CSI-RS resources.

[0131] The SD basis vector indication information is represented by a SD basis vector. The SD basis vector indication information indicates $N*N_t$ SD basis vectors selected by the terminal. The port selection indication information indicates $N*N_t$ CSI-RS ports selected by the terminal, where N represents a number of CSI-RS resources or a number of port groups, and N_t represents a number of transmitting antenna ports.

[0132] In addition, the CSI sent by the terminal to the network device indicates SD basis vector indication information or port selection indication information, which actually corresponds to the number of CSI-RS resources. It may also be understood as the SD basis vector indication information or the port selection indication information being applied to a plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the SD basis vector indication information or the port selection indication information corresponds to N TRPs, and the terminal reports the SD basis vector indication information or the port selection indication information corresponding to the N TRPs.

[0133] For example, the SD basis vector is used for explanation. The SD basis vector is W_1, where $W_1 \in$ custom-character$^{NN_t \times 2L}$ or $W_1 \in$ custom-character$^{NP \times 2L}$. W_1 represents a matrix consisting of L SD basis vectors corresponding to the plurality of CSI-RS resources, N

represents a number of CSI-RS resources, N_t represents a number of transmitting antenna ports, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, P is a number of CSI-RS ports, $\mathbb{C}^{NN_t \times 2L}$ represents a complex matrix with dimensions of $NN_t \times 2L$, and $\mathbb{C}^{NP \times 2L}$ represents a complex matrix with dimensions of $NP \times 2L$.

[0134] It should be noted that the embodiment of the disclosure is described by taking SD basis vector indication information or port selection indication information corresponding to CSI-RS resources as an example. In another embodiment, SD basis vector indication information or port selection indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0135] The CSI indicates SD basis vector indication information or port selection indication information, and the SD basis vector indication information or the port selection indication information corresponds to the plurality of port groups.

[0136] In addition, the CSI sent by the terminal to the network device indicates the SD basis vector indication information or the port selection indication information, which actually corresponds to the number of port groups. It may also be understood as the SD basis vector indication information or the port selection indication information being applied to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the SD basis vector indication information or the port selection indication information corresponds to N TRPs, and the terminal reports a SD basis vector corresponding to the N TRPs.

[0137] For example, the SD basis vector is used for explanation. The SD basis vector is W_1, where $W_1 \in \mathbb{C}^{NN_t \times 2L}$ or $W_1 \in \mathbb{C}^{NP \times 2L}$. W_1 represents a matrix consisting of L SD basis vectors corresponding to the plurality of port groups, N represents a number of port groups, N_t represents a number of transmitting antenna ports, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, P is a number of CSI-RS ports, $\mathbb{C}^{NN_t \times 2L}$ represents a complex matrix with dimensions of $NN_t \times 2L$, and $\mathbb{C}^{NP \times 2L}$ represents a complex matrix with dimensions of $NP \times 2L$.

[0138] (2) combination coefficient indication information, and the combination coefficient indication information corresponds to a plurality of CSI-RS resources.

[0139] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates combination coefficient indication information, which is actually shared by the plurality of CSI-RS resources. It may also be understood as combination coefficient indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0140] For example, the combination coefficient indication information is $\tilde{W}_2$, representing a combination coefficient matrix, where $\tilde{W}_2 \in \mathbb{C}^{2L \times M}$. N represents a number of CSI-RS resources, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, M represents a number of FD basis vectors corresponding to the CSI-RS resources, and $\mathbb{C}^{2L \times M}$ represents a complex matrix with dimensions of $2L \times M$.

[0141] Optionally, if the number of CSI-RS resources is 2, the number of SD basis vectors corresponding to each CSI-RS resource is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and $\tilde{W}_2 \in \mathbb{C}^{12 \times 4}$.

[0142] It should be noted that the embodiment of the disclosure is described by taking combination coefficient indication information corresponding to one CSI-RS resource as an example. In another embodiment, combination coefficient indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0143] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes combination coefficient indication information, which is actually shared by the plurality of port groups. It may also be understood as combination coefficient indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0144] For example, the combination coefficient indication information is $\tilde{W}_2$, represents

a combination coefficient matrix, where $\{\tilde{W}\}_2 \in$ custom-character.sup.$2L \times M$. N represents a number of port groups, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, and M represents a number of FD basis vectors corresponding to the port groups.

[0145] Optionally, if the number of port groups is 2, and the number of SD basis vectors corresponding to each port group is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and $\{\tilde{W}\}_2 \in$ custom-character.sup.12×4.

[0146] (3) FD basis vector indication information, and the FD basis vector indication information corresponds to the plurality of CSI-RS resources.

[0147] The FD basis vector indication information indicates M FD basis vectors selected by the terminal. In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates FD basis vector indication information, which is actually shared by the plurality of CSI-RS resources. It may also be understood as FD basis vector indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0148] For example, the FD basis vector indication information is W_f, representing a FD basis vector matrix, where $W_f \in$ custom-character.sup.$N_3 \times M$. N_3 represents a number of PMI subbands, M represents a number of FD basis vectors corresponding to the CSI-RS resources, and custom-character.sup.$N_3 \times M$ represents a complex matrix with dimensions of $N_3 \times M$.

[0149] Optionally, if the number of FD basis vectors corresponding to at least two CSI- RS resources is 4, then M is 4, and $W_f \in$ custom-character.sup.$N_3 \times 4$.

[0150] It should be noted that the embodiment of the disclosure is described by taking SD basis vector indication information corresponding to one CSI-RS resource as an example. In another embodiment, SD basis vector indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0151] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes FD basis vector indication information, which is actually shared by the plurality of port groups. It may also be understood as FD basis vector indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0152] For example, the FD basis vector indication information is W_f, representing a FD basis vector matrix, where $W_f \in$ custom-character.sup.$N_3 \times M$. N_3 represents a number of PMI subbands, and M represents a number of FD basis vectors corresponding to the port group, and custom-character.sup.$N_3 \times M$ represents a complex matrix with dimensions of $N_3 \times M$.

[0153] Optionally, if the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and $W_f \in$ custom-character.sup.$N_3 \times 4$.

[0154] It should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0155] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0156] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0157] It should be noted that, in the third situation, the codebook structure is expressed by following formulas:

$W = W_1 \{\tilde{W}\}_2 W_f^H$, $W_1 \in$ custom-character.sup.$N N_t \times 2L$, or $W_1 \in$ custom-character.sup.$NP \times 2L$, $\{\tilde{W}\}_2 \in$ custom-character.sup.$2L \times M$, $W_f \in$

custom-character.sup.N.sup.3.sup.×M

where W represents the codebook structure, N represents the number of the CSI-RS resources, N_t represents a number of transmitting antenna ports, L represents a number of SD basis vectors or CSI-RS ports corresponding to the CSI-RS resources, M represents a number of FD basis vectors corresponding to the CSI-RS resources, N_3 represents a number of PMI subbands, W_1 represents a matrix consisting of L SD basis vectors or unit basis vectors for port selection for the CSI-RS resources, $\tilde{W}_2$ represents a matrix consisting of the combination coefficient indication information, W_f represents a matrix consisting of M frequency domain basis vectors, H is a conjugate transpose, and custom-character $C^{X \times Y}$ represents a complex matrix with dimensions of X rows and Y columns.

[0158] It should be noted that all the above three ways are described by taking the combination coefficient indication information as an example. In another embodiment, the combination coefficient indication information includes a plurality of types of information.

[0159] Optionally, the combination coefficient indication information includes non-zero coefficient information and non-zero coefficient position information, the non-zero coefficient information indicates a non-zero coefficient in the combination coefficient indication information, and the non-zero coefficient position information indicates a position of the non-zero coefficient in the combination coefficient indication information.

[0160] It should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0161] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0162] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0163] In the solution according to the embodiment of the disclosure, the parameters indicated by the CSI include a plurality of situations, which expands the ways of the indicated parameters and thus improves the diversity of the indicated parameters.

[0164] Based on the embodiment illustrated in FIG. **3**, a specific process of the terminal sending the CSI is illustrated in FIG. **4**. Referring to FIG. **4**, the method includes the following steps at **401-403**.

[0165] At **401**, the terminal determines, according to channel information or valid channel information corresponding to each CSI-RS resource and the codebook parameter information, the SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information.

[0166] The valid channel information refers to channel information that can be used, which may also be understood as channel information including valid parameters.

[0167] In an embodiment of the disclosure, after measuring each CSI-RS resource, the terminal may determine the channel information or valid channel information corresponding to each CSI-RS resource, and the terminal can also determine the SD basis vector indication information or the port selection indication information according to the determined channel information or valid channel information and the codebook parameter information, and after the terminal determines the SD basis vector indication information or the port selection indication information, the terminal can also determine the combination coefficient indication information and the FD basis vector indication information.

[0168] At **402**, the terminal sends the CSI to the network device, in which the CSI includes the SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information.

[0169] At **403**, the network device receives the CSI from the terminal, in which the CSI includes the SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information.

[0170] In the embodiments of the disclosure, after the terminal determines the SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information, the CSI can be further determined. The CSI can indicate the above three types of information determined by the terminal, and the CSI is then sent to the network device. The network device can then receive the CSI from the terminal.

[0171] In the solution according to the embodiment of the disclosure, after measuring the CSI-RS corresponding to each CSI-RS resource, the indication information reported to the network device includes information shared by the plurality of TRPs and individual parameters for each TRP, so the network device may determine the precoding of the terminal according to the parameters reported by the terminal, which not only reduces the feedback overhead by reporting the shared parameters, but also improves the precoding gain of the terminal by integrating the parameters of the plurality of TRPs.

[0172] Based on the embodiment illustrated in FIG. **3**, the network device configures codebook parameters for the terminal via configuration information. Referring to FIG. **5**, the method includes the following steps at **501-502**.

[0173] At **501**, the network device sends configuration information to the terminal, in which the configuration information is used to configure codebook parameter information, and the codebook parameter information is used by the terminal to determine the CSI.

[0174] At **502**, the terminal receives configuration information from the network device, in which the configuration information is used to configure codebook parameter information, and the codebook parameter information is used by the terminal to determine the CSI.

[0175] In an embodiment of the disclosure, the network device sends configuration information to the terminal, and configures the codebook parameter information for the terminal via the configuration information. Subsequently, the terminal can send the CSI to the network device based on the codebook parameter information.

[0176] In some embodiments, before the network device sends the configuration information to the terminal, the network device also determines the codebook structure first, so as to configure, based on the codebook structure, the terminal with codebook parameter information matching the codebook structure.

[0177] Optionally, the terminal determines the codebook structure, and then indicates the determined codebook structure to the network device via indication information.

[0178] The terminal sends first indication information to the network device, in which the first indication information indicates an adopted codebook structure.

[0179] Optionally, the network device determines the codebook structure, and then indicates the codebook structure to the terminal via indication information.

[0180] The terminal receives second indication information from the network device, in which the second indication information indicates an adopted codebook structure.

[0181] It should be noted that the embodiment of the disclosure is described by taking the indication information indicating the codebook structure as an example. In another embodiment, the codebook structure between the network device and the terminal is agreed upon by a protocol, and the network device directly configures the terminal with codebook parameter information corresponding to the agreed codebook structure.

[0182] In the solution according to the embodiment of the disclosure, after the network device determines the codebook structure, the network device configures codebook parameter information for the terminal according to the codebook structure, which improves the accuracy of the codebook parameter information configured by the network device.

[0183] It should be noted that the above-mentioned embodiments can be split into new embodiments, or combined with other embodiments to form new embodiments. The combination of the embodiments is not limited in the disclosure.

[0184] FIG. **6** illustrates a flowchart of a method for determining precoding based on a codebook according to an embodiment of the disclosure, which can be exemplarily applied to a terminal as illustrated in FIG. **1**. The method includes at least part of following contents.

[0185] At **601**, the terminal determines channel information corresponding to each CSI- RS resource based on at least two CSI-RS resources.

[0186] The CSI-RS resources are used to transmit the CSI-RS. In addition, the CSI-RS resources are configured by the network device, and the network device can send the CSI-RS to the terminal via the configured CSI-RS resources.

[0187] In the embodiment of the disclosure, the terminal measures the CSI-RS based on the at least one CSI-RS resource to obtain channel information corresponding to each CSI-RS resource measured.

[0188] In some embodiments, the CSI-RS resource is a channel measurement resource (CMR). That is, the CSI-RS resource in the embodiments of the disclosure is a CMR resource.

[0189] Optionally, different CMRs belong to a same CSI-RS resource set or different CSI-RS resource sets.

[0190] In some embodiments, each of the at least one CSI-RS resource corresponds to one TRP, and at least two TRPs are configured for coherent joint transmission (CJT).

[0191] In some other embodiments, each of the plurality of port groups in the one CSI- RS resource corresponds to one TRP, and at least two TRPs are configured for CJT.

[0192] One CSI-RS resource corresponds to a plurality of CSI-RS ports, a plurality of port groups are obtained by grouping the plurality of CSI-RS ports, each port group includes at least one CSI-RS port, and each port group corresponds to one TRP.

[0193] At **602**, the terminal sends, according to the channel information determined corresponding to each CSI-RS resource and codebook parameter information, CSI to the network device. The CSI includes indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or the CSI includes indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, the port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource, and the CSI is configured to determine precoding of the terminal based on a codebook structure corresponding to the codebook parameter information.

[0194] The codebook parameter information is used by the terminal to report indication information, so that the network device can determine the precoding of the terminal. In addition, the codebook parameter information corresponds to the codebook structure. That is to say, the precoding of the terminal can be determined according to the codebook structure corresponding to the codebook parameter information and the CSI. In addition, the CSI in the embodiments of the disclosure is used to determine the precoding of the terminal based on the codebook structure corresponding to the codebook parameter information, and the CSI includes indication information. That is, the indication information included in the CSI is used to determine the precoding of the terminal based on the codebook structure corresponding to the codebook parameter information.

[0195] The CSI includes the indication information corresponding to the plurality of CSI-RS resources and the indication information corresponding to each CSI-RS resource. The indication information corresponding to the plurality of CSI-RS resources means that the indication information for determining the precoding of the terminal included in the CSI can be applied to each CSI-RS resource. That is, sending indication information can be applied to each CSI-RS resource. The indication information corresponding to each CSI-RS resource means that the parameters for determining the precoding of the terminal included in the CSI are applied to one CSI-RS resource. That is, the indication information corresponding to each CSI-RS resource is applied to the corresponding CSI-RS resource, but is not applied to other CSI-RS resources.

[0196] Alternatively, the CSI includes indication information corresponding to the plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, and the port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource. The indication information corresponding to the plurality of port groups means that the indication information for determining the precoding of the terminal included in the CSI can be applied to each port group. That is, sending indication information can be applied to each port group. The indication information corresponding to each port group means that the indication information for determining the precoding of the terminal included in the CSI is applied to one port group. That is, the parameters corresponding to each port group are applied to the corresponding port group, but are not applied to other port groups.

[0197] In an embodiment of the disclosure, after the terminal determines the channel information corresponding to each CSI-RS resource in the at least one CSI-RS resource, the terminal determines the indication information that needs to be reported to the network device based on the acquired channel information and codebook parameter information. The terminal then sends the CSI including the indication information to the network device, and the CSI is used to determine precoding parameters of the terminal.

[0198] If the at least one CSI-RS resource includes a plurality of CSI-RS resources, the terminal determines the channel information corresponding to each CSI-RS resource. If the at least one CSI-RS resource includes one CSI-RS resource, and the one CSI-RS resource corresponds to a plurality of CSI-RS ports, the terminal determines the channel information corresponding to each port group in the plurality of port groups.

[0199] In some embodiments, the network device configures the codebook parameter information for the terminal via a radio resource control (RRC) signaling, or other signaling.

[0200] In some embodiments, the terminal determines, according to the channel information corresponding to each CSI-RS resource and the codebook parameter information, the SD basis vector indication information, the combination coefficient indication information and the FD basis vector indication information, and the terminal sends to the network device the CSI including the SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information.

[0201] In an embodiment of the disclosure, after the terminal measures each CSI-RS resource, the terminal can determine the channel information corresponding to each CSI-RS resource, and the terminal can also determine the SD basis vector indication information based on the determined channel information and the codebook parameter information. After the terminal determines the SD basis vector indication information, the terminal can further determine the combination coefficient indication information and the FD basis vector indication information according to the SD basis vector indication information and the codebook parameter information. After the terminal determines the SD basis vector indication information, the combination coefficient indication information and the FD basis vector indication information, the terminal can further determine the CSI. The CSI can indicate the above three types of information determined by the terminal, and the CSI is sent to the network device.

[0202] Based on the embodiment illustrated in FIG. **6**, the CSI sent by the terminal indicates types of information, and the included types of information includes different situations.

[0203] In the first type of information, the CSI includes at least one of following information (1)-(3).

[0204] (1) N pieces of SD basis vector indication information or N pieces of port selection indication information, where N is the same as a number of CSI-RS resources and N is a positive integer greater than 1.

[0205] The SD basis vector indication information is represented by a SD basis vector. The SD basis vector indication information indicates L_i SD basis vectors selected by the terminal, where i belongs to $\{1,2 . . . ,N\}$. In some embodiments, the SD basis vector indication information is a SD beam basis vector, which may be referred to as a beam basis vector, or as a SD basis vector, or as a beam. The port selection indication information indicates L_i CSI-RS ports selected by the terminal.

[0206] In addition, the CSI sent by the terminal to the network device includes N pieces of SD basis vector indication information or N pieces of port selection indication information, which actually correspond to the number of CSI-RS resources. It may also be understood as a one-to-one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to each TRP.

[0207] For example, the SD basis vector indication information is used for explanation. The SD basis vector indicated by the SD basis vector indication information is $W_{1,i}$, where $W_{1,i} \in \mathbb{C}^{N_t \times 2L_i}$, or $W_{1,i} \in \mathbb{C}^{P \times 2L_i}$. $W_{1,i}$ represents a matrix consisting of L_i SD basis vectors corresponding to an ith CSI-RS resource, N represents the number of the CSI-RS resources, N_t represents a number of transmitting antenna ports, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the ith CSI-RS resource, $i \in \{1, . . . , N\}$, and P is a number of CSI-RS ports. $\mathbb{C}^{X \times Y}$ represents a complex matrix with dimensions of X rows and Y columns, for example, X is N_t and Y is $2L_i$, that is, $\mathbb{C}^{N_t \times 2L_i}$. The complex matrix in the following embodiments is similar to $\mathbb{C}^{N_t \times 2L_i}$ in the embodiment of the disclosure, which is not repeated herein.

[0208] Optionally, if the number of CSI-RS resources is 2, the number of SD basis vectors corresponding to each CSI-RS resource is 4, and L_i is 4, then $W_{1,i} \in \mathbb{C}^{N_t \times 8}$.

[0209] It should be noted that the embodiment of the disclosure is described by taking N pieces of SD basis vector indication information or N pieces of port selection indication information corresponding to CSI-RS resources as an example. In another embodiment, the N pieces of SD basis vector indication information or the N pieces of port selection indication information may also correspond to the plurality of port groups in one CSI-RS resource.

[0210] The CSI includes N pieces of SD basis vector indication information or N pieces of port selection

indication information, and N is the same as the number of port groups, and N is a positive integer greater than 1.

[0211] The CSI sent by the terminal to the network device includes N pieces of SD basis vector indication information or N pieces of port selection indication information, which actually correspond to the number of port groups. It may also be understood as a one-to-one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to each TRP.

[0212] For example, the SD basis vector indication information is used for explanation. The SD basis vector indicated by the SD basis vector indication information is $W_{1,i}$, where $W_{1,i} \in$ custom-character$^{N_t \times 2L_i}$, or $W_{1,i} \in$ custom-character$^{P \times 2L_i}$. $W_{1,i}$ represents a matrix consisting of L_i SD basis vectors corresponding to an ith port group, N represents the number of at least two port groups, N_t represents a number of transmitting antenna ports, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the ith port group, $i \in \{1, \ldots, N\}$, and P is a number of CSI-RS ports.

[0213] Optionally, if the number of port groups is 2, the number of SD basis vectors corresponding to each port group is 4, and L_i is 4, then $W_{1,i} \in$ custom-character$^{N_t \times 8}$.

[0214] (2) combination coefficient indication information, and the combination coefficient indication information corresponds to the plurality of CSI-RS resources.

[0215] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes combination coefficient indication information, which is actually shared by the plurality of CSI-RS resources, and may also be understood as combination coefficient indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0216] For example, a combination coefficient matrix indicated by the combination coefficient indication information is $\tilde{W}_2$, where $\tilde{W}_2 \in$ custom-character$^{\Sigma_{i=1}^{N} 2L_i \times M}$. N represents the number of CSI-RS resources, L_i represents a number of pieces of SD basis vector indication information or a number of CSI-RS ports corresponding to the ith CSI-RS resource, $i \in \{1, \ldots, N\}$, and M represents a number of frequency domain (FD) basis vectors corresponding to the CSI-RS resource.

[0217] Optionally, if the number of CSI-RS resources is 2, the number of SD basis vectors corresponding to each CSI-RS resource is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and $\tilde{W}_2 \in$ custom-character$^{12 \times 4}$.

[0218] It should be noted that the embodiment of the disclosure is described by taking combination coefficient indication information corresponding to one CSI-RS resource as an example. In another embodiment, combination coefficient indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0219] The CSI includes combination coefficient indication information, and the combination coefficient indication information corresponds to the plurality of port groups.

[0220] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes combination coefficient indication information, which is actually shared by the plurality of port groups, and may also be understood as combination coefficient indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0221] For example, a combination coefficient matrix indicated by the combination coefficient indication information is $\tilde{W}_2$, where $\tilde{W}_2 \in$ custom-character$^{\Sigma_{i=1}^{N} 2L_i \times M}$. N represents the number of port groups, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the ith port group, $i \in \{1, \ldots, N\}$, and M represents a number of FD basis vectors corresponding to the port group.

[0222] Optionally, if the number of port groups is 2, and the number of SD basis vectors corresponding to each port group is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two port

groups is 4, then M is 4, and ${\tilde{W}}_2 \in$ custom-character.sup.12×4.

[0223] (3) FD basis vector indication information, and the FD basis vector indication information corresponds to the plurality of CSI-RS resources.

[0224] The FD basis vector indication information indicates M FD basis vectors selected by the terminal. The FD basis vector indication information is used to represent a change rule of the channel in the FD. The FD basis vectors can be specifically used to represent a change rule of a weighted coefficient of each SD basis vector in each FD unit. The changing rule represented by the FD base is related to factors such as a multipath delay.

[0225] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes FD basis vector indication information, which is actually shared by the plurality of CSI-RS resources, and may also be understood as FD basis vector indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0226] For example, a FD basis vector indicated by the FD basis vector indication information is W_f, representing a FD basis vector matrix, N_3 represents a number of precoding matrix indication (PMI) subbands, and M represents a number of FD basis vectors corresponding to the CSI-RS resources.

[0227] Optionally, if the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and $W_f \in$ custom-character.sup.$N_3 \times 4$.

[0228] It should be noted that the embodiment of the disclosure is described by taking FD basis vector indication information corresponding to one CSI-RS resource as an example. In another embodiment, FD basis vector indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0229] The CSI includes FD basis vector indication information, and the FD basis vector indication information corresponds to the plurality of port groups.

[0230] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes FD basis vector indication information, which is actually shared by the plurality of port groups, and may also be understood as FD basis vector indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0231] For example, a FD basis vector indicated by the FD basis vector indication information is W_f, representing a FD basis vector matrix, $W_f \in$ custom-character.sup.$N_3 \times M$, N_3 represents a number of PMI subbands, and M represents a number of FD basis vectors corresponding to the port group.

[0232] Optionally, if the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and $W_f \in$ custom-character.sup.$N_3 \times 4$.

[0233] It should be noted that the SD basis vector indication information, the combination coefficient indication information and the FD basis vector indication information indicated by the CSI in the embodiments of the disclosure correspond to the CSI-RS resources or the port groups at the same time.

[0234] In addition, it should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0235] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0236] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0237] In the second type of information, the plurality of CSI-RS resources are grouped to obtain G CSI-RS resource groups, and the CSI indicates information corresponding to each CSI-RS resource group in the G CSI-RS resource groups. G is the same as the number of CSI-RS resource groups in the plurality of CSI-RS

resources, the CSI-RS resource group includes at least one CSI-RS resource, and G is a positive integer greater than 1. Alternatively, the plurality of port groups are grouped to obtain G first groups, and the CSI indicates information corresponding to each of the G first groups. G is the same as the number of first groups among the plurality of port groups, the first group includes at least one port group, and G is a positive integer greater than 1.

[0238] The CSI indicates at least one of following information:

[0239] (1) G pieces of SD basis vector indication information or G pieces of port selection indication information (1)-(3).

[0240] The SD basis vector indication information is represented by a SD basis vector. The SD basis vector indication information indicates L_g SD basis vectors selected by the terminal, where L_g represents a number of SD basis vectors corresponding to a gth CSI-RS resource group, $g \in \{1, \ldots, G\}$. L_g represents a number and a value of SD basis vectors corresponding to each CSI-RS resource in the gth CSI-RS resource group, Alternatively, the port selection indication information indicates L_g CSI-RS ports selected by the terminal, where L_g represents a number of CSI-RS ports corresponding to a gth first group, $g \in \{1, \ldots, G\}$. L_g represents a number and a value of CSI-RS ports corresponding to each port group in the gth first group.

[0241] In addition, the CSI sent by the terminal to the network device indicates G pieces of SD basis vector indication information or G pieces of port selection indication information, which actually correspond to the number of G CSI-RS resource groups. It may also be understood as a one-to-one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and CSI-RS resource groups. In addition, each CSI-RS resource group includes at least one CSI-RS resource, and each CSI-RS resource corresponds to one TRP, that is, the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to the CSI-RS resource in each CSI-RS resource group.

[0242] For example, the SD basis vector is used for explanation. The SD basis vector is $W_{1,g}$, where $W_{1,g} \in$ custom-character$^{N_g N_t \times 2L_g}$. $W_{1,g}$ represents a matrix consisting of one or more SD basis vectors corresponding to the gth CSI-RS resource group, N_g represents a number of CSI-RS resources or a number of port groups in the gth group, N_t represents a number of transmitting antenna ports, L_g represents a number of SD basis vectors or a number of CSI-RS ports selected for the gth group, and custom-character$^{N_g N_t \times 2L_g}$ represents a complex matrix with dimensions of $N_g N_t \times 2L_g$.

[0243] Optionally, the embodiment of the disclosure includes 4 CSI-RS resources, where CSI-RS resource 1 and CSI-RS resource 2 are the 1st CSI-RS resource group, CSI-RS resource 3 and CSI-RS resource 4 are the 2nd CSI-RS resource group, and the CSI-RS resource 1, the CSI-RS resource 2, the CSI-RS resource 3 and the CSI-RS resource 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st CSI-RS resource group, TRP**3** and TRP**4** being the 2nd CSI-RS resource group. The number of SD basis vectors is $L_1 = L_2 = 4$, $L_3 = L_4 = 3$, then $W_{1,2} \in$ custom-character$^{2N_t \times 16}$ and $W_{1,2} \in$ custom-character$^{2N_t \times 12}$. custom-character$^{2N_t \times 16}$ represents a complex matrix with dimensions of $2N_t \times 16$, and custom-character$^{2N_t \times 12}$ represents a complex matrix with dimensions of $2N_t \times 12$.

[0244] It should be noted that the embodiment of the disclosure is described by taking grouping CSI-RS resources to obtain G CSI-RS resource groups as an example. In another embodiment, G first groups may be obtained by grouping a plurality of port groups in one CSI-RS resource.

[0245] In addition, the CSI sent by the terminal to the network device indicates G pieces of SD basis vector indication information or G pieces of port selection indication information, which actually correspond to the number of G first groups. It may also be understood as a one-to- one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and first groups. In addition, each first group includes at least one port group, and each port group corresponds to one TRP, that is, the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to the port group in each first group.

[0246] For example, the SD basis vector is used for explanation. The SD basis vector is $W_{1,g}$, where $W_{1,g} \in$ custom-character$^{N_g N_t \times 2L_g}$. $W_{1,g}$ represents a matrix consisting of SD basis vectors corresponding to the gth first group, N_g represents a number of CSI-

RS resources or a number of port groups in the g.sup.th group, N_t represents a number of transmitting antenna ports, L_g represents a number of SD basis vectors or a number of CSI-RS ports selected for the g.sup.th group, and $\mathbb{C}^{N_g N_t \times 2L_g}$ represents a complex matrix with dimensions of $N_g N_t \times 2L_g$.

[0247] Optionally, the embodiment of the disclosure includes 4 port groups, where port group 1 and port group 2 are the 1.sup.st first group, port group 3 and port group 4 are the 2.sup.nd first group, and the port group 1, the port group 2, the port group 3 and the port group 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1.sup.st first group, TRP**3** and TRP**4** being the 2.sup.nd first group. The number of SD basis vectors is $L_1=L_2=4$, $L_3=L_4=3$, then $W_{1,1} \in \mathbb{C}^{2N_t \times 16}$ and $W_{1,2} \in \mathbb{C}^{2N_t \times 12}$. $\mathbb{C}^{2N_t \times 16}$ represents a complex matrix with dimensions of $2N_t \times 16$, and $\mathbb{C}^{2N_t \times 12}$ represents a complex matrix with dimensions of $2N_t \times 12$.

[0248] (2) G pieces of combination coefficient indication information.

[0249] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G pieces of combination coefficient indication information, which actually correspond to the number of G CSI-RS resource groups. It may also be understood as a one-to- one correspondence between pieces of combination coefficient indication information and CSI- RS resource groups. In addition, each CSI-RS resource group includes at least one CSI-RS resource, and each CSI-RS resource corresponds to one TRP, that is, the terminal reports the piece of combination coefficient indication information corresponding to the CSI-RS resource in each CSI-RS resource group.

[0250] For example, the combination coefficient indication information is $\tilde{W}_{2,g}$, representing a combination coefficient matrix. In $\tilde{W}_{2,g} \in \mathbb{C}^{2L_g \times M_g}$, N_g represents a number of CSI-RS resources in the g.sup.th group, L_g represents a number of CSI-RS ports selected for the g.sup.th group, M_g represents a number of FD basis vectors selected for the g.sup.th group, and $\mathbb{C}^{2L_g \times M_g}$ represents a complex matrix with dimensions of $2L_g \times M_g$.

[0251] Optionally, the embodiment of the disclosure includes 4 CSI-RS resources, where CSI-RS resource 1 and CSI-RS resource 2 are the 1.sup.st CSI-RS resource group, CSI-RS resource 3 and CSI-RS resource 4 are the 2.sup.nd CSI-RS resource group, and the CSI-RS resource 1, the CSI-RS resource 2, the CSI-RS resource 3 and the CSI-RS resource 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1.sup.st CSI-RS resource group, TRP**3** and TRP**4** being the 2.sup.nd CSI-RS resource group. The number of SD basis vectors is $L_1=L_2=4$, $L_3=L_4=3$. The number of FD basis vectors corresponding to one of the two groups is $M_1=4$, the number of FD basis vectors corresponding to the other of the two groups is $M_2=7$, $\tilde{W}_{2,1} \in \mathbb{C}^{16 \times 4}$, and $\tilde{W}_{2,2} \in \mathbb{C}^{12 \times 3}$.

[0252] It should be noted that the embodiment of the disclosure is described by taking grouping CSI-RS resources to obtain G CSI-RS resource groups as an example. In another embodiment, G first groups may be obtained by grouping a plurality of port groups in one CSI-RS resource.

[0253] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G pieces of combination coefficient indication information, which actually correspond to the number of G first groups. It may also be understood as a one-to-one correspondence between pieces of combination coefficient indication information and first groups. In addition, each first group includes at least one port group, and each port group corresponds to one TRP, that is, the terminal reports combination coefficient indication information corresponding to the port group in each first group.

[0254] For example, the combination coefficient indication information is $\tilde{W}_{2,g}$, representing a combination coefficient matrix. In $\tilde{W}_{2,g} \in \mathbb{C}^{2L_g \times M_g}$, N_g represents a number of port groups in the g.sup.th group, L_g represents a number of CSI-RS ports selected for the g.sup.th group, M_g represents a number of FD basis vectors selected for the g.sup.th group, and $\mathbb{C}^{2L_g \times M_g}$ represents a complex matrix with dimensions of $2L_g \times M_g$.

[0255] Optionally, the embodiment of the disclosure includes 4 port groups, where port group 1 and port group 2 are the 1.sup.st first group, port group 3 and port group 4 are the 2.sup.nd first group, and the port group 1, the port group 2, the port group 3 and the port group 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4**

respectively, which may also be understood as TRP**1** and TRP**2** being the 1.sup.st first group, TRP**3** and TRP**4** being the 2.sup.nd first group. The number of SD basis vectors is L.sub.1=L.sub.2=4, L.sub.3=L.sub.4=3. The number of FD basis vectors corresponding to one of the two groups is M.sub.1=4, the number of FD basis vectors corresponding to the other of the two groups is M.sup.2=7, {tilde over (W)}.sup.2,1⊃custom-character.sup.16×4, and {tilde over (W)}.sub.2,2∈custom-character.sup.12×3.

[0256] (3) G pieces of FD basis vector indication information.

[0257] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G pieces of FD basis vectors, which actually correspond to the number of G CSI-RS resource groups. It may also be understood as a one-to-one correspondence between pieces of FD basis vector indication information and CSI-RS resource groups. In addition, each CSI-RS resource group includes at least one CSI-RS resource, and each CSI-RS resource corresponds to one TRP, that is, the terminal reports the FD basis vector corresponding to the CSI-RS resource in each CSI-RS resource group.

[0258] For example, the FD basis vector is W.sub.f,g.sup.H, representing a FD basis vector matrix. In W.sub.f,g.sup.H∈custom-character.sup.N.sup.3.sup.×M.sup.g, N represents a number of CSI-RS resources, M.sub.g represents a number of FD basis vectors selected for the g.sup.th group, H is a conjugate transpose, and custom-character.sup.N.sup.3.sup.×M.sup.g represents a complex matrix with dimensions of N.sub.3×M.sub.g.

[0259] Optionally, the embodiment of the disclosure includes 4 CSI-RS resources, where CSI-RS resource 1 and CSI-RS resource 2 are the 1.sup.st CSI-RS resource group, CSI-RS resource 3 and CSI-RS resource 4 are the 2.sup.nd CSI-RS resource group, and the CSI-RS resource 1, the CSI-RS resource 2, the CSI-RS resource 3 and the CSI-RS resource 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1.sup.st CSI-RSresource group, TRP**3** and TRP**4** being the 2.sup.nd CSI-RS resource group. The number of SD basis vectors is L.sub.1=L.sub.2=4, L.sub.3=L.sub.4=3. The number of FD basis vectors corresponding to one of the two groups is M.sub.1=4, the number of FD basis vectors corresponding to the other of the two groups is M.sub.2=7, W.sub.f,1∈custom-character.sup.N.sup.3.sup.×4, and W.sub.f,2∈custom-character.sup.N.sup.3.sup.×7.

[0260] It should be noted that the embodiment of the disclosure is described by taking grouping CSI-RS resources to obtain G CSI-RS resource groups as an example. In another embodiment, G first groups may be obtained by grouping a plurality of port groups in one CSI-RS resource.

[0261] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G FD basis vectors. The G pieces of FD basis vector indication information actually corresponds to the number of G first groups, which may also be understood as a one-to-one correspondence between pieces of FD basis vector indication information and first groups. In addition, each first group includes at least one port group, and each port group corresponds to one TRP, that is, the terminal reports the FD basis vector corresponding to the port group in each first group.

[0262] For example, the FD basis vector is W.sub.f,g.sup.H, representing a FD basis vector matrix. In W.sub.f,g.sup.H∈custom-character.sup.N.sup.3.sup.×M.sup.g, H is a conjugate transpose, N.sub.g represents a number of CSI-RS resources or a number of port groups in the g.sup.th group, H is the conjugate transpose, N.sub.3 represents a number of PMI subbands, M.sub.g represents a number of FD basis vectors selected for the g.sup.th group, and custom-character.sup.N.sup.3.sup.×M.sub.g represents a complex matrix with dimensions of N.sub.3×M.sub.g.

[0263] Optionally, the embodiment of the disclosure includes 4 port groups, where port group 1 and port group 2 are the 1.sup.st first group, port group 3 and port group 4 are the 2.sup.nd first group, and the port group 1, the port group 2, the port group 3 and the port group 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1.sup.st first group, TRP**3** and TRP**4** being the 2.sup.nd first group. The number of SD basis vectors is L.sub.1=L.sub.2=4, L.sub.3=L.sub.4=3. The number of FD basis vectors corresponding to one of the two groups is M.sub.1=4, the number of FD basis vectors corresponding to the other of the two groups is M.sub.2=7, W.sub.f,1∈ custom-character.sup.N.sup.3.sup.×4, and W.sub.f,1∈custom-character.sup.N.sup.3.sup.×7.

[0264] It should be noted that the SD basis vector indication information, the combination coefficient indication information and the FD basis vector indication information indicated by the CSI in the embodiment of the disclosure correspond to the CSI-RS resource group or the first group in the port group at the same time.

[0265] It should be noted that the embodiment of the disclosure is described by taking specific information

indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0266] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0267] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0268] In the third type of information, the CSI indicates at least one of following information (1)-(3).

[0269] (1) SD basis vector indication information or port selection indication information, and the SD basis vector indication information or the port selection indication information corresponds to a plurality of CSI-RS resources.

[0270] The SD basis vector indication information is represented by a SD basis vector. The SD basis vector indication information indicates $N*N_t$ SD basis vectors selected by the terminal. The port selection indication information indicates $N*N_t$ CSI-RS ports selected by the terminal, where N represents a number of CSI-RS resources or a number of port groups, and N_t represents a number of transmitting antenna ports.

[0271] In addition, the CSI sent by the terminal to the network device indicates SD basis vector indication information or port selection indication information, which actually corresponds to the number of CSI-RS resources. It may also be understood as the SD basis vector indication information or the port selection indication information being applied to a plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the SD basis vector indication information or the port selection indication information corresponds to N TRPs, and the terminal reports the SD basis vector indication information or the port selection indication information corresponding to the N TRPs.

[0272] For example, the SD basis vector is used for explanation. The SD basis vector is W_1, where $W_1 \in \mathbb{C}^{N N_t \times 2L}$ or $W_1 \in \mathbb{C}^{NP \times 2L}$. W_1 represents a matrix consisting of L SD basis vectors corresponding to the plurality of CSI-RS resources, N represents a number of CSI-RS resources, N_t represents a number of transmitting antenna ports, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, P is a number of CSI-RS ports, $\mathbb{C}^{N N_t \times 2L}$ represents a complex matrix with dimensions of $N N_t \times 2L$, and $\mathbb{C}^{NP \times 2L}$ represents a complex matrix with dimensions of $NP \times 2L$.

[0273] It should be noted that the embodiment of the disclosure is described by taking SD basis vector indication information or port selection indication information corresponding to CSI-RS resources as an example. In another embodiment, SD basis vector indication information or port selection indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0274] The CSI indicates SD basis vector indication information or port selection indication information, and the SD basis vector indication information or the port selection indication information corresponds to the plurality of port groups.

[0275] In addition, the CSI sent by the terminal to the network device indicates the SD basis vector indication information or the port selection indication information, which actually corresponds to the number of port groups. It may also be understood as the SD basis vector indication information or the port selection indication information being applied to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the SD basis vector indication information or the port selection indication information corresponds to N TRPs, and the terminal reports a SD basis vector corresponding to the N TRPs.

[0276] For example, the SD basis vector is used for explanation. The SD basis vector is W_1, where $W_1 \in \mathbb{C}^{N N_t \times 2L}$ or $W_1 \in \mathbb{C}^{NP \times 2L}$. W_1 represents a matrix consisting of L SD basis vectors corresponding to the plurality of port groups, N represents a number of port groups, N_t represents a number of transmitting antenna ports, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, P is a

number of CSI-RS ports, $\mathbb{C}^{NN_t \times 2L}$ represents a complex matrix with dimensions of $NN_t \times 2L$, and $\mathbb{C}^{NP \times 2L}$ represents a complex matrix with dimensions of $NP \times 2L$.

[0277] (2) combination coefficient indication information, and the combination coefficient indication information corresponds to a plurality of CSI-RS resources.

[0278] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates combination coefficient indication information, which is actually shared by the plurality of CSI-RS resources. It may also be understood as combination coefficient indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0279] For example, the combination coefficient indication information is $\tilde{W}_2$, representing a combination coefficient matrix, where $\tilde{W}_2 \in \mathbb{C}^{2L \times M}$. N represents a number of CSI-RS resources, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, M represents a number of FD basis vectors corresponding to the CSI-RS resources, and $\mathbb{C}^{2L \times M}$ represents a complex matrix with dimensions of $2L \times M$.

[0280] Optionally, if the number of CSI-RS resources is 2, the number of SD basis vectors corresponding to each CSI-RS resource is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and $\tilde{W}_2 \in \mathbb{C}^{12 \times 4}$.

[0281] It should be noted that the embodiment of the disclosure is described by taking combination coefficient indication information corresponding to one CSI-RS resource as an example. In another embodiment, combination coefficient indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0282] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes combination coefficient indication information, which is actually shared by the plurality of port groups. It may also be understood as combination coefficient indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0283] For example, the combination coefficient indication information is $\tilde{W}_2$, represents a combination coefficient matrix, where $\tilde{W}_2 \in \mathbb{C}^{2L \times M}$. N represents a number of port groups, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, and M represents a number of FD basis vectors corresponding to the port groups.

[0284] Optionally, if the number of port groups is 2, and the number of SD basis vectors corresponding to each port group is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and $\tilde{W}_2 \in \mathbb{C}^{12 \times 4}$.

[0285] (3) FD basis vector indication information, and the FD basis vector indication information corresponds to the plurality of CSI-RS resources.

[0286] The FD basis vector indication information indicates M FD basis vectors selected by the terminal. In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates FD basis vector indication information, which is actually shared by the plurality of CSI-RS resources. It may also be understood as FD basis vector indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0287] For example, the FD basis vector indication information is W_f, representing a FD basis vector matrix, where $W_f \in \mathbb{C}^{N_3 \times M}$. N_3 represents a number of PMI subbands, M represents a number of FD basis vectors corresponding to the CSI-RS resources, and $\mathbb{C}^{N_3 \times M}$ represents a complex matrix with dimensions of $N_3 \times M$.

[0288] Optionally, if the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and $W_f \in \mathbb{C}^{N_3 \times 4}$.

[0289] It should be noted that the embodiment of the disclosure is described by taking SD basis vector indication information corresponding to one CSI-RS resource as an example. In another embodiment, SD

basis vector indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0290] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes FD basis vector indication information, which is actually shared by the plurality of port groups. It may also be understood as FD basis vector indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0291] For example, the FD basis vector indication information is W_f, representing a FD basis vector matrix, where $W_f \in$ custom-character$^{N_3 \times M}$. N_3 represents a number of PMI subbands, and M represents a number of FD basis vectors corresponding to the port group, and custom-character$^{N_3 \times M}$ represents a complex matrix with dimensions of $N_3 \times M$.

[0292] Optionally, if the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and $W_f \in$ custom-character$^{N_3 \times 4}$.

[0293] It should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0294] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0295] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0296] It should be noted that all the above three ways are described by taking the combination coefficient indication information as an example. In another embodiment, the combination coefficient indication information includes a plurality of types of information.

[0297] Optionally, the combination coefficient indication information includes non-zero coefficient information and non-zero coefficient position information, the non-zero coefficient information indicates a non-zero coefficient in the combination coefficient indication information, and the non-zero coefficient position information indicates a position of the non-zero coefficient in the combination coefficient indication information.

[0298] It should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0299] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0300] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0301] In the solution according to the embodiment of the disclosure, the parameters indicated by the CSI include a plurality of situations, which expands the ways of the indicated parameters and thus improves the diversity of the indicated parameters.

[0302] In some embodiments, the terminal determines, according to channel information or valid channel information corresponding to each CSI-RS resource and the codebook parameter information, the SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information. Then, the terminal sends to the

network device, CSI including the SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information.

[0303] The valid channel information refers to channel information that can be used, which may also be understood as channel information including valid parameters.

[0304] In an embodiment of the disclosure, after measuring each CSI-RS resource, the terminal may determine the channel information or valid channel information corresponding to each CSI-RS resource, and the terminal can also determine the SD basis vector indication information or the port selection indication information according to the determined channel information or valid channel information and the codebook parameter information, and after the terminal determines the SD basis vector indication information or the port selection indication information, the terminal can also determine the combination coefficient indication information and the FD basis vector indication information. Then the terminal determines the CSI. The CSI can indicate the above three types of information determined by the terminal, and the CSI is then sent to the network device.

[0305] In the solution according to the embodiment of the disclosure, after measuring the CSI-RS corresponding to each CSI-RS resource, the indication information reported to the network device includes the information shared by the plurality of TRPs and individual parameters for each TRP, so the network device may determine the precoding of the terminal according to the parameters reported by the terminal, which not only reduces the feedback overhead by reporting the shared parameters, but also improves the precoding gain of the terminal by integrating the parameters of the plurality of TRPs.

[0306] Based on the embodiment illustrated in FIG. **6**, the terminal receives configuration information from the network device, in which the configuration information is used to configure codebook parameter information, and the codebook parameter information is used by the terminal to determine the CSI.

[0307] In an embodiment of the disclosure, the network device sends configuration information to the terminal, and configures codebook parameter information for the terminal via the configuration information. Subsequently, the terminal can send the CSI to the network device based on the codebook parameter information.

[0308] In some embodiments, before the network device sends the configuration information to the terminal, the network device also determines the codebook structure first, so as to configure, based on the codebook structure, the terminal with codebook parameter information matching the codebook structure.

[0309] Optionally, the terminal determines the codebook structure, and then indicates the determined codebook structure to the network device via indication information.

[0310] The terminal sends first indication information to the network device, in which the first indication information indicates an adopted codebook structure.

[0311] Optionally, the network device determines the codebook structure, and then indicates the codebook structure to the terminal via indication information.

[0312] The terminal receives second indication information from the network device, in which the second indication information indicates an adopted codebook structure.

[0313] It should be noted that the embodiment of the disclosure is described by taking the indication information indicating the codebook structure as an example. In another embodiment, the codebook structure between the network device and the terminal is agreed upon by a protocol, and the network device directly configures the terminal with codebook parameter information corresponding to the agreed codebook structure.

[0314] In the solution according to the embodiment of the disclosure, after the network device determines the codebook structure, the network device configures codebook parameter information for the terminal according to the codebook structure, which improves the accuracy of the codebook parameter information configured by the network device.

[0315] FIG. **7** illustrates a flowchart of a method for determining precoding based on a codebook according to an embodiment Csf the disclosure, which can be exemplarily applied to the network device illustrated in FIG. **1**. The method includes at least part of following contents.

[0316] At **701**, the network device receives CSI from the terminal, in which the CSI includes indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or the CSI includes indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, the port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource, and the CSI is determined by the terminal

based on channel information corresponding to each CSI-RS resource in at least one CSI-RS resource and codebook parameter information.

[0317] The CSI-RS resources are used to transmit the CSI-RS. In addition, the CSI-RS resources are configured by the network device, and the network device can send the CSI-RS to the terminal via the configured CSI-RS resources.

[0318] In the embodiment of the disclosure, the terminal measures the CSI-RS based on the at least one CSI-RS resource to obtain channel information corresponding to each CSI-RS resource measured.

[0319] In some embodiments, the CSI-RS resource is a channel measurement resource (CMR). That is, the CSI-RS resource in the embodiments of the disclosure is a CMR resource.

[0320] Optionally, different CMRs belong to a same CSI-RS resource set or different CSI-RS resource sets.

[0321] In some embodiments, each of the at least one CSI-RS resource corresponds to one TRP, and at least two TRPs are configured for CJT.

[0322] In some other embodiments, each of the plurality of port groups in the one CSI- RS resource corresponds to one TRP, and at least two TRPs are configured for CJT.

[0323] One CSI-RS resource corresponds to a plurality of CSI-RS ports, a plurality of port groups are obtained by grouping the plurality of CSI-RS ports, each port group includes at least one CSI-RS port, and each port group corresponds to one TRP.

[0324] The codebook parameter information is used by the terminal to report indication information, so that the network device can determine the precoding of the terminal. In addition, the codebook parameter information corresponds to the codebook structure. That is to say, the precoding of the terminal can be determined according to the codebook structure corresponding to the codebook parameter information and the CSI. In addition, the CSI in the embodiments of the disclosure is used to determine the precoding of the terminal based on the codebook structure corresponding to the codebook parameter information, and the CSI includes indication information. That is, the indication information included in the CSI is used to determine the precoding of the terminal based on the codebook structure corresponding to the codebook parameter information.

[0325] The CSI includes the indication information corresponding to the plurality of CSI-RS resources and the indication information corresponding to each CSI-RS resource. The indication information corresponding to the plurality of CSI-RS resources means that the indication information for determining the precoding of the terminal included in the CSI can be applied to each CSI-RS resource. That is, sending indication information can be applied to each CSI-RS resource. The indication information corresponding to each CSI-RS resource means that the parameters for determining the precoding of the terminal included in the CSI are applied to one CSI-RS resource. That is, the indication information corresponding to each CSI-RS resource is applied to the corresponding CSI-RS resource, but is not applied to other CSI-RS resources.

[0326] Alternatively, the CSI includes indication information corresponding to the plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, and the port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource. The indication information corresponding to the plurality of port groups means that the indication information for determining the precoding of the terminal included in the CSI can be applied to each port group. That is, sending indication information can be applied to each port group. The indication information corresponding to each port group means that the indication information for determining the precoding of the terminal included in the CSI is applied to one port group. That is, the parameters corresponding to each port group are applied to the corresponding port group, but are not applied to other port groups.

[0327] In an embodiment of the disclosure, after the terminal determines the channel information corresponding to each CSI-RS resource in the at least one CSI-RS resource, the terminal determines the indication information that needs to be reported to the network device based on the acquired channel information and codebook parameter information. The terminal then sends the CSI including the indication information to the network device, and the CSI is used to determine precoding parameters of the terminal.

[0328] If the at least one CSI-RS resource includes a plurality of CSI-RS resources, the terminal determines the channel information corresponding to each CSI-RS resource. If the at least one CSI-RS resource includes one CSI-RS resource, and the one CSI-RS resource corresponds to a plurality of CSI-RS ports, the terminal determines the channel information corresponding to each port group in the plurality of port groups.

[0329] In some embodiments, the network device configures the codebook parameter information for the terminal via a RRC signaling, or other signaling.

[0330] At **702**, the network device determines precoding of the terminal according to the CSI and the

codebook structure corresponding to the codebook parameter information.

[0331] The codebook parameter information corresponds to a codebook structure. If the codebook structure is different, the network device determines the precoding of the terminal based on the codebook structure in different ways.

[0332] In an embodiment of the disclosure, after the network device receives the CSI, the network device can determine parameters shared by the plurality of CSI-RS resources and parameters corresponding to each CSI-RS resource based on the CSI, indicated by the CSI, or determine parameters shared by the plurality of port groups in one CSI-RS resource and parameters corresponding to each port group, indicated by the CSI, and determine the precoding of the terminal according to the determined parameters and the codebook structure corresponding to the codebook parameter information.

[0333] In the solution according to the embodiment of the disclosure, after the terminal measures the CSI-RS corresponding to each CSI-RS resource, the indication information reported to the network device includes parameters shared by the CSI-RS resources and the parameters corresponding to each CSI-RS resource, or includes the parameters shared by the plurality of port groups corresponding to one CSI-RS resource and the parameters corresponding to each port group. The plurality of CSI-RS resources or the plurality of port groups may be understood as corresponding to the plurality of TRPs. That is, the disclosure determines parameters shared by the plurality of TRPs and individual parameters for each TRP, so the network device may determine the precoding of the terminal according to the parameters reported by the terminal, which not only reduces the feedback overhead by reporting the shared parameters, but also improves the precoding gain of the terminal by integrating the parameters of the plurality of TRPs.

[0334] Based on the embodiment illustrated in FIG. **7**, the CSI sent by the terminal includes types of information, and the included types of information includes different situations.

[0335] In the first type of information, the CSI includes at least one of following information (1)-(3).

[0336] (1) N pieces of SD basis vector indication information or N pieces of port selection indication information, where N is the same as a number of CSI-RS resources and N is a positive integer greater than 1.

[0337] The SD basis vector indication information is represented by a SD basis vector. The SD basis vector indication information indicates L_i SD basis vectors selected by the terminal, where i belongs to $\{1,2 \ldots ,N\}$. In some embodiments, the SD basis vector indication information is a SD beam basis vector, which may be referred to as a beam basis vector, or as a SD basis vector, or as a beam. The port selection indication information indicates L_i CSI-RS ports selected by the terminal.

[0338] In addition, the CSI sent by the terminal to the network device includes N pieces of SD basis vector indication information or N pieces of port selection indication information, which actually correspond to the number of CSI-RS resources. It may also be understood as a one-to-one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to each TRP.

[0339] For example, the SD basis vector indication information is used for explanation. The SD basis vector indicated by the SD basis vector indication information is $W_{1,i}$, where $W_{1,i} \in$ $^{N_t \times 2L_i}$, or $W_{1,i} \in$ $^{P \times 2L_i}$. $W_{1,i}$ represents a matrix consisting of L_i SD basis vectors corresponding to an ith CSI-RS resource, N represents the number of the CSI-RS resources, N_t represents a number of transmitting antenna ports, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the ith CSI-RS resource, $i \in \{1, \ldots , N\}$, and P is a number of CSI-RS ports. $^{X \times Y}$ represents a complex matrix with dimensions of X rows and Y columns, for example, X is N_t and Y is $2L_i$, that is, $^{N_t \times 2L_i}$. The complex matrix in the following embodiments is similar to $^{N_t \times 2L_i}$ in the embodiment of the disclosure, which is not repeated herein.

[0340] Optionally, if the number of CSI-RS resources is 2, the number of SD basis vectors corresponding to each CSI-RS resource is 4, and L_i is 4, then $W_{1,i} \in$ $^{N_t \times 8}$.

[0341] It should be noted that the embodiment of the disclosure is described by taking N pieces of SD basis vector indication information or N pieces of port selection indication information corresponding to CSI-RS resources as an example. In another embodiment, the N pieces of SD basis vector indication information or the N pieces of port selection indication information may also correspond to the plurality of port groups in

one CSI-RS resource.

[0342] The CSI includes N pieces of SD basis vector indication information or N pieces of port selection indication information, and N is the same as the number of port groups, and N is a positive integer greater than 1.

[0343] The CSI sent by the terminal to the network device includes N pieces of SD basis vector indication information or N pieces of port selection indication information, which actually correspond to the number of port groups. It may also be understood as a one-to-one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to each TRP.

[0344] For example, the SD basis vector indication information is used for explanation. The SD basis vector indicated by the SD basis vector indication information is $W_{1,i}$, where $W_{1,i} \in$ custom-character $^{N_t \times 2L_i}$, or $W_{1,i} \in$ custom-character $^{P \times 2L_i}$. $W_{1,i}$ represents a matrix consisting of L_i SD basis vectors corresponding to an ith port group, N represents the number of at least two port groups, N_t represents a number of transmitting antenna ports, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the ith port group, $i \in \{1, \ldots, N\}$, and P is a number of CSI-RS ports.

[0345] Optionally, if the number of port groups is 2, the number of SD basis vectors corresponding to each port group is 4, and L_i is 4, then $W_{1,i} \in$ custom-character $^{N_t \times 8}$.

[0346] (2) combination coefficient indication information, and the combination coefficient indication information corresponds to the plurality of CSI-RS resources.

[0347] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes combination coefficient indication information, which is actually shared by the plurality of CSI-RS resources. It may also be understood as combination coefficient indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0348] For example, a combination coefficient matrix indicated by the combination coefficient indication information is $\tilde{W}_2$, where $\tilde{W}_2 \in$ custom-character $^{\Sigma_{i=1}^{N} 2L_i \times M}$. N represents the number of CSI-RS resources, L_i represents a number of pieces of SD basis vector indication information or a number of CSI-RS ports corresponding to the ith CSI-RS resource, $i \in \{1, \ldots, N\}$, and M represents a number of FD basis vectors corresponding to the CSI-RS resource.

[0349] Optionally, if the number of CSI-RS resources is 2, the number of SD basis vectors corresponding to each CSI-RS resource is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and $\tilde{W}_2 \in$ custom-character $^{12 \times 4}$.

[0350] It should be noted that the embodiment of the disclosure is described by taking combination coefficient indication information corresponding to one CSI-RS resource as an example. In another embodiment, combination coefficient indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0351] The CSI includes combination coefficient indication information, and the combination coefficient indication information corresponds to the plurality of port groups.

[0352] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes combination coefficient indication information, which is actually shared by the plurality of port groups. It may also be understood as combination coefficient indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0353] For example, a combination coefficient matrix indicated by the combination coefficient indication information is $\tilde{W}_2$, where $\tilde{W}_2 \in$ custom-character $^{\Sigma_{i=1}^{N} 2L_i \times M}$. N represents the number of port groups, L_i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the ith port group, $i \in \{1, \ldots, N\}$, and M represents a number of FD basis vectors corresponding to the port group.

[0354] Optionally, if the number of port groups is 2, and the number of SD basis vectors corresponding to each port group is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and $\tilde{W}_2 \in \mathbb{C}^{12\times 4}$.

[0355] (3) FD basis vector indication information, and the FD basis vector indication information corresponds to the plurality of CSI-RS resources.

[0356] The FD basis vector indication information indicates M FD basis vectors selected by the terminal. The FD basis vector indication information is used to represent a change rule of the channel in the FD. Specifically, the FD basis vectors can be used to represent a change rule of a weighted coefficient of each SD basis vector in each FD unit. The change rule represented by the FD base is related to factors such as a multipath delay.

[0357] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes FD basis vector indication information, which is actually shared by the plurality of CSI-RS resources. It may also be understood as FD basis vector indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0358] For example, a FD basis vector indicated by the FD basis vector indication information is W_f, representing a FD basis vector matrix, where $W_f \in \mathbb{C}^{N_3 \times M}$. N_3 represents a number of PMI subbands, and M represents a number of FD basis vectors corresponding to the CSI-RS resources.

[0359] Optionally, if the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and $W_f \in \mathbb{C}^{N_3 \times 4}$.

[0360] It should be noted that the embodiment of the disclosure is described by taking FD basis vector indication information corresponding to one CSI-RS resource as an example. In another embodiment, FD basis vector indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0361] The CSI includes FD basis vector indication information, and the FD basis vector indication information corresponds to the plurality of port groups.

[0362] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes FD basis vector indication information, which is actually shared by the plurality of port groups. It may also be understood as FD basis vector indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0363] For example, a FD basis vector indicated by the FD basis vector indication information is W_f, representing a FD basis vector matrix, $W_f \in \mathbb{C}^{N_3 \times M}$, N_3 represents a number of PMI subbands, and M represents a number of FD basis vectors corresponding to the port group.

[0364] Optionally, if the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and $W_f \in \mathbb{C}^{N_3 \times 4}$.

[0365] It should be noted that the SD basis vector indication information, the combination coefficient indication information and the FD basis vector indication information indicated by the CSI in the embodiments of the disclosure correspond to the CSI-RS resources or the port groups at the same time.

[0366] In addition, it should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0367] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0368] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0369] It should be noted that, in the first situation, the codebook structure is expressed by following formulas:

[00004]

$$W = \begin{bmatrix} W_{1,1} & & \\ & \ddots & \\ & & W_{1,N} \end{bmatrix} \tilde{W}_2 W_f^H, W_{1,i} \in \mathbb{C}^{N_t \times 2L_i}, \text{ or } W_{1,i} \in \mathbb{C}^{P \times 2L_i}, \tilde{W}_2 \in \mathbb{C}^{.\text{Math}_{.i=1}^{N} 2L_i \times M}, W_f \in \mathbb{C}^{N_3 \times M},$$

where W represents the codebook structure, N represents the number of the CSI-RS resources, N.sub.t represents a number of transmitting antenna ports, P is a number of CSI-RS ports, L.sub.i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to an i.sup.th CSI-RS resource, i∈{1, . . . , N}, M represents a number of FD basis vectors corresponding to the i.sup.th CSI-RS resource, or a number of FD basis vectors corresponding to the i.sup.th port group, N.sub.3 represents a number of PMI subbands, W.sub.1,i represents a matrix consisting of L.sub.i SD basis vectors or unit basis vectors for port selection corresponding to the i.sup.th CSI-RS resource, {tilde over (W)}.sub.2 represents a matrix consisting of the combination coefficient indication information, W.sub.f represents a matrix consisting of M FD basis vectors, and z,**102** .sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

[0370] Alternatively, where the W represents the codebook structure, N represents the number of the port groups, N.sub.t represents a number of transmitting antenna ports, P is a number of CSI-RS ports, L.sub.i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to an i.sup.th port group, i∈{1, . . . , N}, M represents a number of FD basis vectors corresponding to the i.sup.th port group, N.sub.3 represents a number of PMI subbands, W.sub.1,i represents a matrix consisting of L.sub.i SD basis vectors or unit basis vectors for port selection corresponding to the i.sup.th port group, {tilde over (W)}.sub.2 represents a matrix consisting of the combination coefficient indication information, W.sub.f represents a matrix consisting of M FD basis vectors, and .sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

[0371] In some embodiments, if W.sub.f is off, M=1. The terminal selects L.sub.1=2, L.sub.2=4 and L.sub.3=8 ports respectively according to estimated valid information of each port, and calculates, based on the selected ports, a port combination coefficient as {tilde over (W)}.sub.2∈.sup.28×1. The network device determines a calculation formula for the precoding of the terminal

[00005]
$$W = \begin{bmatrix} W_{1,1} & & \\ & \ddots & \\ & & W_{1,3} \end{bmatrix} W_2 .$$

The UE reports indication information of W.sub.1,1, W.sub.1,2 and W.sub.1,3, respectively and each quantization coefficient information in {tilde over (W)}.sub.2, so that the network device uses them to calculate the precoding of the terminal.

[0372] In the second type of information, the plurality of CSI-RS resources are grouped to obtain G CSI-RS resource groups, and the CSI indicates information corresponding to each of the G CSI-RS resource groups. G is the same as the number of CSI-RS resource groups in the plurality of CSI-RS resources, the CSI-RS resource group includes at least one CSI-RS resource, and G is a positive integer greater than 1. Alternatively, the plurality of port groups are grouped to obtain G first groups, and the CSI indicates information corresponding to each of the G first groups. G is the same as the number of first groups among the plurality of port groups, the first group includes at least one port group, and G is a positive integer greater than 1.

[0373] The CSI indicates at least one of following information:

[0374] (1) G pieces of SD basis vector indication information or G pieces of port selection indication information (1)-(3).

[0375] The SD basis vector indication information is represented by a SD basis vector. The SD basis vector indication information indicates L.sub.g SD basis vectors selected by the terminal, where L.sub.g represents a number of SD basis vectors corresponding to a g.sup.th CSI-RS resource group, g∈{1, . . . , G}. L.sub.g represents a number and a value of SD basis vectors corresponding to each CSI-RS resource in the g.sup.th CSI-RS resource group, Alternatively, the port selection indication information indicates L.sub.g CSI-RS ports selected by the terminal, where L.sub.g represents a number of CSI-RS ports corresponding to a g.sup.th first group, g∈{1, . . . , G}. L.sub.g represents a number and a value of CSI-RS ports corresponding

to each port group in the gth first group.

[0376] In addition, the CSI sent by the terminal to the network device indicates G pieces of SD basis vector indication information or G pieces of port selection indication information, which actually correspond to the number of G CSI-RS resource groups. It may also be understood as a one-to-one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and CSI-RS resource groups. In addition, each CSI-RS resource group includes at least one CSI-RS resource, and each CSI-RS resource corresponds to one TRP, that is, the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to the CSI-RS resource in each CSI-RS resource group.

[0377] For example, the SD basis vector is used for explanation. The SD basis vector is $W_{1,g}$, where $W_{1,g} \in \mathbb{C}^{N_g N_t \times 2L_g}$. $W_{1,g}$ represents a matrix consisting of one or more SD basis vectors corresponding to the gth CSI-RS resource group, N_g represents a number of CSI-RS resources or a number of port groups in the gth group, N_t represents a number of transmitting antenna ports, L_g represents a number of SD basis vectors or a number of CSI-RS ports selected for the gth group, and $\mathbb{C}^{N_g N_t \times 2L_g}$ represents a complex matrix with dimensions of $N_g N_t \times 2L_g$.

[0378] Optionally, the embodiment of the disclosure includes 4 CSI-RS resources, where CSI-RS resource 1 and CSI-RS resource 2 are the 1st CSI-RS resource group, CSI-RS resource 3 and CSI-RS resource 4 are the 2nd CSI-RS resource group, and the CSI-RS resource 1, the CSI-RS resource 2, the CSI-RS resource 3 and the CSI-RS resource 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st CSI-RS resource group, TRP**3** and TRP**4** being the 2nd CSI-RS resource group. The number of SD basis vectors is $L_1=L_2=4$, $L_3=L_4=3$, then $W_{1,1} \in \mathbb{C}^{2N_t \times 16}$ and $W_{1,2} \in \mathbb{C}^{2N_t \times 12}$. $\mathbb{C}^{2N_t \times 16}$ represents a complex matrix with dimensions of $2N_t \times 16$, and $\mathbb{C}^{2N_t \times 12}$ represents a complex matrix with dimensions of $2N_t \times 12$.

[0379] It should be noted that the embodiment of the disclosure is described by taking grouping CSI-RS resources to obtain G CSI-RS resource groups as an example. In another embodiment, G first groups may be obtained by grouping a plurality of port groups in one CSI-RS resource.

[0380] In addition, the CSI sent by the terminal to the network device indicates G pieces of SD basis vector indication information or G pieces of port selection indication information, which actually correspond to the number of G first groups. It may also be understood as a one-to- one correspondence between pieces of SD basis vector indication information or pieces of port selection indication information and first groups. In addition, each first group includes at least one port group, and each port group corresponds to one TRP, that is, the terminal reports the piece of SD basis vector indication information or the piece of port selection indication information corresponding to the port group in each first group.

[0381] For example, the SD basis vector is used for explanation. The SD basis vector is $W_{1,g}$, where $W_{1,g} \in \mathbb{C}^{N_g N_t \times 2L_g}$. $W_{1,g}$ represents a matrix consisting of SD basis vectors corresponding to the gth first group, N_g represents a number of CSI-RS resources or a number of port groups in the gth group, N_t represents a number of transmitting antenna ports, L_g represents a number of SD basis vectors or a number of CSI-RS ports selected for the gth group, and $\mathbb{C}^{N_g N_t \times 2L_g}$ represents a complex matrix with dimensions of $N_g N_t \times 2L_g$.

[0382] Optionally, the embodiment of the disclosure includes 4 port groups, where port group 1 and port group 2 are the 1st first group, port group 3 and port group 4 are the 2nd first group, and the port group 1, the port group 2, the port group 3 and the port group 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st first group, TRP**3** and TRP**4** being the 2nd first group. The number of SD basis vectors is $L_1=L_2=4$, $L_3=L_4=3$, then $W_{1,1} \in \mathbb{C}^{2N_t \times 16}$ and $W_{1,2} \in \mathbb{C}^{2N_t \times 12}$. $\omega^{2N_t \times 16}$ represents a complex matrix with dimensions of $2N_t \times 16$, and $\mathbb{C}^{2N_t \times 12}$ represents a complex matrix with dimensions of $2N_t \times 12$.

[0383] (2) G pieces of combination coefficient indication information.

[0384] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G

pieces of combination coefficient indication information, which actually correspond to the number of G CSI-RS resource groups. It may also be understood as a one-to-one correspondence between pieces of combination coefficient indication information and CSI-RS resource groups. In addition, each CSI-RS resource group includes at least one CSI-RS resource, and each CSI-RS resource corresponds to one TRP, that is, the terminal reports the piece of combination coefficient indication information corresponding to the CSI-RS resource in each CSI-RS resource group.

[0385] For example, the combination coefficient indication information is $\tilde{W}_{2,g}$, representing a combination coefficient matrix. In $\tilde{W}_{2,g} \in \mathbb{C}^{2L_g \times M_g}$, N_g represents a number of CSI-RS resources in the gth group, L_g represents a number of CSI-RS ports selected for the gth group, M_g represents a number of FD basis vectors selected for the gth group, and $\mathbb{C}^{2L_g \times M_g}$ represents a complex matrix with dimensions of $2L_g \times M_g$.

[0386] Optionally, the embodiment of the disclosure includes 4 CSI-RS resources, where CSI-RS resource 1 and CSI-RS resource 2 are the 1st CSI-RS resource group, CSI-RS resource 3 and CSI-RS resource 4 are the 2nd CSI-RS resource group, and the CSI-RS resource 1, the CSI-RS resource 2, the CSI-RS resource 3 and the CSI-RS resource 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st CSI-RS resource group, TRP**3** and TRP**4** being the 2nd CSI-RS resource group. The number of SD basis vectors is $L_1=L_2=4$, $L_3=L_4=3$. The number of FD basis vectors corresponding to one of the two groups is $M_1=4$, the number of FD basis vectors corresponding to the other of the two groups is $M_2=7$, $\tilde{W}_{2,1} \in \mathbb{C}^{16 \times 4}$, and $\tilde{W}_{2,2} \in \mathbb{C}^{12 \times 3}$.

[0387] It should be noted that the embodiment of the disclosure is described by taking grouping CSI-RS resources to obtain G CSI-RS resource groups as an example. In another embodiment, G first groups may be obtained by grouping a plurality of port groups in one CSI-RS resource.

[0388] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G pieces of combination coefficient indication information, which actually correspond to the number of G first groups. It may also be understood as a one-to-one correspondence between pieces of combination coefficient indication information and first groups. In addition, each first group includes at least one port group, and each port group corresponds to one TRP, that is, the terminal reports combination coefficient indication information corresponding to the port group in each first group.

[0389] For example, the combination coefficient indication information is $\tilde{W}_{2,g}$, representing a combination coefficient matrix. In $\tilde{W}_{2,g} \in \mathbb{C}^{2L_g \times M_g}$, N_g represents a number of port groups in the gth group, L_g represents a number of CSI-RS ports selected for the gth group, M_g represents a number of FD basis vectors selected for the gth group, and $\mathbb{C}^{2L_g \times M_g}$ represents a complex matrix with dimensions of $2L_g \times M_g$.

[0390] Optionally, the embodiment of the disclosure includes 4 port groups, where port group 1 and port group 2 are the 1st first group, port group 3 and port group 4 are the 2nd first group, and the port group 1, the port group 2, the port group 3 and the port group 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st first group, TRP**3** and TRP**4** being the 2nd first group. The number of SD basis vectors is $L_1=L_2=4$, $L_3=L_4=3$. The number of FD basis vectors corresponding to one of the two groups is $M_1=4$, the number of FD basis vectors corresponding to the other of the two groups is $M_2=7$, $\tilde{W}_{2,1} \in \mathbb{C}^{16 \times 4}$, and $\tilde{W}_{2,2} \in \mathbb{C}^{12 \times 3}$.

[0391] (3) G pieces of FD basis vector indication information.

[0392] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G pieces of FD basis vectors, which actually correspond to the number of G CSI-RS resource groups. It may also be understood as a one-to-one correspondence between pieces of FD basis vector indication information and CSI-RS resource groups. In addition, each CSI-RS resource group includes at least one CSI-RS resource, and each CSI-RS resource corresponds to one TRP, that is, the terminal reports the FD basis vector corresponding to the CSI-RS resource in each CSI-RS resource group.

[0393] For example, the FD basis vector is $W_{f,g}^{H}$, representing a FD basis vector matrix. In $W_{f,g}^{H} \in \mathbb{C}^{N_3 \times M_g}$, N represents a number of CSI-RS resources, M_g represents a number of FD basis vectors selected for the gth group, H is a conjugate

transpose, and $\text{custom-character}^{N_3 \times M_g}$ represents a complex matrix with dimensions of $N_3 \times M_g$.

[0394] Optionally, the embodiment of the disclosure includes 4 CSI-RS resources, where CSI-RS resource 1 and CSI-RS resource 2 are the 1st CSI-RS resource group, CSI-RS resource 3 and CSI-RS resource 4 are the 2nd CSI-RS resource group, and the CSI-RS resource 1, the CSI-RS resource 2, the CSI-RS resource 3 and the CSI-RS resource 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st CSI-RS resource group, TRP**3** and TRP**4** being the 2nd CSI-RS resource group. The number of SD basis vectors is $L_1 = L_2 = 4$, $L_3 = L_4 = 3$. The number of FD basis vectors corresponding to one of the two groups is $M_1 = 4$, the number of FD basis vectors corresponding to the other of the two groups is $M_2 = 7$, $W_{f,1} \in \text{custom-character}^{N_3 \times 4}$, and $W_{f,2} \in \text{custom-character}^{N_3 \times 7}$.

[0395] It should be noted that the embodiment of the disclosure is described by taking grouping CSI-RS resources to obtain G CSI-RS resource groups as an example. In another embodiment, G first groups may be obtained by grouping a plurality of port groups in one CSI-RS resource.

[0396] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates G FD basis vectors. The G pieces of FD basis vector indication information actually corresponds to the number of G first groups, which may also be understood as a one-to-one correspondence between pieces of FD basis vector indication information and first groups. In addition, each first group includes at least one port group, and each port group corresponds to one TRP, that is, the terminal reports the FD basis vector corresponding to the port group in each first group.

[0397] For example, the FD basis vector is $W_{f,g}^H$, representing a FD basis vector matrix. In $W_{f,g}^H \in \text{custom-character}^{N_3 \times M_g}$, H is a conjugate transpose, N_g represents a number of CSI-RS resources or a number of port groups in the gth group, H is the conjugate transpose, N_3 represents a number of PMI subbands, M_g represents a number of FD basis vectors selected for the gth group, and $\text{custom-character}^{N_3 \times M_g}$ represents a complex matrix with dimensions of $N_3 \times M_g$.

[0398] Optionally, the embodiment of the disclosure includes 4 port groups, where port group 1 and port group 2 are the 1st first group, port group 3 and port group 4 are the 2nd first group, and the port group 1, the port group 2, the port group 3 and the port group 4 correspond to TRP**1**, TRP**2**, TRP**3** and TRP**4** respectively, which may also be understood as TRP**1** and TRP**2** being the 1st first group, TRP**3** and TRP**4** being the 2nd first group. The number of SD basis vectors is $L_1 = L_2 = 4$, $L_3 = L_4 = 3$. The number of FD basis vectors corresponding to one of the two groups is $M_1 = 4$, the number of FD basis vectors corresponding to the other of the two groups is $M_2 = 7$, $W_{f,1} \in \text{custom-character}^{N_3 \times 4}$, and $W_{f,1} \in \text{custom-character}^{N_3 \times 7}$.

[0399] It should be noted that the SD basis vector indication information, the combination coefficient indication information and the FD basis vector indication information indicated by the CSI in the embodiment of the disclosure correspond to the CSI-RS resource group or the first group in the port group at the same time.

[0400] It should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0401] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0402] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0403] It should be noted that, in the second situation, the codebook structure is expressed by following formulas:

[00006] $W = \begin{bmatrix} W_{1,1} \tilde{W}_{2,1} W_{f,1}^{H} \\ \quad .\text{Math.} \\ W_{1,g} \tilde{W}_{2,g} W_{f,g}^{H} \end{bmatrix}$, $W_{1,g} \in \mathbb{C}^{N_g N_t \times 2L_g}$, $\tilde{W}_{2,g} \mathbb{C}^{2L_g \times M_g}$, $W_{f,g}^{H} \in \mathbb{C}^{N_3 \times M_g}$

where W represents the codebook structure, W.sub.1,g represents a matrix consisting of SD basis vectors or unit basis vectors for port selection corresponding to CSI-RS resources in the g.sup.th group, N.sub.g represents a number of CSI-RS resources in the g.sup.th group, N.sub.t represents a number of transmitting antenna ports, W.sup.f,g represents a matrix consisting of M.sup.g FD basis vectors corresponding to the CSI-RS resource in the g.sup.th group, M.sub.g represents a number of FD basis vectors selected for the g.sup.th group, {tilde over (W)}.sub.2,g represents a matrix consisting of combination coefficients corresponding to CSI-RS resources in the g.sup.th group, L.sub.g represents a number of SD basis vectors or a number of CSI-RS ports selected for the g.sup.th group, G represents being the same as the number of CSI-RS resource groups in the plurality of CSI-RS resources, G is a positive integer greater than 1, H is a conjugate transpose, N.sub.3 represents a number of PMI subbands, custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

[0404] Alternatively, where W represents the codebook structure, W.sub.1,g represents a matrix consisting of SD basis vectors or unit basis vectors for port selection corresponding to port groups in the g.sup.th group, N.sub.g represents a number of port groups in the g.sup.th group, N.sub.t represents a number of transmitting antenna ports, W.sub.f,g represents a matrix consisting of M.sub.g FD basis vectors corresponding to port groups in the g.sup.th group, M.sub.g represents a number of FD basis vectors selected for the g.sup.th group, {tilde over (W)}.sub.2,g represents a matrix consisting of combination coefficients corresponding to port groups in the g.sup.th group, L.sub.g represents a number of SD basis vectors or a number of CSI-RS ports selected for the g.sup.th group, G represents being the same as the number of first groups among the port groups, G is a positive integer greater than 1, H is a conjugate transpose, N.sub.3 represents a number of PMI subbands, and custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

[0405] In the third type of information, the CSI indicates at least one of following information (1)-(3).

[0406] (1) SD basis vector indication information or port selection indication information, and the SD basis vector indication information or the port selection indication information corresponds to a plurality of CSI-RS resources.

[0407] The SD basis vector indication information is represented by a SD basis vector. The SD basis vector indication information indicates N*N.sub.t SD basis vectors selected by the terminal. The port selection indication information indicates N*N.sub.t CSI-RS ports selected by the terminal, where N represents a number of CSI-RS resources or a number of port groups, and N.sub.t represents a number of transmitting antenna ports.

[0408] In addition, the CSI sent by the terminal to the network device indicates SD basis vector indication information or port selection indication information, which actually corresponds to the number of CSI-RS resources. It may also be understood as the SD basis vector indication information or the port selection indication information being applied to a plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the SD basis vector indication information or the port selection indication information corresponds to N TRPs, and the terminal reports the SD basis vector indication information or the port selection indication information corresponding to the N TRPs.

[0409] For example, the SD basis vector is used for explanation. The SD basis vector is W.sub.1, where W.sub.1∈custom-character.sup.NN.sup.t.sup.×2L or W.sub.1∈custom-character.sup.NP×2L. W.sub.1 represents a matrix consisting of L SD basis vectors corresponding to the plurality of CSI-RS resources, N represents a number of CSI-RS resources, N.sub.t represents a number of transmitting antenna ports, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, P is a number of CSI-RS ports, custom-character.sup.NN.sup.t.sup.×2L represents a complex matrix with dimensions of NN.sub.t×2L, and custom-character.sup.NP×2L represents a complex matrix with dimensions of NP×2L.

[0410] It should be noted that the embodiment of the disclosure is described by taking SD basis vector indication information or port selection indication information corresponding to CSI-RS resources as an example. In another embodiment, SD basis vector indication information or port selection indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0411] The CSI indicates SD basis vector indication information or port selection indication information, and the SD basis vector indication information or the port selection indication information corresponds to the plurality of port groups.

[0412] In addition, the CSI sent by the terminal to the network device indicates the SD basis vector indication information or the port selection indication information, which actually corresponds to the number of port groups. It may also be understood as the SD basis vector indication information or the port selection indication information being applied to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the SD basis vector indication information or the port selection indication information corresponds to N TRPs, and the terminal reports a SD basis vector corresponding to the N TRPs.

[0413] For example, the SD basis vector is used for explanation. The SD basis vector is W_1, where $W_1 \in$ custom-character$^{NN_t \times 2L}$ or $W_1 \in$ custom-character$^{NP \times 2L}$. W_1 represents a matrix consisting of L SD basis vectors corresponding to the plurality of port groups, N represents a number of port groups, N_t represents a number of transmitting antenna ports, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, P is a number of CSI-RS ports, custom-character$^{NN_t \times 2L}$ represents a complex matrix with dimensions of $NN_t \times 2L$, and custom-character$^{NP \times 2L}$ represents a complex matrix with dimensions of $NP \times 2L$.

[0414] (2) combination coefficient indication information, and the combination coefficient indication information corresponds to a plurality of CSI-RS resources.

[0415] In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates combination coefficient indication information, which is actually shared by the plurality of CSI-RS resources. It may also be understood as combination coefficient indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0416] For example, the combination coefficient indication information is $\tilde{W}_2$, representing a combination coefficient matrix, where $\tilde{W}_2 \in$ custom-character$^{2L \times M}$. N represents a number of CSI-RS resources, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, M represents a number of FD basis vectors corresponding to the CSI-RS resources, and custom-character$^{2L \times M}$ represents a complex matrix with dimensions of $2L \times M$.

[0417] Optionally, if the number of CSI-RS resources is 2, the number of SD basis vectors corresponding to each CSI-RS resource is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and $\tilde{W}_2 \in$ custom-character$^{12 \times 4}$.

[0418] It should be noted that the embodiment of the disclosure is described by taking combination coefficient indication information corresponding to one CSI-RS resource as an example. In another embodiment, combination coefficient indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0419] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes combination coefficient indication information, which is actually shared by the plurality of port groups. It may also be understood as combination coefficient indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports combination coefficient indication information shared by the plurality of TRPs.

[0420] For example, the combination coefficient indication information is $\tilde{W}_2$, represents a combination coefficient matrix, where $\tilde{W}_2 \in$ custom-character$^{2L \times M}$. N represents a number of port groups, L represents a number of SD basis vectors or a number of CSI-RS ports corresponding to the CSI-RS resources, and M represents a number of FD basis vectors corresponding to the port groups.

[0421] Optionally, if the number of port groups is 2, and the number of SD basis vectors corresponding to each port group is 4, L_i is 4, and the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and $\tilde{W}_2 \in$ custom-character$^{12 \times 4}$.

[0422] (3) FD basis vector indication information, and the FD basis vector indication information corresponds to the plurality of CSI-RS resources.

[0423] The FD basis vector indication information indicates M FD basis vectors selected by the terminal. In an embodiment of the disclosure, the CSI sent by the terminal to the network device indicates FD basis vector indication information, which is actually shared by the plurality of CSI-RS resources. It may also be understood as FD basis vector indication information corresponding to the plurality of CSI-RS resources. In addition, each CSI-RS resource corresponds to one TRP, that is, the N CSI-RS resources correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0424] For example, the FD basis vector indication information is W.sub.f, representing a FD basis vector matrix, where W.sub.f∈ custom-character.sup.N.sup.3.sup.×M. N.sub.3 represents a number of PMI subbands, M represents a number of FD basis vectors corresponding to the CSI-RS resources, and custom-character.sup.N.sup.3.sup.×M represents a complex matrix with dimensions of N.sub.3×M.

[0425] Optionally, if the number of FD basis vectors corresponding to at least two CSI-RS resources is 4, then M is 4, and W.sub.f∈ custom-character.sup.N.sup.3.sup.×4.

[0426] It should be noted that the embodiment of the disclosure is described by taking SD basis vector indication information corresponding to one CSI-RS resource as an example. In another embodiment, SD basis vector indication information may also correspond to a plurality of port groups in one CSI-RS resource.

[0427] In an embodiment of the disclosure, the CSI sent by the terminal to the network device includes FD basis vector indication information, which is actually shared by the plurality of port groups. It may also be understood as FD basis vector indication information corresponding to the plurality of port groups. In addition, each port group corresponds to one TRP, that is, the N port groups correspond to N TRPs, and the terminal reports FD basis vector indication information shared by the plurality of TRPs.

[0428] For example, the FD basis vector indication information is W.sub.f, representing a FD basis vector matrix, where W.sub.f∈ custom-character.sup.N.sup.3.sup.×M. N.sub.3 represents a number of PMI subbands, and M represents a number of FD basis vectors corresponding to the port group, and custom-character.sup.N.sup.3.sup.×M represents a complex matrix with dimensions of N.sub.3×M.

[0429] Optionally, if the number of FD basis vectors corresponding to at least two port groups is 4, then M is 4, and W.sub.f∈ custom-character.sup.N.sup.3.sup.×4.

[0430] It should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0431] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0432] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0433] It should be noted that, in the third situation, the codebook structure is expressed by following formulas:

$$W=W.sub.1\{tilde\ over\ (W)\}.sub.2 W.sub.f.sup.H,\ W.sub.1∈ \text{custom-character.sup.NN.sup.t.sup.×2L, or}$$

W.sub.1∈ custom-character.sup.NP×2L, *{tilde over (W)}*.sub.2∈ custom-character.sup.2L×M, W.sub.f∈ custom-character.sup.N.sup.3.sup.×M

where W represents the codebook structure, N represents the number of the CSI-RS resources, N.sub.t represents a number of transmitting antenna ports, L represents a number of SD basis vectors or CSI-RS ports corresponding to the CSI-RS resources, M represents a number of FD basis vectors corresponding to the CSI-RS resources, N.sub.3 represents a number of PMI subbands, W.sub.1 represents a matrix consisting of L SD basis vectors or unit basis vectors for port selection for the CSI-RS resources, {tilde over (W)}.sub.2 represents a matrix consisting of the combination coefficient indication information, W.sub.f represents a matrix consisting of M frequency domain basis vectors, H is a conjugate transpose, and custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

[0434] It should be noted that all the above three ways are described by taking the combination coefficient indication information as an example. In another embodiment, the combination coefficient indication information includes a plurality of types of information.

[0435] Optionally, the combination coefficient indication information includes non-zero coefficient information and non-zero coefficient position information, the non-zero coefficient information indicates a non-zero coefficient in the combination coefficient indication information, and the non-zero coefficient position information indicates a position of the non-zero coefficient in the combination coefficient indication information.

[0436] In some embodiments, the network device receives CSI from the terminal, in which the CSI includes the SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information.

[0437] The SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information are determined by the terminal according to the channel information or the valid channel information corresponding to each CSI-RS resource and the codebook parameter information.

[0438] It should be noted that the embodiment of the disclosure is described by taking specific information indicated by the CSI sent by the terminal to the network device as an example. In another embodiment, the network device needs to configure codebook parameter information for the terminal first, and then the terminal sends CSI to the network device according to the codebook parameter information.

[0439] The codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each CSI-RS resource, a number of FD basis vectors corresponding to the CSI-RS resource, a number of PMI subbands, or a number of transmitting antenna ports. Alternatively, the codebook parameter information configured by the network device for the terminal includes at least one of: a number of SD basis vectors corresponding to each port group, a number of FD basis vectors corresponding to the port group, a number of PMI subbands, or a number of transmitting antenna ports.

[0440] In some embodiments, after the network device configures codebook parameter information for the terminal, the terminal determines parameters indicated by the CSI according to the configured codebook parameter information, and then sends the CSI to the network device.

[0441] In the solution according to the embodiment of the disclosure, the parameters indicated by the CSI include a plurality of situations, which expands the ways of the indicated parameters and thus improves the diversity of the indicated parameters.

[0442] Based on the embodiment illustrated in FIG. 7, the network device configures codebook parameters for the terminal via configuration information. The network device sends the configuration information to the terminal. The configuration information is used to configure codebook parameter information, and the codebook parameter information is used by the terminal to determine the CSI.

[0443] In an embodiment of the disclosure, the network device sends configuration information to the terminal, and configures the codebook parameter information for the terminal via the configuration information. Subsequently, the terminal can send the CSI to the network device based on the codebook parameter information.

[0444] In some embodiments, before the network device sends the configuration information to the terminal, the network device also determines the codebook structure first, so as to configure, based on the codebook structure, the terminal with codebook parameter information matching the codebook structure.

[0445] Optionally, the terminal determines the codebook structure, and then indicates the determined codebook structure to the network device via indication information.

[0446] The terminal sends first indication information to the network device, in which the first indication information indicates an adopted codebook structure.

[0447] Optionally, the network device determines the codebook structure, and then indicates the codebook structure to the terminal via indication information.

[0448] The terminal receives second indication information from the network device, in which the second indication information indicates an adopted codebook structure.

[0449] It should be noted that the embodiment of the disclosure is described by taking the indication information indicating the codebook structure as an example. In another embodiment, the codebook structure between the network device and the terminal is agreed upon by a protocol, and the network device directly configures the terminal with codebook parameter information corresponding to the agreed codebook

structure.

[0450] In the solution according to the embodiment of the disclosure, after the network device determines the codebook structure, the network device configures codebook parameter information for the terminal according to the codebook structure, which improves the accuracy of the codebook parameter information configured by the network device.

[0451] FIG. **8** illustrates a block diagram of an apparatus for determining precoding based on a codebook according to an embodiment of the disclosure. Referring to FIG. **8**, the apparatus includes a determination module **801** and a sending module **802**.

[0452] The determination module **801** is configured to determine channel information corresponding to each CSI-RS resource based on at least one CSI-RS resource.

[0453] The sending module **802** is configured to send, according to the channel information determined corresponding to each CSI-RS resource and codebook parameter information, CSI to a network device. The CSI includes indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or the CSI includes indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, the port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource.

[0454] The CSI is configured to determine the precoding of the terminal based on a codebook structure corresponding to the codebook parameter information.

[0455] In some embodiments, the CSI includes at least one of following information: N pieces of SD basis vector indication information or N pieces of port selection indication information, where N is the same as a number of the CSI-RS resources or the same as a number of the port groups, and N is a positive integer greater than 1; one piece of combination coefficient indication information, in which the combination coefficient indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource; or one piece of FD basis vector indication information, in which the one piece of FD basis vector indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource.

[0456] In some embodiments, the CSI includes at least one of following information: G pieces of SD basis vector indication information or G pieces of port selection indication information; G pieces of combination coefficient indication information; or G pieces of FD basis vector indication information. G is the same as a number of CSI-RS resource groups in the plurality of CSI-RS resources, and the CSI-RS resource group includes at least one CSI-RS resource, or G is the same as a number of first groups among the plurality of port groups in the one CSI-RS resource, and the first group includes at least one port group, and G is a positive integer greater than 1.

[0457] In some embodiments, the CSI includes at least one of following information: one piece of SD basis vector indication information or one piece of port selection indication information, in which the SD indication information or the port selection indication information corresponds to the plurality of CSI-RS resources, or the plurality of port groups in the one CSI-RS resource; one piece of combination coefficient indication information, in which the combination coefficient indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource; or one piece of FD basis vector indication information, in which the FD basis vector indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource.

[0458] In some embodiments, the combination coefficient indication information includes non-zero coefficient information and non-zero coefficient position information, the non- zero coefficient information indicates a non-zero coefficient in the combination coefficient indication information, and the non-zero coefficient position information indicates a position of the non-zero coefficient in the combination coefficient indication information.

[0459] In some embodiments, the determination module **801** is configured to determine, according to channel information or valid channel information corresponding to each CSI-RS resource and the codebook parameter information, the SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information.

[0460] The sending module is also configured to send the CSI to the network device, in which the CSI includes the SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information.

[0461] In some embodiments, referring to FIG. **9**, the apparatus further includes: a receiving module **803** is configured to receive configuration information from the network device, in which the configuration information is used to configure the codebook parameter information, and the codebook parameter information is used by the terminal to determine the CSI.

[0462] In some embodiments, the sending module **802** is further configured to: send first indication information to the network device, in which the first indication information indicates an adopted codebook structure; or receive second indication information from the network device, in which the second indication information indicates an adopted codebook structure.

[0463] In some embodiments, the CSI-RS resource is a CMR.

[0464] In some embodiments, different CMRs belong to a same CSI-RS resource set or different CSI-RS resource sets.

[0465] In some embodiments, each of the plurality of CSI-RS resources corresponds to one TRP, and at least two TRPs are configured for CJT; or each of the plurality of port groups in the one CSI-RS resource corresponds to one TRP, and at least two TRPs are configured for CJT.

[0466] It should be noted that the apparatus according to the above embodiments, when implementing the functions of the apparatus, only the division of the above-mentioned functional modules is taken as an example. In actual applications, the above-mentioned functions can be assigned to different functional modules as needed. That is, the internal structure of the apparatus can be divided into different functional modules to complete all or part of the functions described above. In addition, the apparatus and the method according to the above embodiments belong to the same concept, and the specific implementations of the apparatus are detailed in the method embodiments, which will not be repeated here.

[0467] FIG. **10** illustrates a block diagram of an apparatus for determining precoding based on a codebook according to an embodiment of the disclosure. Referring to FIG. **10**, the apparatus includes a receiving module **1001** and a determination module **1002**.

[0468] The receiving module **1001** is configured to receive CSI from a terminal, in which the CSI includes indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or the CSI includes indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, the port group includes a plurality of CSI-RS ports corresponding to the CSI-RS resource, and the CSI is determined by a terminal based on channel information corresponding to each CSI-RS resource in at least one CSI-RS resource and codebook parameter information.

[0469] The determination module **1002** is configured to determine, according to the CSI and a codebook structure corresponding to the codebook parameter information, precoding of the terminal.

[0470] In some embodiments, the CSI includes at least one of following information: N pieces of SD basis vector indication information or N pieces of port selection indication information, where N is the same as a number of the CSI-RS resources or a number of the port groups, and N is a positive integer greater than 1; one piece of combination coefficient indication information, in which the one piece of combination coefficient indication information corresponds to the plurality of CSI-RS resources, or corresponds to the plurality of port groups in the one CSI- RS resource; one piece of FD basis vector indication information, in which the one piece of FD basis vector indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource.

[0471] In some embodiments, the codebook structure is expressed by following formulas:

[00007]

$$W = \begin{bmatrix} W_{1,1} & & \\ & \ddots & \\ & & W_{1,N} \end{bmatrix} \tilde{W}_2 W_f^H , W_{1,i} \in \mathbb{C}^{N_t \times 2L_i} \text{ or } W_{1,i} \in \mathbb{C}^{P \times 2L_i} , \tilde{W}_2 \in \mathbb{C}^{.\text{Math.}_{i=1}^{N} 2L_i \times M} , W_f \in \mathbb{C}^{N_3 \times M}$$

where W represents the codebook structure, N represents the number of the CSI-RS resources or the number of the port groups, N.sub.t represents a number of transmitting antenna ports, P is a number of CSI-RS ports, L.sub.i represents a number of SD basis vectors or a number of CSI-RS ports corresponding to an i.sup.th CSI-RS resource, i∈{1, . . . , N}, or a number of SD basis vectors or a number of CSI-RS ports corresponding to an i.sup.th port group, i∈{1, . . . , N}, M represents a number of FD basis vectors corresponding to the i.sup.th CSI-RS resource, or a number of FD basis vectors corresponding to the i.sup.th port group, N.sub.3 represents a number of PMI subbands, W.sub.1,i represents a matrix consisting of L.sub.i SD basis vectors or unit basis vectors for port selection corresponding to the i.sup.th CSI-RS resource, or a

matrix consisting of L.sub.i SD basis vectors or unit basis vectors for port selection corresponding to the i.sup.th port group, {tilde over (W)}.sub.2 represents a matrix consisting of the combination coefficient indication information, W.sub.f represents a matrix consisting of M FD basis vectors, H is a conjugate transpose, and custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

[0472] In some embodiments, the CSI includes at least one of following information: G pieces of SD basis vector indication information or G pieces of port selection indication information; G pieces of combination coefficient indication information; or G pieces of FD basis vector indication information. G is the same as a number of CSI-RS resource groups in the plurality of CSI-RS resources, and the CSI-RS resource group includes at least one CSI-RS resource, or G is the same as a number of first groups among the plurality of port groups in the one CSI-RS resource, and the first group includes at least one port group, and G is a positive integer greater than 1.

[0473] In some embodiments, the codebook structure is expressed by following formulas:

$$[00008]\ W = \begin{bmatrix} W_{1,1}\,\tilde{W}_{2,1}\,W_{f,1}^{H} \\ .\text{Math.} \\ W_{1,g}\,\tilde{W}_{2,g}\,W_{f,g}^{H} \end{bmatrix},\ W_{1,g} \in \mathbb{C}^{N_g N_t \times 2L_g},\ \tilde{W}_{2,g}\,\mathbb{C}^{2L_g \times M_g},\ W_{f,g}^{H} \in \mathbb{C}^{N_3 \times M_g}$$

where the W represents the codebook structure, W.sub.1,g represents a matrix consisting of SD basis vectors or unit basis vectors for port selection corresponding to CSI-RS resources in a g.sup.th group, g∈{1, . . . , G}, or a matrix consisting of SD basis vectors or unit basis vectors for port selection corresponding to port groups in a g.sup.th group, N.sub.g represents a number of CSI-RS resources or a number of port groups in the g.sup.th group, N.sub.t represents a number of transmitting antenna ports, W.sub.f,g represents a matrix consisting of M.sub.g FD basis vectors corresponding to CSI-RS resources in the g.sup.th group, or a matrix consisting of M.sub.g FD basis vectors corresponding to port groups in the g.sup.th group, M.sub.g represents a number of FD basis vectors selected for the g.sup.th group, {tilde over (W)}.sub.2,g represents a matrix consisting of combination coefficients corresponding to CSI-RS resources in the g.sup.th group, or a matrix consisting of combination coefficients corresponding to port groups in the g.sup.th group, L.sub.g represents a number of SD basis vectors or a number of CSI-RS ports selected for the g.sup.th group, G represents being the same as the number of CSI-RS resource groups in the plurality of CSI-RS resources or the number of first groups among the port groups, G is a positive integer greater than 1, N.sub.3 represents a number of PMI subbands, H is a conjugate transpose, and custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

[0474] In some embodiments, the CSI includes at least one of following information: one piece of SD basis vector indication information, in which the SD basis vector indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource; one piece of combination coefficient indication information, in which the one piece of combination coefficient indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource; or one piece of FD basis vector indication information, in which the one piece of FD basis vector indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource.

[0475] In some embodiments, the codebook structure is expressed by following formulas:

W=W.sub.1{tilde over (W)}.sub.2*W*.sub.f.sup.H, *W*.sub.1∈custom-character.sup.NN.sup.t.sup.×2L, or *W*.sub.1∈custom-character.sup.NP×2L, *{tilde over (W)}*.sub.2∈custom-character.sup.2L×M, *W*.sub.f∈custom-character.sup.N.sup.3.sup.×M

where W represents the codebook structure, N represents the number of the CSI-RS resources or the number of the port groups, N.sub.t represents a number of transmitting antenna ports, L represents a number of SD basis vectors or CSI-RS ports corresponding to the CSI-RS resources, or a number of SD basis vectors or CSI-RS ports corresponding to the port groups, M represents a number of FD basis vectors corresponding to the CSI-RS resources, or a number of FD basis vectors corresponding to the port groups, N.sub.3 represents a number of PMI subbands, W.sub.1 represents a matrix consisting of L SD basis vectors or unit basis vectors for port selection for the CSI-RS resources, or a matrix consisting of L SD basis vectors or unit basis vectors for port selection for the port groups, {tilde over (W)}.sub.2 represents a matrix consisting of the combination coefficient indication information, W.sub.f represents a matrix consisting of M FD basis

vectors, H is a conjugate transpose, and custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

[0476] In some embodiments, the combination coefficient indication information includes non-zero coefficient information and non-zero coefficient position information, the non-zero coefficient information indicates a non-zero coefficient in the combination coefficient indication information, and the non-zero coefficient position information indicates a position of the non-zero coefficient in the combination coefficient indication information.

[0477] In some embodiments, the receiving module **1001** is further configured to receive the CSI from the terminal, in which the CSI includes the SD basis vector indication information, the combination coefficient indication information and the FD basis vector indication information. The SD basis vector indication information or the port selection indication information, the combination coefficient indication information and the FD basis vector indication information are determined by the terminal according to channel information or valid channel information corresponding to each CSI-RS resource and the codebook parameter information.

[0478] In some embodiments, referring to FIG. **11**, the apparatus further comprises: a sending module **1003**, configured to send configuration information to the terminal, in which the configuration information is used to configure codebook parameter information, and the codebook parameter information is used by the terminal to determine the CSI.

[0479] In some embodiments, the receiving module **1001** is further configured to: receive first indication information from a terminal, in which the first indication information indicates an adopted codebook structure; or send second indication information to the terminal, in which the second indication information indicates an adopted codebook structure.

[0480] In some embodiments, the CSI-RS resource is a CMR.

[0481] In some embodiments, different CMRs belong to a same CSI-RS resource set or different CSI-RS resource sets.

[0482] In some embodiments, each of the plurality of CSI-RS resources corresponds to one TRP, and at least two TRPs are configured for CJT; or each of the plurality of port groups in the one CSI-RS resource corresponds to one TRP, and at least two TRPs are configured for CJT.

[0483] It should be noted that the apparatus according to the above embodiments, when implementing the functions of the apparatus, only the division of the above-mentioned functional modules is taken as an example. In actual applications, the above-mentioned functions can be assigned to different functional modules as needed. That is, the internal structure of the apparatus can be divided into different functional modules to complete all or part of the functions described above. In addition, the apparatus and the method according to the above embodiments belong to the same concept, and the specific implementations of the apparatus are detailed in the method embodiments, which will not be repeated here.

[0484] FIG. **12** illustrates a structure diagram of a communication device according to an embodiment of the disclosure. The communication device includes: a processor **1201**, a receiver **1202**, a transmitter **1203**, a memory **1204** and a bus **1205**.

[0485] The processor **1201** includes one or more processing cores. The processor **1201** executes various functional applications and information processing by running software programs and modules.

[0486] The receiver **1202** and the transmitter **1203** may be implemented as a communication component, which may be a communication chip.

[0487] The memory **1204** is connected to the processor **1201** via the bus **1205**.

[0488] The memory **1204** may be used to store at least one program code, and the at least one program code is executed by the processor **1201**, to implement each step in the above method embodiments.

[0489] Furthermore, the communication device may be a terminal or a network device. The memory **1204** may be implemented by any type of volatile or non-volatile storage device or their combination, and the volatile or non-volatile storage devices include but are not limited to: a magnetic disk or an optical disk, an electrically erasable programmable read-only memory (EEPROM), an erasable programmable read-only memory (EPROM), a static random access memory (SRAM), a read-only memory (ROM), a magnetic memory, a flash memory, and a programmable read-only memory (PROM).

[0490] In an embodiment, a computer-readable storage medium is also provided, in which executable program code is stored. The executable program code is loaded and executed by a processor, to implement the method for determining precoding based on a codebook according to the above-mentioned various method embodiments, which is executed by the communication device.

[0491] In an embodiment, a chip is provided, which includes a programmable logic circuit and/or program instructions. When the chip runs on a terminal or a network device, it is used to implement the method for determining precoding based on a codebook according to each of the above-mentioned method embodiments.

[0492] In an embodiment, a computer program product is provided. When the computer program product is executed by a processor of a terminal or a network device, it is used to implement the method for determining precoding based on a codebook according to each of the above-mentioned method embodiments.

[0493] A person skilled in the art may understand that all or part of the steps to implement the above embodiments may be accomplished by hardware or by instructing related hardware via a program, and the program may be stored in a computer-readable storage medium, and the above-mentioned storage medium may be a ROM, a disk or an optical disk, etc.

[0494] The above descriptions are only optional embodiments of the disclosure and are not intended to limit the disclosure. Any modifications, equivalent substitutions, improvements, etc. made within the principles of the disclosure shall be included in the protection scope of the disclosure.

Claims

1. A method for determining precoding based on a codebook, performed by a terminal, the method comprising: determining, based on at least one channel status information reference signal (CSI-RS) resource, channel information corresponding to each CSI-RS resource; and sending, according to the channel information determined corresponding to each CSI-RS resource and codebook parameter information, CSI to a network device, wherein the CSI comprises indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or the CSI comprises indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, the port group comprises a plurality of CSI-RS ports corresponding to the CSI-RS resource; wherein the CSI is configured to determine precoding of the terminal based on a codebook structure corresponding to the codebook parameter information.

2. The method according to claim 1, wherein the CSI comprises at least one of following information: N pieces of spatial domain basis vector indication information or N pieces of port selection indication information, where N is the same as a number of the CSI-RS resources or a number of the port groups, and N is a positive integer greater than 1; combination coefficient indication information, wherein the combination coefficient indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource; or frequency domain basis vector indication information, wherein the frequency domain basis vector indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource; or wherein the CSI comprises at least one of following information: G pieces of spatial domain basis vector indication information or G pieces of port selection indication information; G pieces of combination coefficient indication information; or G pieces of frequency domain basis vector indication information; wherein G is the same as a number of CSI-RS resource groups in the plurality of CSI- RS resources, and the CSI-RS resource group comprises at least one CSI-RS resource, or G is the same as a number of first groups among the plurality of port groups in the one CSI-RS resource, and the first group comprises at least one port group, and G is a positive integer greater than 1; or wherein the CSI comprises at least one of following information: spatial domain basis vector indication information or port selection indication information, wherein the spatial domain basis vector indication information or the port selection indication information corresponds to the plurality of CSI-RS resources, or the plurality of port groups in the one CSI-RS resource; combination coefficient indication information, wherein the combination coefficient indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource; or frequency domain basis vector indication information, wherein the frequency domain basis vector indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource.

3. (canceled)

4. (canceled)

5. The method according to claim 2, wherein the combination coefficient indication information comprises non-zero coefficient information and non-zero coefficient position information, the non-zero coefficient

information indicates non-zero coefficient(s) in the combination coefficient indication information, and the non-zero coefficient position information indicates a position of the non-zero coefficient in the combination coefficient indication information.

6. The method according to claim 2, wherein sending, according to the channel information determined corresponding to each CSI-RS resource and codebook parameter information, CSI to the network device comprises: determining, according to channel information or valid channel information corresponding to each CSI-RS resource and the codebook parameter information, the spatial domain basis vector indication information or the port selection indication information, the combination coefficient indication information and the frequency domain basis vector indication information; and sending the CSI to the network device, wherein the CSI comprises the spatial domain basis vector indication information or the port selection indication information, the combination coefficient indication information and the frequency domain basis vector indication information.

7. The method according to claim 1, further comprising: receiving configuration information from the network device, wherein the configuration information is used to configure the codebook parameter information, and the codebook parameter information is used by the terminal to determine the CSI.

8. The method according to claim 7, further comprising one of: sending first indication information to the network device, wherein the first indication information indicates an adopted codebook structure; or receiving second indication information from the network device, wherein the second indication information indicates an adopted codebook structure.

9. The method according to claim 1, wherein the CSI-RS resource is a channel measurement resource (CMR).

10. The method according to claim 9, wherein different CMRs belong to a same CSI-RS resource set or different CSI-RS resource sets.

11. The method according to claim 1, wherein each of the plurality of CSI- RS resources corresponds to one transmission reception point (TRP), and at least two TRPs are configured for coherent joint transmission (CJT); or each of the plurality of port groups in the one CSI-RS resource corresponds to one TRP, and at least two TRPs are configured for CJT.

12. A method for determining precoding based on a codebook, performed by a network device, the method comprising: receiving channel status information (CSI) from a terminal, wherein the CSI comprises indication information corresponding to a plurality of channel status information reference signal (CSI-RS) resources and indication information corresponding to each CSI-RS resource, or the CSI comprises indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, the port group comprises a plurality of CSI-RS ports corresponding to the CSI-RS resource, and the CSI is determined by a terminal based on channel information corresponding to each CSI- RS resource in at least one CSI-RS resource and codebook parameter information; and determining, according to the CSI and a codebook structure corresponding to the codebook parameter information, precoding of the terminal.

13. The method according to claim 12, wherein the CSI comprises at least one of following information: N pieces of spatial domain basis vector indication information or N pieces of port selection indication information, where N is the same as a number of the CSI-RS resources or a number of the port groups, and N is a positive integer greater than 1; combination coefficient indication information, wherein the combination coefficient indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource; or frequency domain basis vector indication information, wherein the frequency domain basis vector indication information corresponds to the plurality of CSI-RS resources or the plurality of port groups in the one CSI-RS resource.

14. The method according to claim 13, wherein the codebook structure is expressed by following formulas:

$$W = \begin{bmatrix} W_{1,1} & & \\ & \ddots & \\ & & W_{1,N} \end{bmatrix} \tilde{W}_2 W_f^H, \ W_{1,i} \in \mathbb{C}^{N_t \times 2L_i} \ \text{or} \ W_{1,i} \in \mathbb{C}^{P \times 2L_i}, \ \tilde{W}_2 \in \mathbb{C}^{.Math.\sum_{i=1}^{N} 2L_i \times M}, \ W_f \in \mathbb{C}^{N_3 \times M}$$

where W represents the codebook structure, N represents the number of the CSI-RS resources or the number of the port groups, N.sub.t represents a number of transmitting antenna ports, P is a number of CSI-RS ports, L.sub.i represents a number of spatial domain basis vectors or a number of CSI-RS ports corresponding to an i.sup.th CSI-RS resource, i∈{1, . . . , N}, or a number of spatial domain basis vectors or a number of CSI-RS ports corresponding to an i.sup.th port group, i∈{1, . . . , N}, M represents a number of frequency domain

basis vectors corresponding to the i.sup.th CSI-RS resource, or a number of frequency domain basis vectors corresponding to the i.sup.th port group, N.sub.3 represents a number of precoding matrix indication (PMI) subbands, W.sub.1,i represents a matrix consisting of L.sub.i spatial domain basis vectors or unit basis vectors for port selection corresponding to the i.sup.th CSI-RS resource, or a matrix consisting of L.sub.i spatial domain basis vectors or unit basis vectors for port selection corresponding to the i.sup.th port group, {tilde over (W)}.sub.2 represents a matrix consisting of the combination coefficient indication information, W.sub.f represents a matrix consisting of M frequency domain basis vectors, H is a conjugate transpose, and ![]custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

15. The method according to claim 12, wherein the CSI comprises at least one of following information: G pieces of spatial domain basis vector indication information or G pieces of port selection indication information; G pieces of combination coefficient indication information; or G pieces of frequency domain basis vector indication information; wherein G is the same as a number of CSI-RS resource groups in the plurality of CSI-RS resources, and the CSI-RS resource group comprises at least one CSI-RS resource, or G is the same as a number of first groups among the plurality of port groups in the one CSI-RS resource, and the first group comprises at least one port group, and G is a positive integer greater than 1.

16. The method according to claim 15, wherein the codebook structure is expressed by following formulas:

$$W = \begin{bmatrix} W_{1,1}\,\tilde{W}_{2,1}\,W_{f,1}^{H} \\ \text{.Math.} \\ W_{1,g}\,\tilde{W}_{2,g}\,W_{f,g}^{H} \end{bmatrix},\ W_{1,g} \in \mathbb{C}^{N_g N_t \times 2L_g},\ \tilde{W}_{2,g}\,\mathbb{C}^{2L_g \times M_g},\ W_{f,g}^{H} \in \mathbb{C}^{N_3 \times M_g}$$

where the W represents the codebook structure, W.sup.1,g represents a matrix consisting of spatial domain basis vectors or unit basis vectors for port selection corresponding to CSI-RS resources in a g.sup.th group, g∈{1, . . . , G}, or a matrix consisting of spatial domain basis vectors or unit basis vectors for port selection corresponding to port groups in a g.sup.th group, N.sub.grepresents a number of CSI-RS resources or a number of port groups in the g.sup.th group, N.sub.t represents a number of transmitting antenna ports, W.sub.f,g represents a matrix consisting of M.sub.g frequency domain basis vectors corresponding to CSI-RS resources in the g.sup.th group, or a matrix consisting of M.sub.g frequency domain basis vectors corresponding to port groups in the g.sup.th group, M.sub.g represents a number of frequency domain basis vectors selected for the g.sup.th group, {tilde over (W)}.sub.2,g represents a matrix consisting of combination coefficients corresponding to CSI-RS resources in the g.sup.th group, or a matrix consisting of combination coefficients corresponding to port groups in the g.sup.th group, L.sub.g represents a number of spatial domain basis vectors or a number of CSI-RS ports selected for the g.sup.th group, G represents being the same as the number of CSI-RS resource groups in the plurality of CSI-RS resources or the number of first groups among the port groups, G is a positive integer greater than 1, N.sub.3 represents a number of precoding matrix indication (PMI) subbands, H is a conjugate transpose, and ![]custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

17. The method according to claim 12, wherein the CSI comprises at least one of following information: spatial domain basis vector indication information, wherein the spatial domain basis vector indication information corresponds to the plurality of CSI-RS resources, or the plurality of port groups in the one CSI-RS resource; combination coefficient indication information, wherein the combination coefficient indication information corresponds to the plurality of CSI-RS resources, or the plurality of port groups in the one CSI-RS resource; frequency domain basis vector indication information, wherein the frequency domain basis vector indication information corresponds to the plurality of CSI-RS resources, or the plurality of port groups in the one CSI-RS resource.

18. The method according to claim 17, wherein the codebook structure is expressed by following formulas: W=W.sub.1{tilde over (W)}.sub.2W.sub.f.sup.H, W.sub.1∈![]custom-character.sup.NN.sup.t.sup.×2L, or W.sub.1∈![]custom-character.sup.NP×2L, {tilde over (W)}.sub.2∈![]custom-character.sup.2L×M, W.sub.f∈![]custom-character.sup.N.sup.3.sup.×M where W represents the codebook structure, N represents the number of the CSI-RS resources or the number of the port groups, N.sub.t represents a number of transmitting antenna ports, L represents a number of spatial domain basis vectors or CSI-RS ports corresponding to the CSI-RS resources, or a number of spatial domain basis vectors or CSI-RS ports corresponding to the port groups, M represents a number of frequency domain basis vectors corresponding to the CSI-RS resources, or a number of frequency domain basis vectors corresponding to the port groups, N.sub.3 represents a number of precoding matrix indication (PMI) subbands, W.sub.1 represents a matrix

consisting of L spatial domain basis vectors or unit basis vectors for port selection for the CSI-RS resources, or a matrix consisting of L spatial domain basis vectors or unit basis vectors for port selection for the port groups, $\{$tilde over (W)$\}$.sub.2 represents a matrix consisting of the combination coefficient indication information, W.sub.f represents a matrix consisting of M frequency domain basis vectors, H is a conjugate transpose, and custom-character.sup.X×Y represents a complex matrix with dimensions of X rows and Y columns.

19. The method according to claim 13, wherein the combination coefficient indication information comprises non-zero coefficient information and non-zero coefficient position information, the non-zero coefficient information indicates non-zero coefficient(s) in the combination coefficient indication information, and the non-zero coefficient position information indicates a position of the non-zero coefficient in the combination coefficient indication information; and wherein receiving the CSI from the terminal comprises: receiving the CSI from the terminal, wherein the CSI comprises the spatial domain basis vector indication information or the port selection indication information, the combination coefficient indication information and the frequency domain basis vector indication information; the spatial domain basis vector indication information or the port selection indication information, the combination coefficient indication information and the frequency domain basis vector indication information are determined by the terminal according to channel information or valid channel information corresponding to each CSI-RS resource and the codebook parameter information.

20. (canceled)

21. The method according to claim 12, further comprising: sending configuration information to the terminal, wherein the configuration information is used to configure the codebook parameter information, and the codebook parameter information is used by the terminal to determine the CSI; and receiving first indication information from the terminal, wherein the first indication information indicates an adopted codebook structure; or sending second indication information to the terminal, wherein the second indication information indicates an adopted codebook structure; wherein the CSI-RS resource is a channel measurement resource (CMR); wherein different CMRs belong to a same CSI-RS resource set or different CSI-RS resource sets; wherein each of the plurality of CSI-RS resources corresponds to one transmission reception point (TRP), and at least two TRPs are configured for coherent joint transmission (CJT); or each of the plurality of port groups in the one CSI-RS resource corresponds to a TRP, and at least two TRPs are configured for CJT.

22.-27. (canceled)

28. A terminal, comprising: a processor; and a transceiver connected to the processor; wherein the processor is configured to: determine, based on at least one channel status information reference signal (CSI-RS) resource, channel information corresponding to each CSI-RS resource; and send, according to the channel information determined corresponding to each CSI-RS resource and codebook parameter information, CSI to a network device, wherein the CSI comprises indication information corresponding to a plurality of CSI-RS resources and indication information corresponding to each CSI-RS resource, or the CSI comprises indication information corresponding to a plurality of port groups in one CSI-RS resource and indication information corresponding to each port group, the port group comprises a plurality of CSI-RS ports corresponding to the CSI-RS resource; wherein the CSI is configured to determine precoding of the terminal based on a codebook structure corresponding to the codebook parameter information.

29. A network device, comprising: a processor; and a transceiver connected to the processor; wherein the processor is configured to perform the method according to claim 12.

30. (canceled)