

the base station may include a channel state information reference signal (Channel State Information Reference Signal, CSI RS), a demodulation reference signal (DeModulation RS, DM RS), a cell-specific reference signal (Cell-specific RS, CRS), or the like. The user equipment may obtain the reference signal by receiving an eNB notification, for example, by receiving radio resource control (Radio Resource Control, RRC) signaling or downlink control information (Down Control Information, DCI); or the user equipment obtains resource configuration of the reference signal based on a cell identity ID and then obtains the reference signal from a corresponding resource or subframe. This embodiment of the present invention sets no limitation on a specific manner of receiving a reference signal.

[0023] It should be understood that the foregoing reference signal is corresponding to an antenna port; the reference signal may be corresponding to a physical antenna or an antenna array element, or may be corresponding to a virtual antenna, where the virtual antenna is a weighted combination of a physical antenna and an antenna array element.

[0024] Step S102: Select a precoding matrix $\mathbf{W}$ from a codebook based on the reference signal, where a column vector of the precoding matrix $\mathbf{W}$ may be expressed as $\alpha \begin{bmatrix} \mathbf{v} & e^{j\phi} \mathbf{v} \end{bmatrix}^T$, $\mathbf{v} = \begin{bmatrix} 1 & e^{j\theta} \end{bmatrix}$, where α is a constant, θ and ϕ are phases, and $[]^T$ indicates transposing of a matrix or vector.

[0025] Specifically, values of phases θ and ϕ may be flexibly selected according to a requirement of quantization precision.

[0026] Further, column vectors of the precoding matrix $\mathbf{W}$ may be orthogonal to each other, that is, $\mathbf{W}$ meets $\mathbf{W}^H \mathbf{W} = \alpha^2 \mathbf{I}$, where $\mathbf{W}^H$ indicates a conjugate transpose of the matrix $\mathbf{W}$, and $\mathbf{I}$ is an identity matrix. The foregoing structure divides antenna ports into two groups; a vector $\mathbf{v}$ may match channel characteristics corresponding to each antenna group of the two groups, and a phase between the two antenna port groups may be expressed by ϕ . The foregoing structure may match actually deployed antenna configuration, for example, configuration of a four-port dual-polarized antenna or a uniform linear array antenna. Phases θ and ϕ are flexibly selected, which cannot only further improve quantization precision as required, but also achieve balance between overheads and the quantization precision.

[0039] In this embodiment of the present invention, the precoding matrix indicator PMI may include only one specific value, and the PMI directly indicates the selected precoding matrix. For example, altogether 256 different precoding matrices may be selected from the matrix set (1) or (2), and then $PMI = 0, \dots, 255$ may be used to respectively indicate the precoding matrices whose index values are 0, 1, ..., 255. Therefore, as an embodiment of the present invention in which a precoding matrix indicator PMI is sent to the base station and the PMI is corresponding to the selected precoding matrix, the precoding matrix indicator PMI may be an index value corresponding to a precoding matrix W in a codebook. Because a base station side also has the codebook, the base station may obtain, according to the PMI, a precoding matrix selected by a UE from the codebook.

[0040] According to another aspect, because the index values i_1 and i_2 can uniquely determine a precoding matrix W , as another embodiment of the present invention in which a precoding matrix indicator PMI is sent to the base station and the PMI is corresponding to the selected precoding matrix, a first precoding matrix indicator PMI_1 and a secondfirst precoding matrix indicator PMI_2 may be sent to the base station, and are respectively corresponding to the index values i_1 and i_2 that are associated with the selected precoding matrix. Because a base station side also has the codebook, the base station may obtain, according to the first precoding matrix indicator PMI_1 and the secondfirst precoding matrix indicator PMI_2 , a precoding matrix selected by a UE from the codebook. For ease of the following description, a precoding matrix indicator PMI_1 and a precoding matrix indicator PMI_2 are respectively used to indicate corresponding precoding matrix indicators indicated by i_1 and i_2 . In this embodiment of the present invention, the PMI_1 and the PMI_2 have different time domain or frequency domain granularities, or are obtained based on different subframe periods or sub-band sizes. For example, the precoding matrix indicator PMI_1 and the precoding matrix indicator PMI_2 respectively indicate channel characteristics with different periods or bandwidth, or are obtained based on different subframe periods or sub-band sizes. Further, the precoding matrix indicator PMI_1 and the precoding matrix indicator PMI_2 are sent to the base station in different time periods.

[0041] When a precoding matrix indicator PMI is sent to a base station, the precoding matrix indicator PMI may be sent to the base station by a user equipment

[0058] As another embodiment of the present invention, the precoding matrix indicator PMI may include two indexes, that is, a first precoding matrix indicator PMI₁ and a secondfirst precoding matrix indicator PMI₂, where the PMI₁ and the PMI₂ are respectively corresponding to index values i_1 and i_2 that are associated with the selected precoding matrix. The base station may obtain, according to the PMI₁ and the PMI₂, the precoding matrix selected by the UE from the codebook.

[0059] When a precoding matrix indicator PMI sent by a user equipment UE is received, the PMI may be received by a base station through a PUCCH or a PUSCH. It should be noted that, the precoding matrix W in this embodiment of the present invention may be a precoding matrix obtained after row or column displacement. For example, different antenna numbers correspondingly lead to row displacement of the precoding matrix.

[0060] It can be learned from the foregoing method for feeding back channel state information according to this embodiment of the present invention that, a base station sends a reference signal and receives a precoding matrix indicator PMI sent by a UE, where the PMI is corresponding to a precoding matrix that is selected by the UE from a codebook based on the reference signal. The codebook includes at least one precoding matrix W, and a column vector of the precoding matrix W may be expressed as $\alpha \begin{bmatrix} \mathbf{v} & e^{j\phi} \mathbf{v} \end{bmatrix}^T$, $\mathbf{v} = \begin{bmatrix} 1 & e^{j\theta} \end{bmatrix}$, where α is a constant, θ and ϕ are

phases, and $\begin{bmatrix} \end{bmatrix}^T$ indicates transposing of a matrix or vector. The foregoing codebook structure may match actually deployed antenna configuration, for example, configuration of a four-port dual-polarized antenna or a uniform linear array antenna; phases θ and ϕ are flexibly selected, which cannot only further improve quantization precision as required, but also achieve balance between overheads and the quantization precision. In addition, column vectors of the precoding matrix W are orthogonal to each other, which further reduces inter-layer interference. After the user equipment feeds back the precoding matrix indicator corresponding to the precoding matrix W to the base station, the base station performs precoding on a sent signal according to the fed back precoding matrix indicator, which improves system throughput.

[0061] The following describes in detail a system for feeding back channel state information, a user equipment, and a base station according to the present invention.

Referring to FIG. 3, FIG. 3 is a schematic diagram of structural composition of a system for feeding back channel state information according to an embodiment of the present invention. The system according to this embodiment of the present invention includes a user equipment 30 and a base station 40. A structure of the user equipment 30 is shown in FIG. 4, and a structure of the base station 40 is shown in FIG. 5.

[0062] Referring to FIG. 4, FIG. 4 is a schematic structural diagram of the user equipment 30 according to the embodiment of the present invention, and the user equipment 30 includes a receiving module 301, a selecting module 302, and a sending module 303, where the receiving module 301 may be implemented by a receiver in the user equipment 30 or a software module/unit or a hardware module/unit of the receiver of the user equipment 30, the selecting module 302 may be implemented by a processor in the user equipment 30 or a software module/unit or a hardware module/unit of the processor of the user equipment 30, and the sending module 303 may be implemented by a transmitter in the user equipment 30 or a software module/unit or a hardware module/unit of the transmitter of the user equipment 30.

[0063] The receiving module 301 is configured to receive a reference signal sent by a base station. The reference signal sent by the base station may include a channel state information reference signal (Channel State Information Reference Signal, CSI RS), a demodulation reference signal (DeModulation RS, DM RS), a cell-specific reference signal (Cell-specific RS, CRS), or the like. The user equipment may obtain the reference signal by receiving an eNB notification, for example, by receiving radio resource control (Radio Resource Control, RRC) signaling or downlink control information (Down Control Information, DCI); or the user equipment obtains resource configuration of the reference signal based on a cell identity ID and then obtains the reference signal from a corresponding resource or subframe. This embodiment of the present invention sets no limitation on a specific manner of receiving a reference signal.

[0064] It should be understood that the foregoing reference signal is corresponding to an antenna port; the reference signal may be corresponding to a physical antenna or an antenna array element, or may be corresponding to a virtual antenna, where the virtual antenna is a weighted combination of a physical antenna and/or an antenna array element.

[0065] The selecting module 302 is configured to select a precoding matrix W from a codebook based on the reference signal received by the receiving module 301,

where a column vector of the precoding matrix $\mathbf{W}$ may be expressed as $\alpha \begin{bmatrix} \mathbf{v} & e^{j\phi} \mathbf{v} \end{bmatrix}^T$, $\mathbf{v} = \begin{bmatrix} 1 & e^{j\theta} \end{bmatrix}$, where α is a constant, θ and ϕ are phases, and $\begin{bmatrix} \cdot \end{bmatrix}^T$ indicates transposing of a matrix or vector.

[0066] Specifically, values of phases θ and ϕ may be flexibly selected according to a requirement of quantization precision.

[0067] Further, column vectors of the precoding matrix $\mathbf{W}$ may be orthogonal to each other, that is, $\mathbf{W}$ meets $\mathbf{W}^H \mathbf{W} = \alpha^2 \mathbf{I}$, where $\mathbf{W}^H$ indicates a conjugate transpose of the matrix $\mathbf{W}$, and $\mathbf{I}$ is an identity matrix. The foregoing structure divides antenna ports into two groups; a vector $\mathbf{v}$ may match channel characteristics corresponding to each antenna group of the two groups, and a phase between the two antenna port groups may be expressed by ϕ . The foregoing structure may match actually deployed antenna configuration, for example, configuration of a four-port dual-polarized antenna or a uniform linear array antenna. Phases θ and ϕ are flexibly selected, which cannot only further improve quantization precision as required, but also achieve balance between overheads and the quantization precision. Column vectors of the precoding matrix $\mathbf{W}$ are orthogonal to each other, which further reduces inter-layer interference, thereby improving a transmission rate and spectral efficiency of a system.

[0068] It can be learned from the foregoing embodiment of the present invention that, a user equipment may select a precoding matrix from a codebook based on a received reference signal, and send a precoding matrix indicator corresponding to the selected precoding matrix $\mathbf{W}$ to the base station, where the codebook includes at least one precoding matrix $\mathbf{W}$, and a column vector of the precoding matrix $\mathbf{W}$ may be expressed as $\alpha \begin{bmatrix} \mathbf{v} & e^{j\phi} \mathbf{v} \end{bmatrix}^T$, $\mathbf{v} = \begin{bmatrix} 1 & e^{j\theta} \end{bmatrix}$, where α is a constant, θ and ϕ are

phases, and $\begin{bmatrix} \cdot \end{bmatrix}^T$ indicates transposing of a matrix or vector. The foregoing codebook structure may match actually deployed antenna configuration, for example, configuration of a four-port dual-polarized antenna or a uniform linear array antenna; phases θ and ϕ are flexibly selected, which cannot only further improve quantization precision as required, but also achieve balance between overheads and the quantization precision. In addition, column vectors of the precoding matrix $\mathbf{W}$ are

orthogonal to each other, which further reduces inter-layer interference. After the user equipment feeds back the precoding matrix indicator corresponding to the precoding matrix W to the base station, the base station performs precoding on a sent signal according to the fed back precoding matrix indicator, which can improve precoding precision, thereby improving a data transmission rate and system throughput.

[0069] The selecting module 302 shown in FIG. 4 may be specifically configured to acquire a channel estimation value based on the reference signal, and select a precoding matrix from a codebook according to the channel estimation value.

[0070] It should be noted that, this embodiment of the present invention sets no limitation on a specific manner of selecting a precoding matrix. Optionally, a precoding matrix is selected from the codebook according to a predefined criterion, such as a criterion of channel capacity or throughput maximization, or a criterion of chordal distance minimization. Selecting a precoding matrix based on a predefined criterion is an existing technology, and details are not described herein again.

[0071] As an embodiment of the present invention, the precoding matrix W is at least one matrix in the matrix set shown in the expression (1), where

$\theta = \frac{\pi}{16}(2i_1 + \lfloor i_2/4 \rfloor)$, $i_1 = 0, \dots, 15$, $i_2 = 0, \dots, 15$, and $\lfloor i_2/4 \rfloor$ indicates that its value is the greatest integer not greater than $i_2/4$.

[0072] As another embodiment of the present invention, the precoding matrix W is at least one matrix in the matrix set shown in the expression (2) or (2'), where

$\theta = \frac{\pi}{16}(2i_1 + \lfloor i_2/4 \rfloor)$, $i_1 = 0, \dots, 15$, $i_2 = 0, \dots, 15$, $\varphi = \frac{\pi}{16}, \frac{\pi}{8}, \dots$, $i_2 = 0, \dots, 15$, and $\lfloor i_2/4 \rfloor$ indicates that its value is the greatest integer not greater than $i_2/4$.

[0073] As another embodiment of the present invention, the precoding matrix W is at least one matrix in the matrix set shown in the expression (3), where

$\theta = \frac{\pi}{8}(4i_1 + 2\lfloor i_2/4 \rfloor)$, $i_1 = 0, 1, 2, 3$, $i_2 = 0, \dots, 15$, and $\lfloor i_2/4 \rfloor$ indicates that its value is the greatest integer not greater than $i_2/4$.

[0074] As another embodiment of the present invention, the precoding matrix W is at least one matrix in the matrix set shown in the expression (4) or (5), where

$\theta = \frac{\pi}{8}(4i_1 + 2\lfloor i_2/2 \rfloor)$, $i_1 = 0, 1, 2, 3$, $i_2 = 0, \dots, 7$, and $\lfloor i_2/2 \rfloor$ indicates that its value

is the greatest integer not greater than $i_2/2$.

[0075] It can be learned from investigation on the foregoing precoding matrix W that, the foregoing matrix structure may match actually deployed antenna configuration, for example, configuration of a four-port dual-polarized antenna or a uniform linear array antenna. Phases θ and ϕ are flexibly selected, which cannot only further improve quantization precision as required, but also achieve balance between overheads and the quantization precision. Column vectors of the precoding matrix W are orthogonal to each other, which further reduces inter-layer interference, thereby improving a transmission rate and spectral efficiency of a system.

[0076] The sending module 303 is configured to send a precoding matrix indicator PMI to the base station, where the PMI is corresponding to the precoding matrix W selected by the selecting module 302. The user equipment may send the precoding matrix indicator PMI to the base station through a PUCCH or a PUSCH.

[0077] As an embodiment of the present invention, the precoding matrix indicator PMI may include only one specific value, and the PMI directly indicates the selected precoding matrix. For example, altogether 256 different precoding matrices may be selected from the matrix set (1) or (2), and then $\text{PMI} = 0, \dots, 255$ may be used to respectively indicate the precoding matrices whose index values are 0, 1, ..., 255. Therefore, as an embodiment of the present invention in which a precoding matrix indicator PMI is sent to the base station and the PMI is corresponding to the selected precoding matrix, the precoding matrix indicator PMI may be an index value corresponding to a precoding matrix W in a codebook. Because a base station side also has the codebook, the base station may obtain, according to the PMI, the precoding matrix selected by the UE from the codebook.

[0078] As another embodiment of the present invention, the precoding matrix indicator PMI may include two indexes, that is, a first precoding matrix indicator PMI_1 and a ~~second~~^{first} precoding matrix indicator PMI_2 , where the PMI_1 and the PMI_2 are respectively corresponding to index values i_1 and i_2 that are associated with the selected precoding matrix. The base station may obtain, according to the first precoding matrix indicator PMI_1 and the ~~second~~^{first} precoding matrix indicator PMI_2 , the precoding matrix selected by the UE from the codebook.

[0079] In this embodiment of the present invention, the PMI_1 and the PMI_2 have different time domain or frequency domain granularities, or are obtained based on

different subframe periods or sub-band sizes. For example, the precoding matrix indicator PMI₁ and the precoding matrix indicator PMI₂ respectively indicate channel characteristics with different periods or bandwidth, or are obtained based on different subframe periods or sub-band sizes. Further, the precoding matrix indicator PMI₁ and the precoding matrix indicator PMI₂ are sent to the base station in different time periods.

[0080] When a precoding matrix indicator PMI is sent to a base station, the precoding matrix indicator PMI may be sent to the base station by a user equipment through a PUCCH or a PUSCH. It should be noted that, the precoding matrix W in this embodiment of the present invention may be a precoding matrix obtained after row or column displacement. For example, different antenna numbers correspondingly lead to row displacement of the precoding matrix.

[0081] It can be learned from the foregoing user equipment according to this embodiment of the present invention that, the user equipment may select a precoding matrix from a codebook based on a received reference signal, and send a precoding matrix indicator corresponding to the selected precoding matrix to the base station.

The codebook includes at least one precoding matrix W, and a column vector of the

precoding matrix W may be expressed as $\alpha \begin{bmatrix} \mathbf{v} & e^{j\phi} \mathbf{v} \end{bmatrix}^T$, $\mathbf{v} = \begin{bmatrix} 1 & e^{j\theta} \end{bmatrix}$, where α is

a constant, θ and ϕ are phases, and $\begin{bmatrix} \end{bmatrix}^T$ indicates transposing of a matrix or vector.

[0082] The foregoing codebook structure may match actually deployed antenna configuration, for example, configuration of a four-port dual-polarized antenna or a uniform linear array antenna; phases θ and ϕ are flexibly selected, which cannot only further improve quantization precision as required, but also achieve balance between overheads and the quantization precision. In addition, column vectors of the precoding matrix W are orthogonal to each other, which further reduces inter-layer interference. After the user equipment feeds back the precoding matrix indicator corresponding to the precoding matrix W to the base station, the base station performs precoding on a sent signal according to the fed back precoding matrix indicator, which improves system throughput.

[0083] It should be noted that, in the foregoing implementation manner of the user equipment, division of functional modules is merely used as an example, and the

DCI; or the base station sends the reference signal over a resource or a subframe of a corresponding reference signal based on a cell identity ID. This embodiment of the present invention sets no limitation on a specific manner of sending a reference signal.

[0087] It should be understood that the foregoing reference signal is corresponding to an antenna port; the reference signal may be corresponding to a physical antenna or an antenna array element, or may be corresponding to a virtual antenna, where the virtual antenna is a weighted combination of a physical antenna and/or an antenna array element.

[0088] The second receiving module 402 is configured to receive a precoding matrix indicator PMI sent by the user equipment UE, where the PMI is corresponding to a precoding matrix W that is selected by the UE from a codebook based on the reference signal, and a column vector of the precoding matrix W may be expressed as $\alpha \begin{bmatrix} \mathbf{v} & e^{j\phi} \mathbf{v} \end{bmatrix}^T$, $\mathbf{v} = \begin{bmatrix} 1 & e^{j\theta} \end{bmatrix}$, where α is a constant, θ and ϕ are phases, and $\begin{bmatrix} \cdot \end{bmatrix}^T$ indicates transposing of a matrix or vector.

[0089] Specifically, values of phases θ and ϕ may be flexibly selected according to a requirement of quantization precision.

[0090] Further, column vectors of the precoding matrix W may be orthogonal to each other, that is, W meets $W^H W = \alpha^2 \mathbf{I}$, where W^H indicates a conjugate transpose of the matrix W , and $\mathbf{I}$ is an identity matrix. The foregoing structure divides antenna ports into two groups; a vector $\mathbf{v}$ may match channel characteristics corresponding to each antenna group of the two groups, and a phase between the two antenna port groups may be expressed by ϕ . The foregoing structure may match actually deployed antenna configuration, for example, configuration of a four-port dual-polarized antenna or a uniform linear array antenna. Phases θ and ϕ are flexibly selected, which cannot only further improve quantization precision as required, but also achieve balance between overheads and the quantization precision. Column vectors of the precoding matrix W are orthogonal to each other, which further reduces inter-layer interference, thereby improving a transmission rate and spectral efficiency of a system.

[0091] As an embodiment of the present invention, the precoding matrix W is at least one matrix in the matrix set shown in the expression (1), where

$\theta = \frac{\pi}{16}(2i_1 + \lfloor i_2/4 \rfloor)$, $i_1 = 0, \dots, 15$, $i_2 = 0, \dots, 15$, and $\lfloor i_2/4 \rfloor$ indicates that its value is the greatest integer not greater than $i_2/4$.

[0092] As another embodiment of the present invention, the precoding matrix W is at least one matrix in the matrix set shown in the expression (2) or (2'), where

5 $\theta = \frac{\pi}{16}(2i_1 + \lfloor i_2/4 \rfloor)$, $i_1 = 0, \dots, 15$, $i_2 = 0, \dots, 15$, $\varphi = \frac{\pi}{16}, \frac{\pi}{8}, \dots$, and $\lfloor i_2/4 \rfloor$ indicates that its value is the greatest integer not greater than $i_2/4$.

[0093] As another embodiment of the present invention, the precoding matrix W is at least one matrix in the matrix set shown in the expression (3), where

$\theta = \frac{\pi}{8}(4i_1 + 2\lfloor i_2/4 \rfloor)$, $i_1 = 0, 1, 2, 3$, $i_2 = 0, \dots, 15$, and $\lfloor i_2/4 \rfloor$ indicates that its value is the greatest integer not greater than $\lfloor i_2/4 \rfloor$.

[0094] As another embodiment of the present invention, the precoding matrix W is at least one matrix in the matrix set shown in the expression (4) or (5), where

$\theta = \frac{\pi}{8}(4i_1 + 2\lfloor i_2/2 \rfloor)$, $i_1 = 0, 1, 2, 3$, $i_2 = 0, \dots, 7$, and $\lfloor i_2/2 \rfloor$ indicates that its value is the greatest integer not greater than $i_2/2$.

15 [0095] It can be learned from investigation on the foregoing precoding matrix W that, the foregoing matrix structure may match actually deployed antenna configuration, for example, configuration of a four-port dual-polarized antenna or a uniform linear array antenna. Phases θ and ϕ are flexibly selected, which cannot only further improve quantization precision as required, but also achieve balance
20 between overheads and the quantization precision. Column vectors of the precoding matrix W are orthogonal to each other, which further reduces inter-layer interference, thereby improving a transmission rate and spectral efficiency of a system.

[0096] ~~It can be learned from investigation on the foregoing precoding matrix W that, the foregoing matrix structure may match actually deployed antenna
25 configuration, for example, configuration of a four-port dual-polarized antenna or a uniform linear array antenna. Phases θ and ϕ are flexibly selected, which cannot only further improve quantization precision as required, but also achieve balance between overheads and the quantization precision. Column vectors of the precoding~~

matrix W are orthogonal to each other, which further reduces inter-layer interference, thereby improving a transmission rate and spectral efficiency of a system.

[0097] The codebook is known to both the base station and the UE. As another embodiment of the present invention, the precoding matrix indicator PMI may include only one specific value, and the PMI directly indicates the selected precoding matrix. For example, altogether 256 different precoding matrices may be selected from the matrix set (1) or (2), and then $PMI = 0, \dots, 255$ may be used to respectively indicate the precoding matrices whose index values are 0, 1, ..., 255. In this case, the base station may obtain, according to the PMI, the precoding matrix selected by the UE from the codebook.

[0098] As another embodiment of the present invention, the precoding matrix indicator PMI may include two indexes, that is, a first precoding matrix indicator PMI_1 and a second first precoding matrix indicator PMI_2 , where the PMI_1 and the PMI_2 are respectively corresponding to index values i_1 and i_2 that are associated with the selected precoding matrix. The base station may obtain, according to the PMI_1 and the PMI_2 , the precoding matrix selected by the UE from the codebook.

[0099] When a precoding matrix indicator PMI sent by a user equipment UE is received, the PMI may be received by a base station through a PUCCH or a PUSCH. It should be noted that, the precoding matrix W in this embodiment of the present invention may be a precoding matrix obtained after row or column displacement. For example, different antenna numbers correspondingly lead to row displacement of the precoding matrix.

[00100] It can be learned from the foregoing base station for feeding back channel state information according to this embodiment of the present invention that, the base station sends a reference signal and receives a precoding matrix indicator PMI sent by a UE, where the PMI is corresponding to a precoding matrix that is selected by the UE from a codebook based on the reference signal. The codebook includes at least one precoding matrix W , and a column vector of the precoding matrix W may be expressed as $\alpha \begin{bmatrix} \mathbf{v} & e^{j\phi} \mathbf{v} \end{bmatrix}^T$, $\mathbf{v} = \begin{bmatrix} 1 & e^{j\theta} \end{bmatrix}$, where α is a constant, θ and ϕ are phases, and $\begin{bmatrix} \end{bmatrix}^T$ indicates transposing of a matrix or vector. The foregoing codebook structure may match actually deployed antenna configuration, for example, configuration of a four-port dual-polarized antenna or a uniform linear array antenna;

CLAIMS

What is claimed is:

1. A method for feeding back channel state information, wherein the method comprises:

5 receiving a reference signal sent by a base station;

selecting a precoding matrix W from a codebook based on the reference signal,

wherein a column vector of the precoding matrix W is expressed as $\alpha \begin{bmatrix} \mathbf{v} & e^{j\phi} \mathbf{v} \end{bmatrix}^T$,
 $\mathbf{v} = \begin{bmatrix} 1 & e^{j\theta} \end{bmatrix}$, wherein α is a constant, θ and ϕ are phases, and $\begin{bmatrix} \end{bmatrix}^T$ indicates
transposing of a matrix or vector; and

10 sending a precoding matrix indicator PMI to the base station, wherein the PMI is corresponding to the selected precoding matrix W .

2. The method according to claim 1, wherein the precoding matrix W is at least one matrix in the following matrix set:

$$\left\{ \frac{1}{2} \begin{bmatrix} 1 \\ e^{j\theta} \\ 1 \\ e^{j\theta} \end{bmatrix}, \frac{1}{2} \begin{bmatrix} 1 \\ e^{j\theta} \\ j \\ je^{j\theta} \end{bmatrix}, \frac{1}{2} \begin{bmatrix} 1 \\ e^{j\theta} \\ -1 \\ -e^{j\theta} \end{bmatrix}, \frac{1}{2} \begin{bmatrix} 1 \\ e^{j\theta} \\ -j \\ -je^{j\theta} \end{bmatrix} \right\}$$

15 wherein $\theta = \frac{\pi}{16} (2i_1 + \lfloor i_2/4 \rfloor)$, $\lfloor i_2/4 \rfloor$ indicates the greatest integer not greater than $i_2/4$, $i_1 = 0, \dots, 15$, and $i_2 = 0, \dots, 15$.

3. The method according to claim 1, wherein the precoding matrix W is at least one matrix in the following matrix set:

$$\left\{ \frac{1}{\sqrt{8}} \begin{bmatrix} 1 & 1 \\ e^{j\theta} & e^{j\theta} \\ 1 & -1 \\ e^{j\theta} & -e^{j\theta} \end{bmatrix}, \frac{1}{\sqrt{8}} \begin{bmatrix} 1 & 1 \\ e^{j\theta} & e^{j\theta} \\ j & -j \\ je^{j\theta} & -je^{j\theta} \end{bmatrix} \right\} \text{ or}$$

$$\left\{ \frac{1}{\sqrt{8}} \begin{bmatrix} 1 & 1 \\ e^{j\theta} & e^{j(\theta+\varphi)} \\ 1 & -1 \\ e^{j\theta} & -e^{j(\theta+\varphi)} \end{bmatrix}, \frac{1}{\sqrt{8}} \begin{bmatrix} 1 & 1 \\ e^{j\theta} & e^{j(\theta+\varphi)} \\ j & -j \\ je^{j\theta} & -je^{j(\theta+\varphi)} \end{bmatrix} \right\}$$

20

indicator PMI₂ that are sent by the UE, wherein the first precoding matrix indicator PMI₁ and the second precoding matrix indicator PMI₂ are respectively used to indicate indexes i_1 and i_2 corresponding to the selected precoding matrix.

13. A user equipment, wherein the user equipment apparatus comprises:

5 a receiving module, configured to receive a reference signal sent by a base station;

a selecting module, configured to select a precoding matrix W from a codebook based on the reference signal received by the receiving module, wherein a column vector of the precoding matrix W is expressed as $\alpha [\mathbf{v} \ e^{j\phi} \mathbf{v}]^T$, $\mathbf{v} = [1 \ e^{j\theta}]$,

10 wherein α is a constant, θ and ϕ are phases, and $[\]^T$ indicates transposing of a matrix or vector; and

a sending module, configured to send a precoding matrix indicator PMI to the base station, wherein the PMI is corresponding to the precoding matrix W selected by the selecting module.

15 14. The user equipment according to claim 13, wherein the precoding matrix W is at least one matrix in the following matrix set:

$$\left\{ \frac{1}{2} \begin{bmatrix} 1 \\ e^{j\theta} \\ 1 \\ e^{j\theta} \end{bmatrix}, \frac{1}{2} \begin{bmatrix} 1 \\ e^{j\theta} \\ j \\ je^{j\theta} \end{bmatrix}, \frac{1}{2} \begin{bmatrix} 1 \\ e^{j\theta} \\ -1 \\ -e^{j\theta} \end{bmatrix}, \frac{1}{2} \begin{bmatrix} 1 \\ e^{j\theta} \\ -j \\ -je^{j\theta} \end{bmatrix} \right\}$$

wherein $\theta = \frac{\pi}{16} (2i_1 + \lfloor i_2/4 \rfloor)$, $i_1 = 0, \dots, 15$, $i_2 = 0, \dots, 15$, and $\lfloor i_2/4 \rfloor$ indicates the greatest integer not greater than $i_2/4$.

20 15. The user equipment according to claim 13, wherein the precoding matrix W is at least one matrix in the following matrix set:

$$\left\{ \frac{1}{\sqrt{8}} \begin{bmatrix} 1 & 1 \\ e^{j\theta} & e^{j\theta} \\ 1 & -1 \\ e^{j\theta} & -e^{j\theta} \end{bmatrix}, \frac{1}{\sqrt{8}} \begin{bmatrix} 1 & 1 \\ e^{j\theta} & e^{j\theta} \\ j & -j \\ je^{j\theta} & -je^{j\theta} \end{bmatrix} \right\} \text{ or}$$

24. The base station according to any one of claims 20 to 23, wherein the second receiving module is specifically configured to:

5 | receive a first precoding matrix indicator PMI_1 and a second precoding matrix indicator PMI_2 that are sent by thea user equipment to the base station, wherein the first precoding matrix indicator PMI_1 and the second precoding matrix indicator PMI_2 are respectively used to indicate indexes i_1 and i_2 corresponding to the selected precoding matrix.

10 | 25. A computer storage medium, wherein the computer storage medium may store a program, and when the program is executed, a step in any one of claims 1 to 7 or a step in any one of claims 8 to 12 is performed.