

WHAT IS CLAIMED IS:

1. A method, comprising:

determining (510), at a terminal device (120), a matrix $\widetilde{\mathbf{W}}_2$ comprising linear combination coefficients for a pre-coder matrix indicator, PMI, matrix, wherein:

5 the PMI matrix is represented by $\mathbf{W} = \mathbf{W}_1 \widetilde{\mathbf{W}}_2 \mathbf{W}_f^H$,

matrix $\mathbf{W}_1$ represents components of a spatial domain orthogonal basis, matrix $\mathbf{W}_f$ represents components of a frequency domain orthogonal basis, and matrix $\widetilde{\mathbf{W}}_2$ has spatial components and frequency components;

characterized by

10 determining a shifted matrix by shifting (520) the frequency components of matrix $\widetilde{\mathbf{W}}_2$ circularly, such that a maximum coefficient of matrix $\widetilde{\mathbf{W}}_2$ is located in a frequency component with a predetermined index;

generating (530) a strongest coefficient indicator indicating the spatial component associated with the maximum coefficient of matrix $\widetilde{\mathbf{W}}_2$; and

15 transmitting (540), to a network device (110), uplink control information comprising the strongest coefficient indicator and non-zero coefficients of the shifted matrix, wherein the transmitted non-zero coefficients exclude the maximum coefficient.

2. The method of claim 1, wherein determining the matrix $\widetilde{\mathbf{W}}_2$ comprises:

20 receiving downlink control information received from the network device;

obtaining a resource indication associated with the spatial components and the frequency components; and

determining the matrix based on the downlink control information and the resource indication.

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3. The method of claim 1, wherein shifting the frequency components comprises:

determining indices of the frequency components;

determining a reference index from the indices of the frequency components, the reference index indicating a frequency component associated with the maximum coefficient
30 in the matrix; and

shifting the frequency components based on the indices of the frequency

components, the predetermined index and the reference index.

4. The method of claim 1, further comprising:

determining, based on the shifted matrix, a bitmap indicating locations of the non-

5 zero linear combination coefficients in the shifted matrix; and

transmitting the uplink control information comprising the bitmap.

5. The method of claim 1, further comprising:

generating, based on the predetermined index and the frequency components, a

10 second indication indicating a frequency range associated with a subset of the frequency components;

transmitting the uplink control information comprising the second indication.

6. The method of claim 5, wherein generating the second indication comprises:

15 determining, from the frequency components, a maximum frequency component associated with the predetermined index;

selecting, from the frequency components, the subset of the frequency components excluding the maximum frequency component;

determining indices of the subset of the frequency components after the shifting; and

20 generating the second indication based on the indices of the subset of the frequency component.

7. A method, comprising:

receiving (610), at a network device (110) and from a terminal device (120), uplink

25 control information comprising a strongest coefficient indicator and non-zero coefficients of a matrix $\widetilde{\mathbf{W}}_2$ for a pre-coder matrix indicator, PMI, matrix, wherein:

the PMI matrix is represented by $\mathbf{W} = \mathbf{W}_1 \widetilde{\mathbf{W}}_2 \mathbf{W}_f^H$,

matrix $\mathbf{W}_1$ represents components of a spatial domain orthogonal basis, matrix

$\mathbf{W}_f$ represents components of a frequency domain orthogonal basis, matrix $\widetilde{\mathbf{W}}_2$ has spatial

30 components and frequency components, and

wherein the received non-zero coefficients exclude a maximum coefficient;

characterized in that

the received strongest coefficient indicator indicates a spatial component associated with a maximum coefficient of matrix $\widetilde{\mathbf{W}}_2$, and in that the method comprises:

determining (620) state information of the channel, wherein a coefficient of matrix $\widetilde{\mathbf{W}}_2$, at a position with the spatial component indicated by the strongest coefficient indicator and with a frequency component determined by a predetermined index, assumes a preconfigured value obtained by applying a common scaling to the coefficients of the matrix $\widetilde{\mathbf{W}}_2$.

8. A terminal device (120), comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the terminal device at least to:

determine a matrix $\widetilde{\mathbf{W}}_2$ comprising linear combination coefficients, for a precoder matrix indicator, PMI, matrix, wherein:

the PMI matrix is represented by $\mathbf{W} = \mathbf{W}_1 \widetilde{\mathbf{W}}_2 \mathbf{W}_f^H$,

matrix $\mathbf{W}_1$ represents components of a spatial domain orthogonal basis, matrix $\mathbf{W}_f$ represents components of a frequency domain orthogonal basis, and the matrix $\widetilde{\mathbf{W}}_2$ has spatial components and frequency components;

characterized in that the terminal device is caused to

determine a shifted matrix by shifting the frequency components of matrix $\widetilde{\mathbf{W}}_2$ circularly, such that a maximum coefficient of matrix $\widetilde{\mathbf{W}}_2$ is located in a frequency component with a predetermined index;

generate a strongest coefficient indicator indicating the spatial component associated with the maximum coefficient of matrix $\widetilde{\mathbf{W}}_2$; and

transmit, to a network device (110), uplink control information comprising the strongest coefficient indicator and non-zero coefficients of the shifted matrix, wherein the transmitted non-zero coefficients exclude the maximum coefficient.

9. The terminal device of claim 8, the device is caused to determine the matrix $\widetilde{\mathbf{W}}_2$ by:

receiving downlink control information received from the network device;

obtaining a resource indication associated with the spatial components and the frequency components; and

determining the matrix based on the downlink control information and the resource indication.

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10. The terminal device of claim 8, the device is caused to shift the frequency components by:

determining indices of the frequency components;

10 determining a reference index from the indices of the frequency components, the reference index indicating a frequency component associated with the maximum coefficient in the matrix;

shifting the frequency components based on the indices of the frequency components, the predetermined index and the reference index.

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11. The terminal device of claim 8, the device is further caused to:

determine, based on the shifted matrix, a bitmap indicating locations of the non-zero linear combination coefficients in the shifted matrix; and

transmit the uplink control information comprising the bitmap.

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12. The terminal device of claim 8, the device is further caused to:

generate, based on the predetermined index and the frequency components, a second indication indicating a frequency range associated with a subset of the frequency components;

transmit the uplink control information comprising the second indication.

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13. The terminal device of claim 12, the device is caused to generate the second indication by:

determining, from the frequency components, a maximum frequency component associated with the predetermined index;

30 selecting, from the frequency components, the subset of the frequency components excluding the maximum frequency component;

determining indices of the subset of the frequency components after shifting; and

generating the second indication based on the indices of the subset of the frequency

component.

14. A network device (110), comprising:

at least one processor; and

5 at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the network device at least to:

receive, from a terminal device (120), uplink control information comprising a strongest coefficient indicator and non-zero coefficients of a matrix $\widetilde{\mathbf{W}}_2$ for a pre-coder matrix indicator, PMI, matrix, wherein:

the PMI matrix is represented by $\mathbf{W} = \mathbf{W}_1 \widetilde{\mathbf{W}}_2 \mathbf{W}_f^H$,

matrix $\mathbf{W}_1$ represents components of a spatial domain orthogonal basis, matrix $\mathbf{W}_f$ represents components of a frequency domain orthogonal basis, matrix $\widetilde{\mathbf{W}}_2$ has spatial components and frequency components, and

15 wherein the received non-zero coefficients exclude a maximum coefficient; characterized in that

the received strongest coefficient indicator indicates a spatial component associated with a maximum coefficient of matrix $\widetilde{\mathbf{W}}_2$, and in that the device is caused to:

determine state information of the channel, wherein a coefficient of matrix $\widetilde{\mathbf{W}}_2$ assumes a value of 1 at a position determined by the strongest coefficient indicator and a predetermined index of the matrix $\widetilde{\mathbf{W}}_2$.

15. A non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method of any of claims 1-6.

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16. A non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method of claim 7.