

RESOURCE TRANSMISSION METHOD, RESOURCE RECEIVING METHOD, COMMUNICATION NODE, AND STORAGE MEDIUM

FIELD

[0001] The present application relates to the field of radio communication network technology, for example, a resource transmission method, a resource receiving method, a communication node, and a storage medium.

BACKGROUND

[0002] Beam scanning is a key process in beam management. A core problem of beam scanning is how to acquire accurate beam pairs with a relatively small amount of resource overhead. In general, if a transmitting end corresponds to A transmit beams and a receiving end corresponds to B receive beams, at most $A * B$ beam scans will be required to select the optimal beam pair. If scanning is performed by stages, for example, one receive beam is fixed to scan A different transmit beams so as to select the optimal transmit beam, and then the transmit beam is fixed based on the optimal transmit beam to scan B different receive beams so as to select the optimal receive beam.

[0003] Therefore, a relatively sound beam pair can be obtained through $A + B$ beam scans. With the further increase of carrier frequency, the number of beams is further increased. That is, when at least one of A or B is very large, the resource overhead is also very large. The number of beam transmissions may be further reduced based on an artificial intelligence method. That is, the number of transmit beams that need to be actually used may be less than A, and the number of receive beams may also be less than B. On this basis, since the number of

actually-transmitted beams is less than the number of configured beams, the number of reference signal resources corresponding to actual transmission is usually less than the

resource control (RRC) and media access control control element (MAC CE). Physical layer signaling may also be transmitted between a network device and a terminal. For example, physical layer signaling is transmitted through a downlink in a physical downlink control channel (PDCCH), through an uplink in a physical uplink control channel (PUCCH), or through a physical random access channel (PRACH).

[0022] In embodiments of the present application, transmission includes sending or receiving, for example, sending or receiving data, and sending or receiving a signal. In some embodiments, the network device configures measurement resource information which is used to acquire channel state information. The measurement resource information includes C_N pieces of channel measurement resource (CMR) information and C_M pieces of interference measurement resource (IMR) information, where C_N and C_M are each a positive integer. The network device configures the measurement resource information in a report configuration (report config) or a reporting setting. The C_N pieces of CMR information are used for the terminal to measure a channel. The C_M pieces of IMR information are used for the terminal to measure interference.

[0023] In some embodiments, artificial intelligence (AI) includes devices, components, software or modules with self-learning functions, such as machine learning (ML), deep learning, reinforcement learning, transfer learning, deep reinforcement learning or meta-learning. In some embodiments, artificial intelligence is implemented through an artificial intelligence network (also referred to as a neural network). The neural network includes multiple layers, and each layer includes at least one node. In an example, the neural network includes an input layer, an output layer, and at least one hidden layer. Each layer of the neural network may use at least one of a fully connected layer, a dense layer, a convolutional layer, a transposed convolutional layer, a direct connection layer, an activation function, a normalization layer, or a pooling layer. In some embodiments, each layer of the neural network may include a sub-neural network, such as a residual network block (Resnet block), a dense network (Densenet Block), or a recurrent neural network (RNN). The artificial intelligence network includes neural network models and/or neural network parameters corresponding to the neural network models. The neural

A and B are relatively great, the overhead is very large. In an example, the beam prediction function of AI may be used. That is, only beam measurement parameters corresponding to M beams are input, but beam measurement parameters corresponding to N beams are predicted according to these beam measurement parameters, where the N beams may include the M beams ($M < N$). Each beam may correspond to a beam direction. A beam may be a transmit beam, a receive beam, or a transmit and receive beam pair.

[0025] In some embodiments, beams include transmit beams, receive beams, precoding, precoding matrices, precoding matrix indicator, receive and transmit beam pairs, and transmit and receive beam pairs. A beam may be a resource (such as sending end precoding, receiving end precoding, an antenna port, an antenna weight vector, and an antenna weight matrix). A beam index may be replaced with a resource index because the beam may be bound to some time-frequency/code resources for transmission. A beam may also be a transmission (sending/receiving) manner including, for example, space division multiplexing or frequency-domain/time-domain diversity. A receive beam indicator refers to that a sending end may perform indication through a current reference signal resource (or a reference signal resource index), a reference signal resource (or a benchmark reference signal resource or reference signal resource index) fed back and reported by an antenna port and a UE, and the quasi-co-location indicator (QCL) assumption of an antenna port. A beam pair includes a combination of a transmit beam indicator and a receive beam indicator.

[0026] In some embodiments, a beam direction or beam angle may include at least one of an angle of arrival (AOA), an angle of departure (AOD), a zenith angle of departure (ZOD), a zenith angle of arrival (ZOA), a vector or vector index constructed from at least one angle of AOA, AOD, ZOD, or ZOA, a discrete Fourier transformation (DFT) vector, a codeword in a codebook, a transmit beam index, a receive beam index, a transmit beam group index, or a receive beam group index.

[0027] In some embodiments, a beam may refer to a spatial filter or a spacial receive/transmit

[0043] The M target reference signal resources are transmitted in L slots, where $L \geq 1$.

[0044] In an embodiment, the step in which the M target reference signal resources are transmitted in the L slots includes transmitting the M target reference signal resources in each of the L slots, where a reference signal resource index set corresponding to the M target reference signal resources transmitted in each of the L slots is the same, or a reference signal resource index set corresponding to the M target reference signal resources transmitted in each of at least two slots among the L slots is different.

[0045] In an embodiment, different numbers of target reference signal resources are transmitted in at least two slots among the L slots.

[0046] In an embodiment, the number of target reference signal resources transmitted in a j-th slot is not less than the number of target reference signal resources transmitted in an i-th slot, where $1 \leq i < j \leq L$.

[0047] In an embodiment, the number of target reference signal resources transmitted in the j-th slot is not less than the number of target reference signal resources transmitted in the i-th slot, where $1 \leq i < j \leq L$, and $j \geq k + c$, where k denotes a slot number of a slot for receiving BFR signaling, c denotes the number of slots corresponding to s time units after a time unit of receiving the BFR signaling, s is a positive integer, and j and k are each a positive integer.

[0048] In an embodiment, the L slots are L consecutive slots.

[0049] In an embodiment, the L slots are L slots with an interval of T, where T denotes a transmission period of periodic or semi-persistent reference signal resources or a transmission interval agreed in aperiodic reference signal resources, and T is an integer greater than 1.

[0050] In an embodiment, the transmission of the M target reference signal resources is triggered in an aperiodic manner, or the transmission of the M target reference signal resources

beams. E is an integer greater than D . D and K are each a positive integer. Beams include transmit beams, receive beams, or transmit and receive beams. In an example, $D = M * R$, where R is the number of receive beams for receiving target reference signals. In an example, $E = N * R1$. N is a positive integer greater than M and denotes the number of reference signal resources. In some cases, N is equal to the number of transmit beams. $R1$ is the number of total receive beams of the terminal and is generally greater than or equal to R .

[0058] In an embodiment, the beam measurement parameter includes at least one of reference signal receiving power (RSRP), the signal to interference plus noise ratio (SINR) of a reference signal, reference signal receiving quality (RSRQ), a beam angle, a transmit beam index, a receive beam index, the beam pair index of a transmit beam and a receive beam, a beam domain receive power map (BDRPM), a channel state information reference signal resource indicator (CSI-RS resource indicator, or CRI), an SS/PBCH block resource indicator (SSBRI), the linear value of RSRP, the linear value of RSRQ, the linear value of SINR, the logarithmic value of RSRP, the logarithmic value of RSRQ, or the logarithmic value of SINR.

[0059] In an embodiment, the method further includes the following.

[0060] In 160, beam measurement parameters at Y moments are predicted according to beam measurement parameters at X historical moments.

[0061] In 170, preferred beams corresponding to the Y moments are determined according to beam measurement parameters at Y moments.

[0062] X is a positive integer, and Y is a positive integer.

[0063] The preceding resource transmission method is described through some exemplary embodiments hereinafter.

[0064] In an embodiment, AI for predicting beam measurement parameters may be

[0074] In these embodiments, $N > M$. For example, N may be a multiple of M . For example, N is a natural multiple of M ; for example, N is twice, three times, four times, five times, or six times as much as M . $N - M$ beams do not actually transmit signals, and their beam measurement values are predicted with no need for transmitting corresponding reference signals.

[0075] In an embodiment, a beam measurement parameter array is a one-dimensional array, for example, a vector. In an embodiment, a beam measurement parameter array is a two-dimensional array, for example, a matrix. In an embodiment, a beam measurement parameter array is an array greater than two dimensions, for example, a tensor. A vector or a matrix may be regarded as a special case of a tensor.

[0076] In an embodiment, a beam measurement parameter is the L1 reference signal received power (L1-RSRP or RSRP) corresponding to at least one beam. In an example, a beam measurement parameter is the L1 signal to interference plus noise ratio (L1-SINR or SINR) of a reference signal corresponding to at least one beam. In an example, a beam measurement parameter is the reference signal received quality (RSRQ) corresponding to at least one beam. In an example, a beam measurement parameter is a beam angle (at least one of AOA, ZOA, AOD, or ZOD, which is sometimes also referred to as a horizontal arrival angle, a vertical arrival angle, a horizontal departure angle, or a vertical departure angle respectively) corresponding to at least one beam. In an example, a beam measurement parameter is a transmit beam index corresponding to at least one beam. In an example, a beam measurement parameter is a receive beam index corresponding to at least one beam. In an example, the beam measurement parameter is a transmit beam and receive beam pair index (a beam pair index or a beam pair for short) corresponding to at least one beam. In an example, a beam measurement parameter is a beam domain receive power map (BDRPM) corresponding to at least one beam. In an example, a beam measurement parameter is a channel state information reference signal resource indicator (CSI-RS Resource Indicator, or CRI) corresponding to at least one beam. In an example, a beam measurement parameter is a synchronization signal block resource indicator (SSBRI) corresponding to at least one beam. In an example, a beam measurement parameter is a

N reference signal resources in the manner of a reference signal resource bitmap. The reference signal resource bitmap may be acquired by the terminal and fed back to the network device. Alternatively, the reference signal resource bitmap may be acquired by the network device and configured to the terminal. In an example, the reference signal resource bitmap includes N bits. Each bit is used to determine whether a reference signal resource of a corresponding index is transmitted, is activated, or is a target reference signal resource. For example, when the i-th bit takes a first value, it indicates that the i-th reference signal resource in the reference signal resource set may be transmitted, be activated, or be a target reference signal resource. When the i-th bit takes a second value, it indicates that the i-th reference signal resource in the reference signal resource set may not be transmitted, may not be activated, or may not be a target reference signal resource. $i = 1, \dots, \text{and } N$. In an example, the first value is 1, and the second value is 0. In an example, the first value is a non-zero value, and the second value is 0. In an example, the first value is True, and the second value is False.

[0087] In an example, the reference signal resource bitmap is an indication vector. The indication vector is a 0 – 1 array of $1 * N$ dimensions, where 1 denotes that a corresponding beam is selected, and 0 denotes that a corresponding reference signal resource is not selected. In an example, the reference signal resource bitmap is an indication vector. The indication vector is a Boolean array of $1 * N$ dimensions, where non-zero or True denotes that a corresponding beam is selected, and 0 or False denotes that a corresponding reference signal resource is not selected.

[0088] In an embodiment, a method for the network device or the terminal to select the M target reference signal resources from the N reference signal resources is that M reference signal resources are selected randomly from the N reference signal resources.

[0089] In an embodiment, a method for the network device or the terminal to select the M target reference signal resources from the N reference signal resources is that M reference signal resources are selected from the N reference signal resources according to an agreed formula or

rule. The formula includes, but is not limited to, finding M smallest values, finding M largest

signaling. The network device starts to transmit target reference signal resources in the S1-th slot after receiving trigger signaling and needs to transmit the target reference signal resources L times in the L slots. The terminal starts to receive the target reference signal resources in the S2-th slot after sending the trigger signaling, receives the target reference signal resources L times in the L slots, and performs measurement L times based on the reference signal resources received L times. One beam measurement parameter array is acquired in each measurement. L is an integer greater than or equal to 1.

[0093] In an embodiment, M target reference signal resources are transmitted in each of the L slots. The reference signal resource index set corresponding to the M target reference signal resources transmitted in each of the L slots is the same.

[0094] In an embodiment, M target reference signal resources are transmitted in each of the L slots. The reference signal resource index set corresponding to the M target reference signal resources transmitted in each of at least two slots among the L slots is different.

[0095] In an embodiment, different numbers of target reference signal resources are transmitted in at least two slots among the L slots, and the number M_j ($j = 1, \dots, \text{and } L$) of target reference signal resources transmitted in the j-th slot is not less than the number M_i ($i = 1, \dots, \text{and } L$) of target reference signal resources transmitted in the i-th slot. That is, $M_i \leq M_j$, where $1 \leq i < j \leq L$.

[0096] In an embodiment, different numbers of target reference signal resources are transmitted in at least two slots among the L slots, and the number M_j of reference signal resources transmitted in the j-th slot is not less than the number M_i of reference signal resources transmitted in the i-th slot. That is, $M_i \leq M_j$, where $i < j$; $i = 1, \dots, \text{and } L$; $j = 1, \dots, \text{and } L$; and $j \geq k + c$. k denotes a slot number of a slot for receiving BFR signaling, c denotes the number of slots corresponding to s time units after a time unit of receiving the BFR signaling, and s, k, and j are each a positive integer. In an example, a time unit is a symbol or a mini slot.

The symbol may be

parameter.

[00107] In an embodiment, the M target reference signal resources correspond to M transmit beams.

[00108] In an embodiment, the step in which the M target reference signal resources in the reference signal resource set are received includes the following: the M target reference signal resources are received in L slots, where $L \geq 1$.

[00109] In an embodiment, the step in which the M target reference signal resources are received in the L slots includes receiving the M target reference signal resources in each of the L slots, where a reference signal resource index set corresponding to the M target reference signal resources received in each of the L slots is the same, or a reference signal resource index set corresponding to the M target reference signal resources received in each of at least two slots is different.

[00110] In an embodiment, different numbers of target reference signal resources are received in at least two slots among the L slots.

[00111] In an embodiment, the number of target reference signal resources transmitted in a j -th slot is not less than the number of target reference signal resources transmitted in an i -th slot, where $1 \leq i < j \leq L$.

[00112] In an embodiment $j \geq k + c$, where k denotes a slot number of a slot for a base station receiving BFR signaling, c denotes the number of slots corresponding to s time units after a time unit of a network device receiving the BFR signaling, s is a positive integer, and k and j are each a positive integer.

[00113] In an embodiment, the L slots are L consecutive slots.

transmitted in the L slots includes transmitting the M target reference signal resources in each of the L slots, where a reference signal resource index set corresponding to the M target reference signal resources transmitted in each of the L slots is the same, or a reference signal resource index set corresponding to the M target reference signal resources transmitted in each of at least two slots is different.

[00132] In an embodiment, different numbers of target reference signal resources are transmitted in at least two slots among the L slots.

[00133] In an embodiment, the number of target reference signal resources transmitted in a j-th shot is not less than the number of target reference signal resources transmitted in an i-th, where $1 \leq i < j \leq L$.

[00134] In an embodiment, the number of target reference signal resources transmitted in the j-th shot is not less than the number of target reference signal resources transmitted in the i-th slot, where $1 \leq i < j \leq L$, and $j \geq k + c$, where k denotes a slot number of a slot for receiving BFR signaling, c denotes the number of slots corresponding to s time units after a time unit of receiving the BFR signaling, and k, j, and s are each a positive integer.

[00135] In an embodiment, the L slots are L consecutive slots.

[00136] In an embodiment, the L slots are L slots with an interval of T, where T denotes a transmission period of periodic or semi-persistent reference signal resources or a transmission interval agreed in aperiodic reference signal resources, and T is an integer greater than 1.

[00137] In an embodiment, the transmission of the M target reference signal resources is triggered in an aperiodic manner, or the transmission of the M target reference signal resources is triggered in the L slots in an aperiodic manner, where $L \geq 1$.

[00138] In an embodiment, the transmission of the M target reference signal resources is

to indicate a BFR parameter.

[00157] In an embodiment, the M target reference signal resources correspond to M transmit beams.

[00158] In an embodiment, the resource receiving module 410 is configured to receive the M target reference signal resources in L slots, where $L \geq 1$.

[00159] In an embodiment, the step in which the M target reference signal resources are received in the L slots includes receiving the M target reference signal resources in each of the L slots, where a reference signal resource index set corresponding to the M target reference signal resources received in each of the L slots is the same, or a reference signal resource index set corresponding to the M target reference signal resources received in at least two slots is different.

[00160] In an embodiment, different numbers of target reference signal resources are received in at least two slots among the L slots.

[00161] In an embodiment, the number of target reference signal resources received in a j-th slot is not less than the number of target reference signal resources received in an i-th slot, where $1 \leq i < j \leq L$.

[00162] In an embodiment, the number of target reference signal resources received in the j-th slot is not less than the number of target reference signal resources received in the i-th slot, where $1 \leq i < j \leq L$, and $j \geq k + c$, where k denotes a slot number of a slot for receiving BFR signaling, c denotes the number of slots corresponding to s time units after a time unit of a network device receiving the BFR signaling, and k, j, and s are each a positive integer.

[00163] In an embodiment, the L slots are L consecutive slots.

CLAIMS

1. A resource transmission method, comprising:

determining M target reference signal resources in a reference signal resource set, wherein the reference signal resource set comprises N reference signal resources, M is a positive integer, N is a positive integer, and $M < N$; and

transmitting the M target reference signal resources.

2. The method according to claim 1, wherein determining the M target reference signal resources in the reference signal resource set comprises one of:

determining that M reference signal resources with smallest indices in the reference signal resource set are the target reference signal resources;

determining that M reference signal resources with largest indices in the reference signal resource set are the target reference signal resources;

determining that M reference signal resources, in the reference signal resource set, whose indices are odd are the target reference signal resources;

determining that M reference signal resources, in the reference signal resource set, whose indices are even are the target reference signal resources;

determining that M reference signal resources indicated by a reference signal resource bitmap are the target reference signal resources;

selecting M reference signal resources randomly from the reference signal resource set to serve as the target reference signal resources;

selecting M reference signal resources from the reference signal resource set according to an agreed formula to serve as the target reference signal resources; or

selecting M reference signal resources from the reference signal resource set according to reference signal resource start and end indices to serve as the target reference signal resources.

3. The method according to claim 1, further comprising at least one of:

receiving first trigger signaling and determining, according to the first trigger signaling, a transmission slot of the target reference signal resources;

receiving second trigger signaling and determining, according to the second trigger signaling, a number of the target reference signal resources;

receiving third trigger signaling and determining, according to the third trigger signaling, at least one of reference signal resource indices or offsets corresponding to the target reference signal resources;

receiving fourth trigger signaling and determining, according to the fourth trigger signaling, reference signal resource start and end indices corresponding to the target reference signal resources;

receiving fifth trigger signaling and determining, according to the fifth trigger signaling, a reference signal resource bitmap; or

receiving sixth trigger signaling and determining, according to the sixth trigger signaling, a beam failure recovery (BFR) parameter.

4. The method according to claim 1, wherein transmitting the M target reference signal resources comprises:

transmitting the M target reference signal resources in L slots, wherein $L \geq 1$.

5. The method according to claim 4, wherein transmitting the M target reference signal resources in the L slots comprises:

transmitting the M target reference signal resources in each of the L slots;

wherein a reference signal resource index set corresponding to the M target reference signal resources transmitted in each of the L slots is the same, or a reference signal resource index set corresponding to the M target reference signal resources received in each of at least two slots among the L slots is different.

6. The method according to claim 4, wherein different numbers of target reference signal resources are transmitted in at least two slots among the L slots.

7. The method according to claim 6, wherein a number of target reference signal resources

transmitted in a j -th slot among the L slots is greater than or equal to a number of target reference signal resources transmitted in an i -th slot among the L slots, wherein $1 \leq i < j \leq L$.

8. The method according to claim 7, wherein $j \geq k + c$, wherein k denotes a slot for receiving beam failure recovery (BFR) signaling, c denotes a number of slots corresponding to s time units after a time unit of receiving the BFR signaling, s is a positive integer, and k is a positive integer.

9. The method according to claim 4, wherein the L slots are L consecutive slots; or

the L slots are L slots with an interval of T , wherein T denotes a transmission period of periodic or semi-persistent reference signal resources or a transmission interval agreed in aperiodic reference signal resources, and T is an integer greater than 1.

10. The method according to claim 1, wherein transmission of the M target reference signal resources is triggered in an aperiodic manner; or transmission of the M target reference signal resources is activated in a semi-persistent manner, or transmission of the M target reference signal resources is deactivated to stop in a semi-persistent manner.

11. A resource receiving method, comprising:

receiving M target reference signal resources in a reference signal resource set, wherein the reference signal resource set comprises N reference signal resources, M is a positive integer, N is a positive integer, and $M < N$; and

determining at least one piece of beam prediction information according to the M target reference signal resources and determining a preferred beam according to the at least one piece of beam prediction information.

12. The method according to claim 11, wherein the M target reference signal resources comprises one of:

M reference signal resources with smallest indices in the reference signal resource set;

M reference signal resources with largest indices in the reference signal resource set;

M reference signal resources, in the reference signal resource set, whose indices are odd;

M reference signal resources, in the reference signal resource set, whose indices are even;

M reference signal resources indicated by a reference signal resource bitmap;

M reference signal resources randomly selected from the reference signal resource set;

M reference signal resources selected from the reference signal resource set according to an agreed formula; or

M reference signal resources selected from the reference signal resource set according to reference signal resource start and end indices.

13. The method according to claim 11, further comprising at least one of:

transmitting first trigger signaling, wherein the first trigger signaling is configured to indicate a transmission slot of the target reference signal resources;

transmitting second trigger signaling, wherein the second trigger signaling is configured to indicate a number of the target reference signal resources;

transmitting third trigger signaling, wherein the third trigger signaling is configured to indicate at least one of reference signal resource indices or offsets corresponding to the target reference signal resources;

transmitting fourth trigger signaling, wherein the fourth trigger signaling is configured to indicate reference signal resource start and end indices corresponding to the target reference signal resources;

transmitting fifth trigger signaling, wherein the fifth trigger signaling is configured to indicate a reference signal resource bitmap; or

transmitting sixth trigger signaling, wherein the sixth trigger signaling is configured to indicate a beam failure recovery (BFR) parameter.

14. The method according to claim 11, wherein receiving the M target reference signal resources in the reference signal resource set comprises:

receiving the M target reference signal resources in L slots, wherein $L \geq 1$.

15. The method according to claim 14, wherein receiving the M target reference signal resources in the L slots comprises:

receiving the M target reference signal resources in each of the L shots;

wherein a reference signal resource index set corresponding to the M target reference signal resources received in each of the L slots is the same, or a reference signal resource index set corresponding to the M target reference signal resources received in each of at least two slots among the L slots is different.

16. The method according to claim 14, wherein different numbers of target reference signal resources are received in at least two slots among the L slots.

17. The method according to claim 16, wherein a number of target reference signal resources received in a j-th shot among the L slots is greater than or equal to a number of target reference signal resources received in an i-th slot among the L slots, wherein $1 \leq i < j \leq L$.

18. The method according to claim 16, wherein the L slots are L consecutive slots; or

the L slots are L slots with an interval of T, wherein T denotes a transmission period of periodic or semi-persistent reference signal resources or a transmission interval agreed in aperiodic reference signal resources, and T is an integer greater than 1.

19. A communication node, comprising a memory and one or more processors, wherein

the memory is configured to store at least one program; and

wherein the at least one program is executed by the at least one processor to cause the at least one processor to perform the resource transmission method according to any one of claims 1 to 10 or the resource receiving method according to any one of claims 11 to 18.

20. A computer-readable storage medium for storing a computer program, wherein the computer program, when executed by a processor, performs the resource transmission method according to any one of claims 1 to 10 or the resource receiving method according to any one of claims 11 to 18.