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(54) **METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION**

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(Continued)

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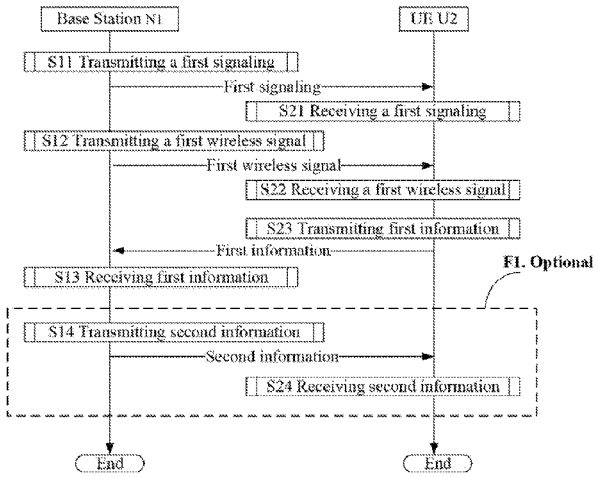
(57) **ABSTRACT**

A method and a device for multi-antenna transmission in a user equipment and a base station are disclosed in the present disclosure. The user equipment first receives a first signaling, receives a first wireless signal, and transmits first information. K antenna port groups are used to transmit the first wireless signal. The first signaling is used to determine the K antenna port groups. The K antenna port groups respectively correspond to K channel quality values. K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values. The K1 is a positive integer less than or equal to the K. A first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values. The first information is used to determine the K1 antenna port groups and the first proportional sequence.

20 Claims, 10 Drawing Sheets



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See application file for complete search history.

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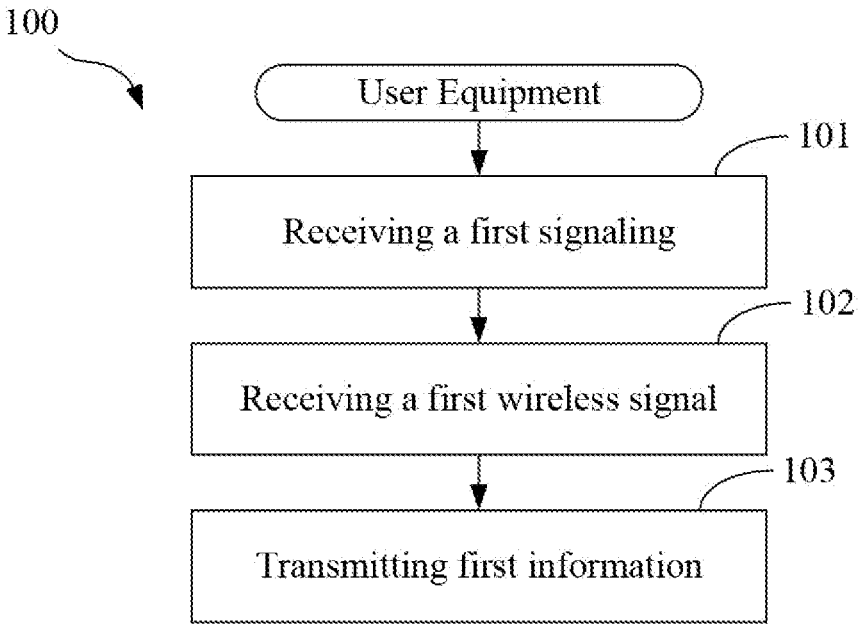
100
User Equipment
101
Receiving a first signaling
102
Receiving a first wireless signal
103
Transmitting first information

Fig. 1

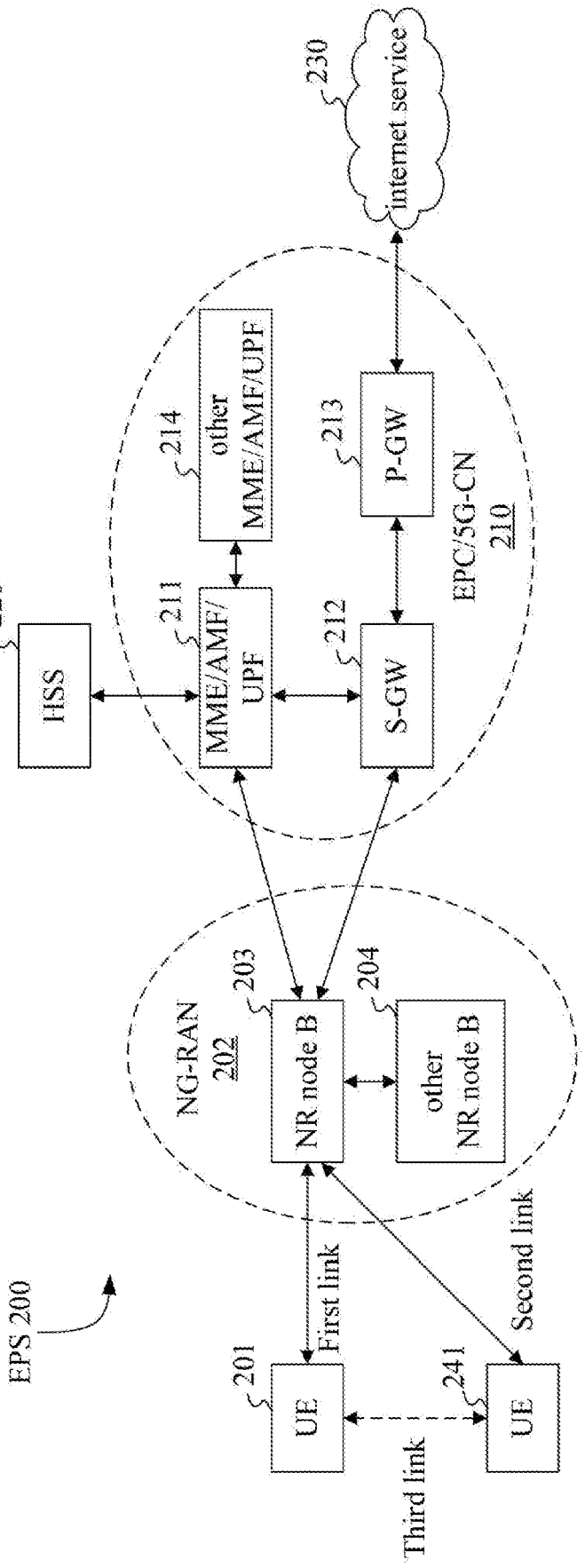
EPS 200
UE
201
UE
241
First link
Second link
Third link
NG-RAN
202
NR node B
203
other
NR node B
204
HSS
220
MME/AMF/
UPF
211
S-GW
212
other
MME/AMF/UPF
214
P-GW
213
EPC/5G-CN
210
internet service
230

Fig. 2

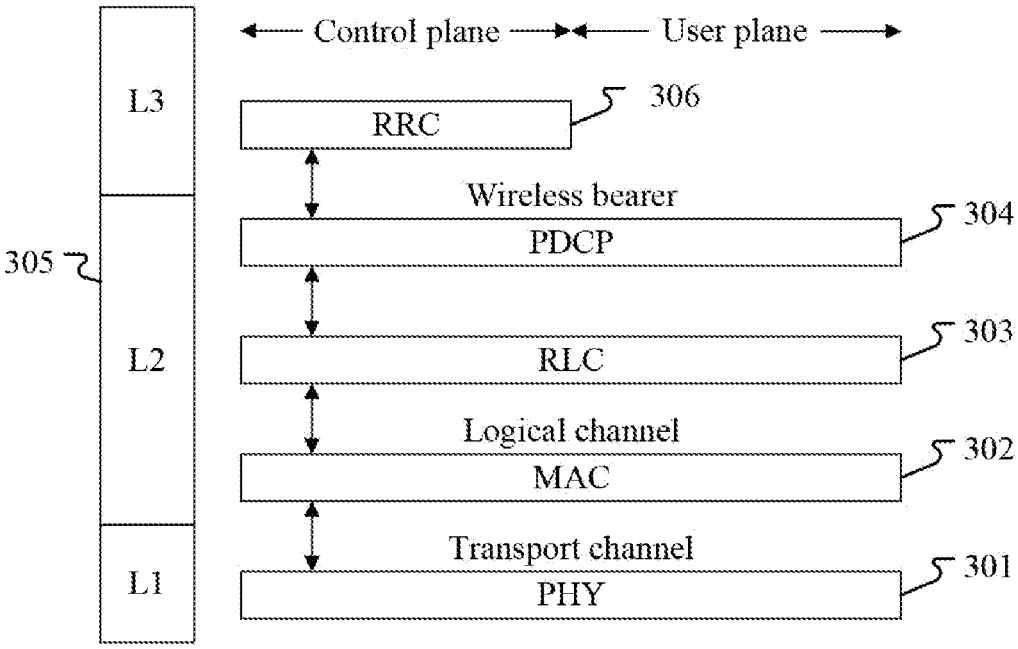
Control plane
User plane
L3
L2
L1
305
RRC
306
Wireless bearer
PDCP
304
RLC
303
Logical channel
MAC
302
Transport channel
PHY
301

Fig. 3

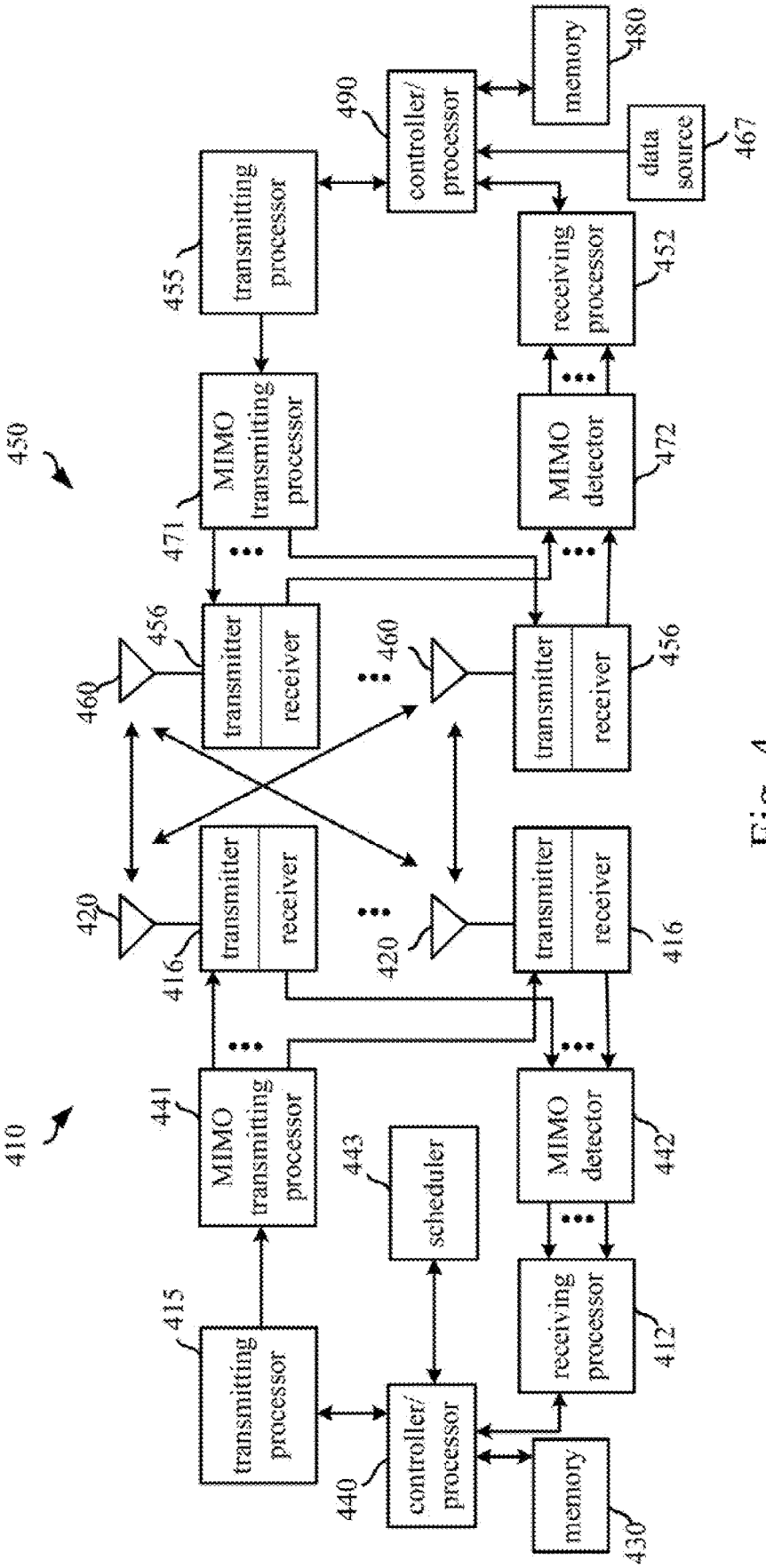
410
450
420
460
416
456
transmitter
receiver
MIMO transmitting processor
441
471
transmitting processor
415
455
scheduler
443
controller/ processor
440
490
memory
430
480
MIMO detector
442
472
receiving processor
412
452
data source
467

Fig. 4

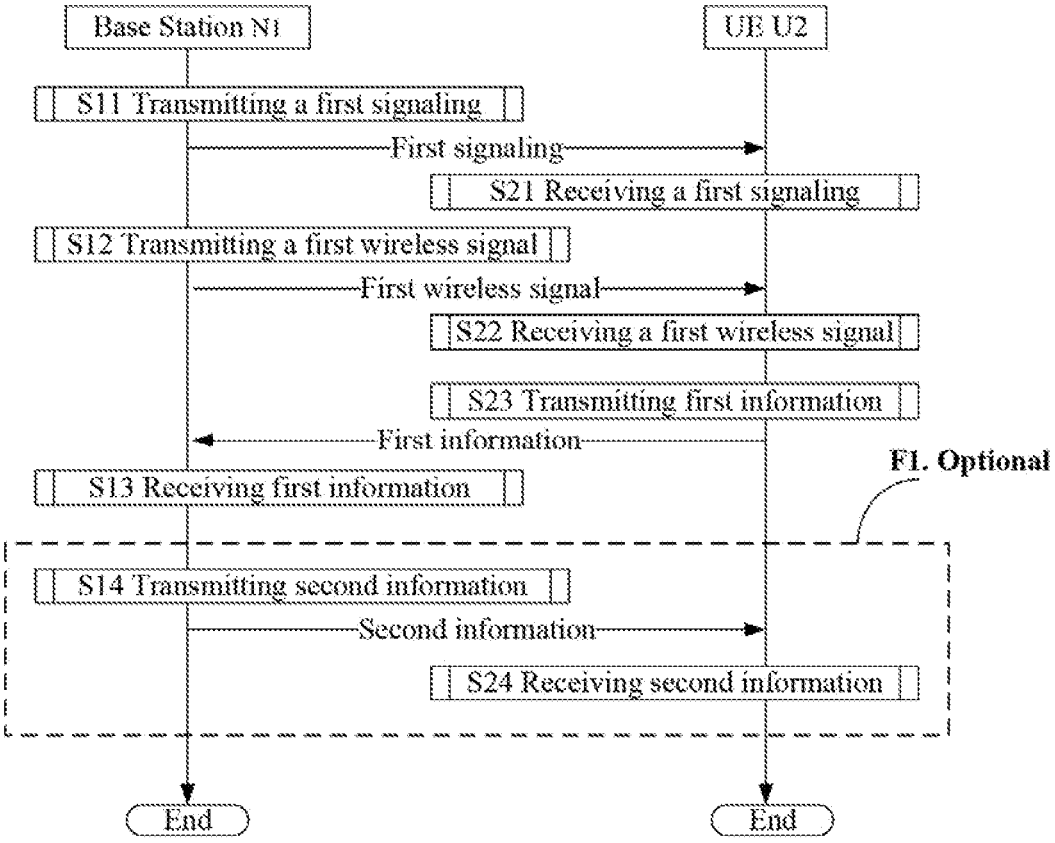
Base Station N1
UE U2
S11 Transmitting a first signaling
First signaling
S21 Receiving a first signaling
S12 Transmitting a first wireless signal
First wireless signal
S22 Receiving a first wireless signal
S23 Transmitting first information
First information
F1. Optional
S13 Receiving first information
S14 Transmitting second information
Second information
S24 Receiving second information
End
End

Fig. 5

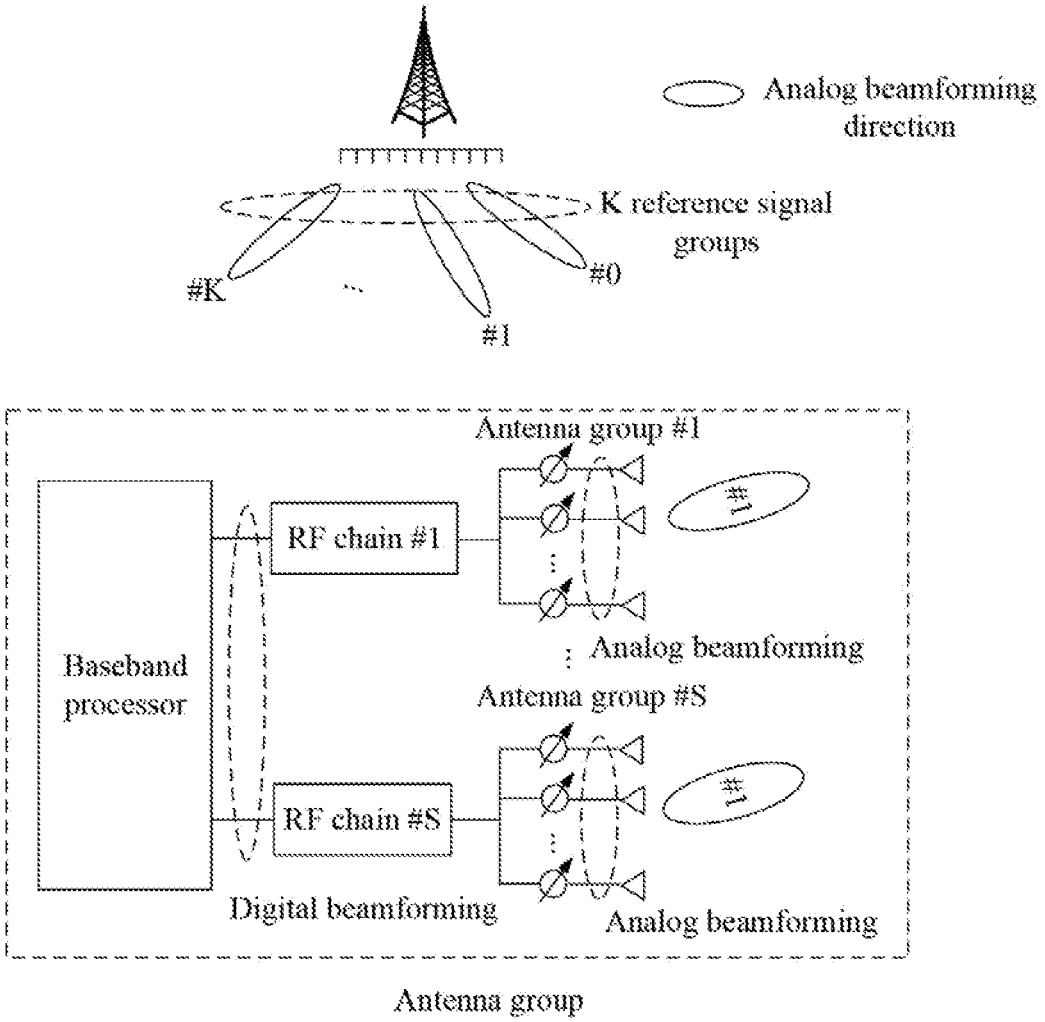
Analog beamforming direction
K reference signal groups
#K
#0
#1
Antenna group #1
RF chain #1
Analog beamforming
Baseband processor
Antenna group #S
RF chain #S
Digital beamforming
Analog beamforming
Antenna group

Fig. 6

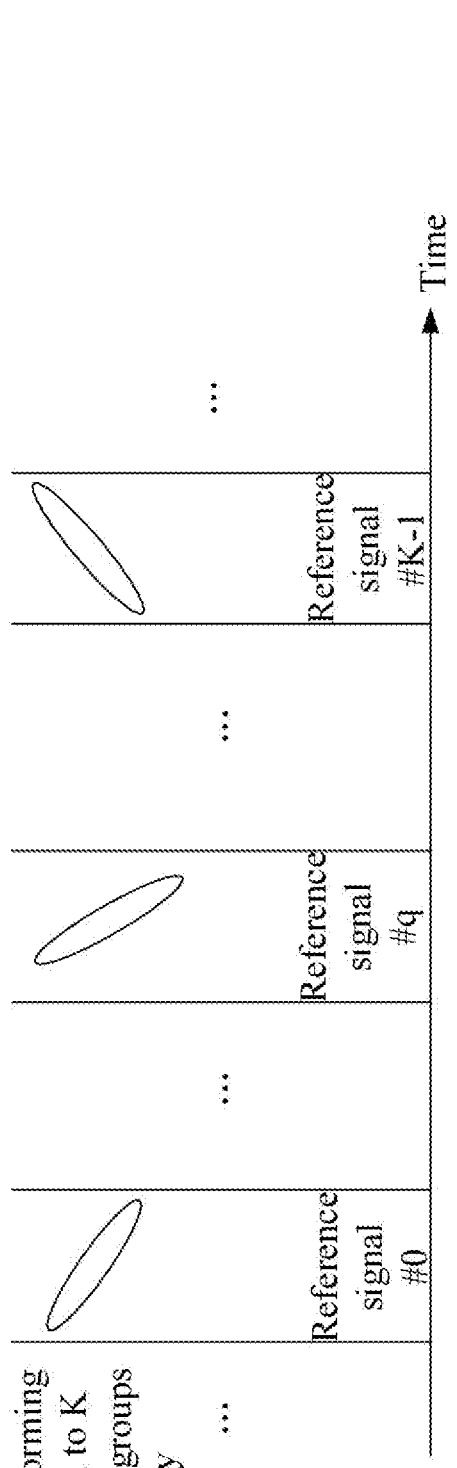
Analog beamforming vector
K analog beamforming vectors applied to K reference signal groups respectively
Reference signal #0
Reference signal #q
Reference signal #K-1
Time window #0
Time window #q
Time window #K-1
Time

FIG. 7

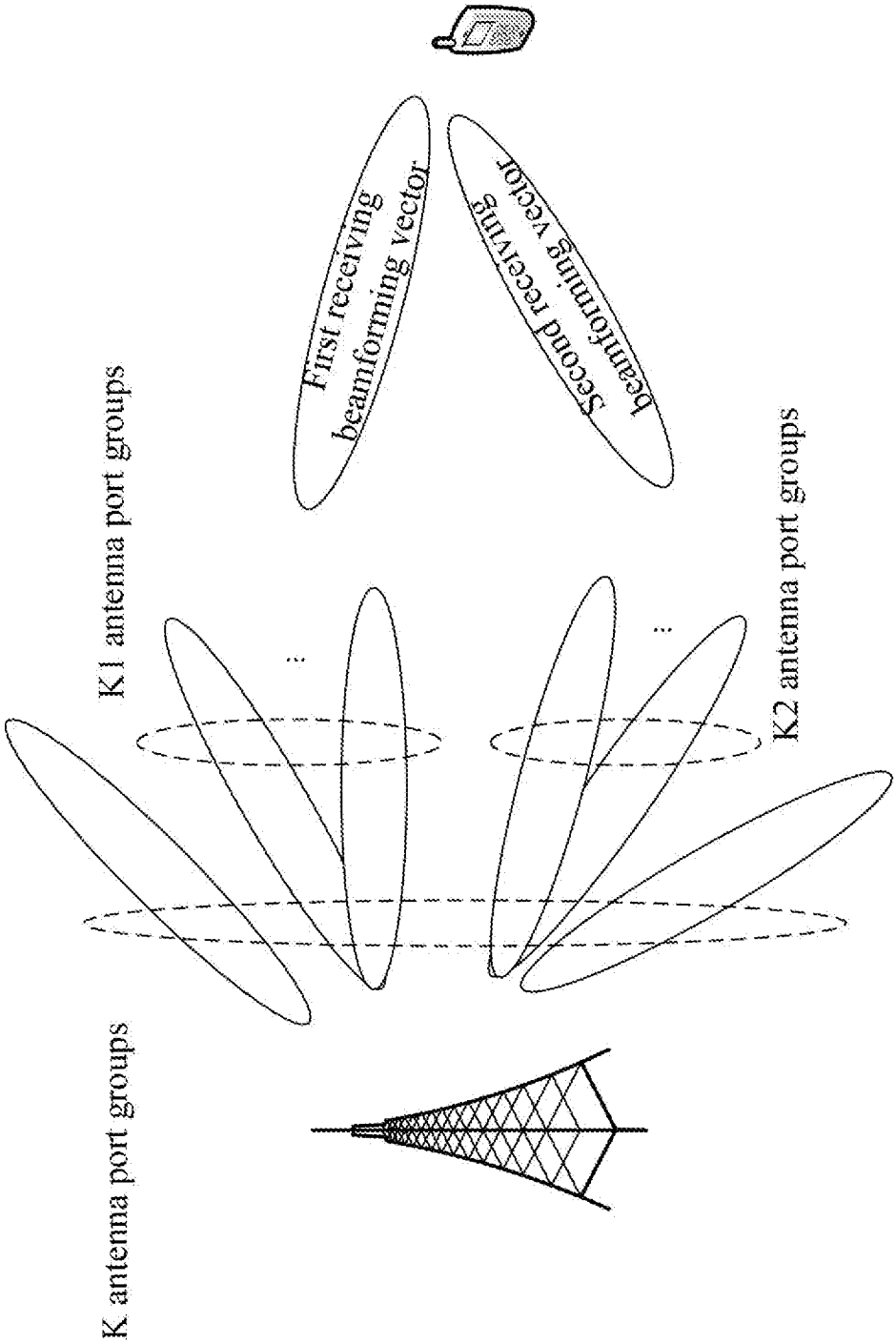
First receiving beamforming vector
Second receiving beamforming vector
K1 antenna port groups
K2 antenna port groups
K antenna port groups

FIG. 8

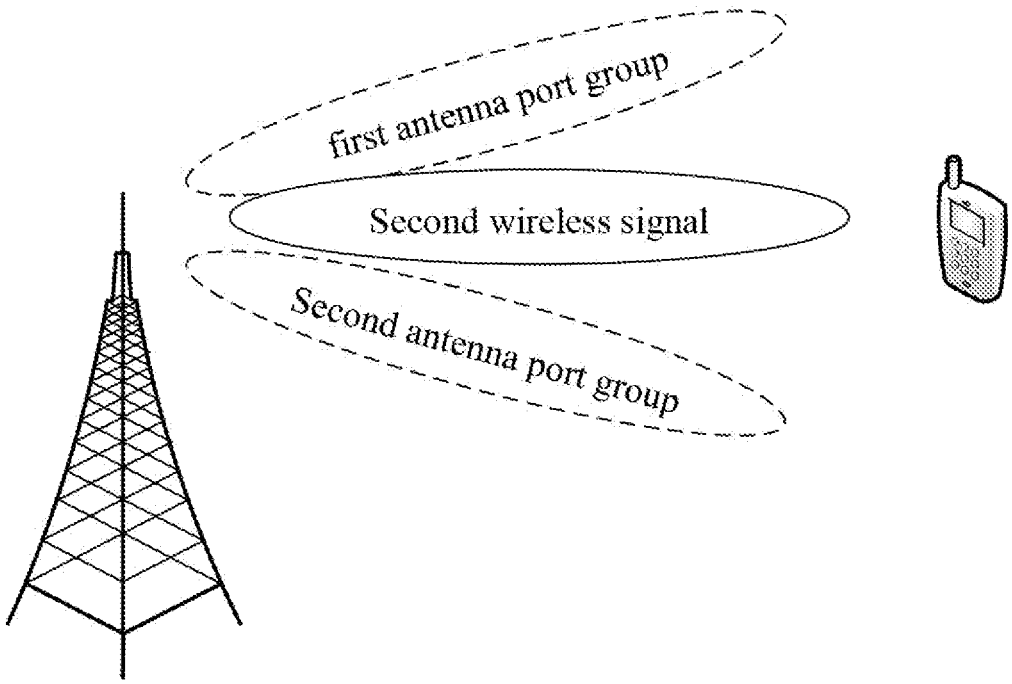
first antenna port group
Second wireless signal
Second antenna port group

Fig. 9

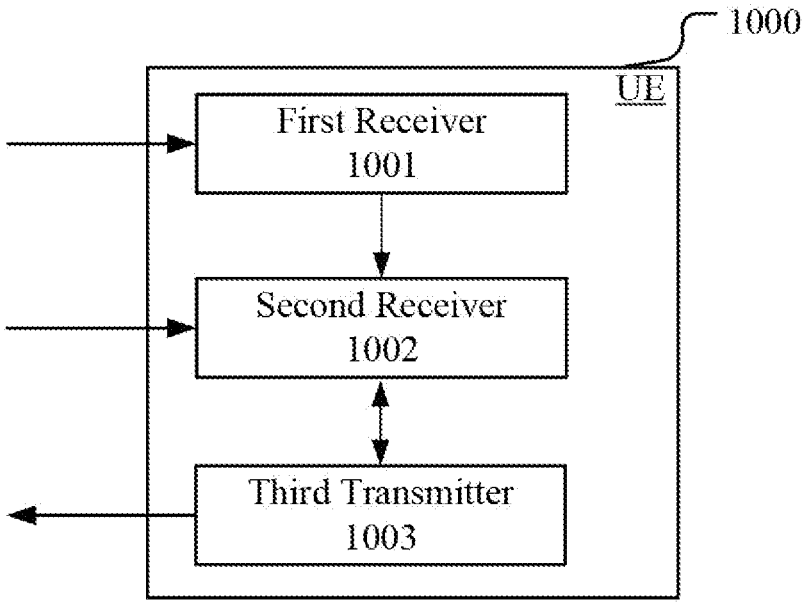
1000
UE
First Receiver
1001
Second Receiver
1002
Third Transmitter
1003

Fig. 10

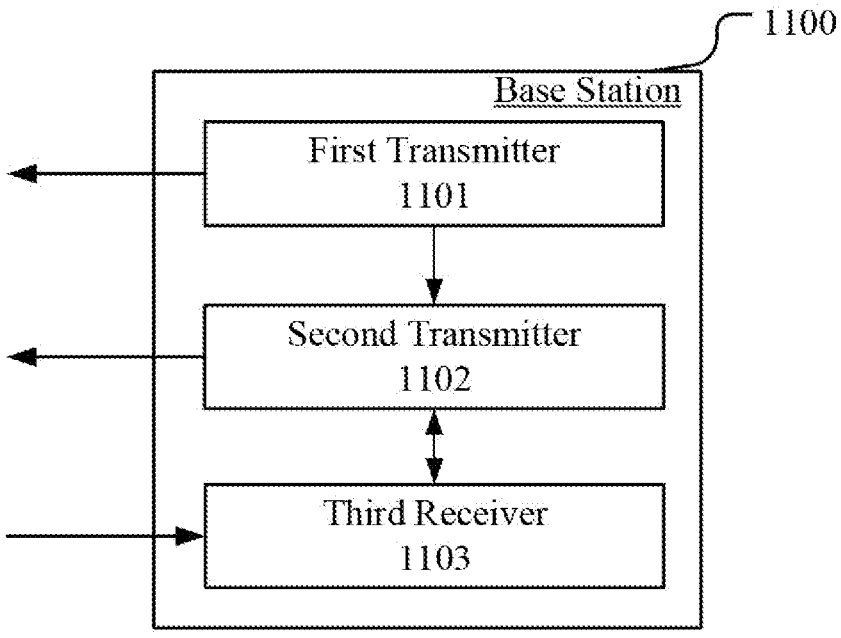
1100
Base Station
First Transmitter
1101
Second Transmitter
1102
Third Receiver
1103

Fig. 11

METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of International Application No. PCT/CN2017/094209, filed Jul. 25, 2017, claiming the priority benefit of Chinese Patent Application Serial Number 201611236923.2, filed on Dec. 28, 2016, the full disclosure of which is incorporated herein by reference.

BACKGROUND

Technical Field

The present disclosure relates to a scheme for multi-antenna transmission in a wireless communication system.

Related Art

Massive Multiple-Input Multiple-Output (MIMO) has become a research hotspot for next-generation mobile communications. In massive MIMO, multiple antennas can improve communication quality by forming narrower beams pointing in a specific direction through beamforming. Massive MIMO can also form different directions through multiple antennas for serving multiple users to improve the throughput of massive MIMO systems and reduce transmission delay.

According to the discussion of 3rd Generation Partner Project (3GPP) Radio Access Network 1 (RAN1), a hybrid beamforming in combination of analog beamforming and digital precoding has become an important research topic for New Radio Technology (NR) systems.

SUMMARY

Through research, the inventors found that in a massive MIMO system, the base station can perform beam scanning over a period of time resources. The UE selects and reports the beam. However, due to the limitation of air interface resources, the number of beams used for beam scanning and the number of beams reported by the UE are limited. In addition, due to the uncertainty of the UE location, the beam used for beam scanning does not necessarily include the beam that best serves the UE. How to use the information reported by the UE to form the best beam to serve the UE service is an urgent problem to be solved.

In view of the above problem, the present disclosure provides a solution. It should be noted that, in the case of no conflict, the embodiments in the user equipment (UE) and the features in the embodiments of the present disclosure can be applied to the base station, and vice versa. Further, in case of no conflicts, the embodiments of the present disclosure and the features of the embodiments may be arbitrarily combined with each other.

The present disclosure provides a method for multi-antenna transmission in a user equipment (UE), including:

receiving a first signaling;

receiving a first wireless signal; and

transmitting first information;

wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine {the K1 antenna port groups, the first proportional sequence}; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

In the embodiment, the advantage of the foregoing method is that the base station may obtain a proportional relationship among reception qualities corresponding to multiple beams, and may generate a more accurate serving beam for the UE according to the proportional relationship, thereby improving transmission quality.

In one embodiment, the beams and the serving beam are analog beams.

In one embodiment, the antenna port is formed by superimposing multiple physical antennas through antenna virtualization. A mapping coefficient of the antenna port to the plurality of physical antennas constitutes a beamforming vector for the antenna virtualization to form a beam.

In one embodiment, the antenna virtualization includes analog beamforming and digital beamforming. The analog beamforming is a mapping of an RF link output to the plurality of physical antennas and is used to form an analog beam. The digital beamforming is a mapping of the antenna port to the RF link and is used to form a digital beam.

In one embodiment, the beamforming vector is a product of an analog beamforming matrix and a digital beamforming vector. The analog beamforming matrix is composed of one or more analog beamforming vectors.

In one embodiment, the beamforming vector is a Kronecker product of an analog beamforming vector and a digital beamforming vector.

In one embodiment, the antenna virtualization only includes analog beamforming.

In one embodiment, the antenna port group is composed of one antenna port.

In one embodiment, the antenna port group is composed of a plurality of antenna ports.

In one embodiment, the same analog beamforming vectors and different digital beamforming vectors are used for antenna virtualization of different antenna ports within the antenna port group.

In one embodiment, the K antenna port groups include two antenna port groups, and the numbers of the antenna ports included in the two antenna port groups are different.

In one embodiment, the antenna port corresponds to a reference signal. The reference signal is transmitted through the antenna port.

In one embodiment, the reference signal is a reference symbol.

In one embodiment, the reference signal includes a plurality of reference symbols. One reference symbol occupies one Resource Element (RE).

In one embodiment, the reference signal is a Synchronization Signal (SS).

In one embodiment, the reference signal is a Primary Synchronization Signal (PSS).

In one embodiment, the reference signal is a Secondary Synchronization Signal (SSS).

In one embodiment, the reference signal is a Channel State Information Reference Signal (CSI-RS).

In one embodiment, the reference signal is a Demodulation Reference Signal (DMRS).

In one embodiment, the reference signal is a DMRS of a Physical Broadcast Channel (PBCH).

In one embodiment, the reference signal is a DMRS of a Physical Downlink Share Channel (PDSCH).

In one embodiment, the first wireless signal is a plurality of multi-carrier symbols.

In one embodiment, the first wireless signal is an SS burst. The SS burst includes a plurality of SS blocks. The SS blocks include at least one synchronization signal.

In one embodiment, the first wireless signal is an CSI-RS burst.

In one embodiment, the first wireless signal is one beam sweep. The beam scanning is an operation of covering a spatial area by a transmitted or received beam in a predetermined manner over a period of time.

In one embodiment, the K antenna port groups respectively correspond to K reference signal groups. The K reference signal groups are respectively transmitted through the K antenna port groups. The first wireless signal is composed of the K reference signal groups.

In one embodiment, K different analog beamforming vectors are used for analog beamforming of the K antenna port groups.

In one embodiment, the time-frequency pattern and the Orthogonal Cover Code (OCC) of at least two reference signals of the K reference signal groups are the same in one time unit. The two reference signals are transmitted on different time resources.

In one embodiment, the time unit is a symbol.

In one embodiment, the time unit is a time slot.

In one embodiment, the time unit is a subframe.

In one embodiment, the time unit is a short Transmission Time Interval (sTTI).

In one embodiment, the first signaling explicitly indicates the K antenna port groups.

In one embodiment, the first signaling implicitly indicates the K antenna port groups.

In one embodiment, the first signaling is higher layer signaling.

In one embodiment, the first signaling is a Radio Resource Control (RRC) signaling.

In one embodiment, the first signaling is a MAC layer signaling.

In one embodiment, the first signaling is a MAC Control Element (MAC CE).

In one embodiment, the first signaling is a physical layer signaling.

In one embodiment, the first signaling is carried by a Physical Downlink Control Channel (PDCCH).

In one embodiment, the first signaling is Downlink Control Information (DCI).

In one embodiment, the first signaling is common to the cell.

In one embodiment, the first signaling is UE-specific.

In one embodiment, the first signaling is UE group specific.

In one embodiment, the channel quality value is one of instantaneous Reference Signal Received Power (RSRP), long-term RSRP, SINR or SNR.

In one embodiment, the K channel quality values are wideband channel quality values.

In one embodiment, the first information explicitly indicates the K1 antenna port groups.

In one embodiment, the first information implicitly indicates the K1 antenna port groups.

In one embodiment, the first information explicitly indicates the first proportional sequence.

In one embodiment, the first information implicitly indicates the first proportional sequence.

In one embodiment, the first information is carried by a Physical Uplink Shared Channel (PUSCH).

In one embodiment, the first information is carried by a Physical Uplink Control Channel (PUCCH).

In one embodiment, the first information is transmitted in a CSI report.

In one embodiment, the first information is transmitted in a plurality of messages.

In one embodiment, a bitmap is used to determine the K1 antenna port groups.

In one embodiment, the K1 antenna port groups correspond to the same receiving beamforming vector.

In one embodiment, the receiving beamforming vector is an analog receiving beamforming vector.

In one embodiment, the K antenna port groups are represented by a bit string of length K, the bit position corresponding to the K1 antenna port groups is 1, and the other bit positions are 0.

In one embodiment, the K1 is greater than 1.

In one embodiment, the K1 is equal to 1.

In one embodiment, the first proportional sequence includes K1-1 positive real number(s). The K1-1 positive real numbers is(are) a ratio(s) between the channel quality values other than the best channel quality value of the K1 channel quality values and the best channel quality value.

In one embodiment, the first proportional sequence is composed of quantized values corresponding to the K1-1 positive real number(s).

In one embodiment, when the K1 is equal to 1, the first proportional sequence is determined to be absent.

In one embodiment, the first proportional sequence is composed of K1 positive real numbers. The K1 positive real numbers are respectively ratios between the K1 channel quality values and the best channel quality value of the K1 channel quality values.

In one embodiment, the first proportional sequence is composed of quantized values corresponding to the K1 positive real numbers.

In one embodiment, the first proportional sequence is composed of K1 positive real numbers less than or equal to 1, and the first proportional sequence includes at least one 1.

In one embodiment, the K1 beamforming vectors and the first proportional sequence respectively corresponding to the K1 antenna port groups are used to generate a service beam for data transmission with the UE.

In one embodiment, the transmitter of the first wireless signal determines a correspondence between a service beam related to a relative position of the UE and a collection of the K1 antenna ports and the first proportional sequence according to the coverage space, and then determines the service beam according to the K1 antenna ports and the first proportional sequence reported by the UE.

In one embodiment, the first antenna port group and the second antenna port group are two antenna port groups of the K1 antenna port groups, and the K1 is equal to 2. A first beamforming vector is used for beamforming of the first antenna port group, and a second beamforming vector is used for beamforming of the second antenna port group. The first proportional sequence is composed of a first element

and a second element, wherein the first element corresponds to the first antenna port group, and the second element corresponds to the second antenna port group. The first element is equal to 1, the second element is equal to a, and the a is a positive real number less than 1.

In one embodiment, a transmitter of the first wireless signal uses the first element and the second element to respectively weight the direction corresponding to the first beamforming vector and the direction corresponding to the second beamforming vector so as to obtain a direction corresponding to the service beam.

In one embodiment, a correspondence table is stored in the transmitter of the first wireless signal. The correspondence table is used to determine a correspondence between a serving beam of the UE and a collection of the K1 antenna ports and the first proportional sequence. The transmitter of the first wireless signal retrieves the correspondence table according to the first antenna port group, the second antenna port group and the first proportional sequence to obtain an analog beam direction for communication with the UE.

In one embodiment, the K1 beamforming vectors and the first proportional sequence respectively corresponding to the K1 antenna port groups are used to generate a signal for the next beam scanning. The variables of the generation function of the plurality of beamforming vectors used by the signal are the K1 beamforming vectors and the first proportional sequence.

In one embodiment, a center of the coverage space of the plurality of beamforming vectors is determined by the K1 antenna port groups and the first proportional sequence.

In one embodiment, the K channel quality values are wideband channel quality values.

In one embodiment, the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence includes K1-1 positive real number(s), and the K1-1 positive real numbers is(are) a ratio(ratios) between the channel quality values other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises a quantized value(s) corresponding to K1-1 positive real number(s).

In one embodiment, K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receive beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

In the embodiments, the above methods have the advantages that multiple candidate service beams are generated for different receive beamforming vectors through different beamforming vectors and different proportional sequences of different antenna port groups respectively, thereby increasing the transmission diversity effects.

In one embodiment, the antenna ports in the K1 antenna port groups and the antenna ports in the K2 antenna port groups do not overlap.

In one embodiment, the K1 antenna port groups, and the first proportional sequence are used to generate a first transmitting beamforming vector, while the K2 antenna port groups and the second proportional sequence are used to generate a second transmitting beamforming vector. The first transmitting beamforming vector and the first receiving beamforming vector are used for beamforming of data transmission over a first time window; the second transmitting beamforming vector and the second receiving beamforming vector are used for beamforming of data transmission over a second time window. The first time window and the second time window are orthogonal in time domain.

In one embodiment, the first target channel quality is a function of the K1 channel quality values and the second target channel quality is a function of the K2 channel quality values. The first transmitting beamforming vector is used preferentially when the first target channel quality is higher than the second target channel quality.

In one embodiment, the first target channel quality and the second target channel quality are respectively a weighted average of the K1 channel quality values and the K2 channel quality values. The first proportional sequence and the second proportional sequence are used for the weighted average respectively.

In one embodiment, the first target channel quality and the second target channel quality are respectively an average of the K1 channel quality values and the K2 channel quality values.

In one embodiment, the transmitting beamforming vector and the receiving beamforming vector are analog beamforming vectors.

In one embodiment, any two antenna port groups in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna port groups in the K1 antenna port groups are on a same carrier, and any two antenna port groups in the K2 antenna port groups are on a same carrier.

In the embodiments, an advantage of the above method is that the base station can utilize the first proportional sequence more efficiently by using the K1 antenna port groups to indicate the co-located (quasi-co-located) or co-carrier antenna ports.

In one embodiment, the first signaling is used to determine the co-located or QCL information.

In one embodiment, the first signaling explicitly indicates the co-located or QCL information.

In one embodiment, the first signaling implicitly indicates the co-located or QCL information.

In one embodiment, the first signaling is used to determine information of the co-carrier.

In one embodiment, the first signaling explicitly indicates the information of the co-carrier.

In one embodiment, the first signaling implicitly indicates the information of the co-carrier.

In one embodiment, the first signaling is also used to determine at least the last one of the K1, the K2 and the target threshold. A third channel quality is a best channel quality value of the K2 channel quality values. A fourth channel quality is the worst channel quality value of the K2 channel quality values. The ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

In the embodiments, the advantage of the above method is that the target threshold can be used to control the reporting overhead, thereby improving the reporting efficiency.

In one embodiment, the unit of the target threshold is dB.

In one embodiment, the first signaling explicitly indicates at least the last of the K1, the K2 and the target threshold.

In one embodiment, the first signaling implicitly indicates at least the last of the K1, the K2 and the target threshold.

In one embodiment, the first signaling is transmitted in a plurality of messages.

In one embodiment, the first information is further used to determine at least one of the first channel quality or the third channel quality.

In the embodiments, the advantage of the above method is that the base station may approximately recover the K1 channel qualities (the K2 channel qualities) by using the first channel quality (the third channel quality) and the first proportional sequence (the second proportional sequence), thereby improving flexibility for beam generation and scheduling.

In one embodiment, the first information is transmitted in a plurality of messages.

In one embodiment, the portion of the first information used to determine the first channel quality (the third channel quality) is transmitted in a measurement report; the portion of the first information used to determine the K1 antenna port groups, and the first proportional sequence (the K2 antenna port groups and the second proportional sequence) is transmitted in a CSI report.

In one embodiment, the method for multi-antenna transmission in a UE further comprises:

receiving a second wireless signal;

wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

In the embodiment, the above method has the advantages that the beamforming vector corresponding to the K1 antenna port groups and the first proportional sequence, or the beamforming vector corresponding to the K2 antenna port groups and the second proportional sequence are used for beamforming of the second wireless signal to increase beamforming gain acting on the second wireless signal.

In one embodiment, the transmitting beamforming vector corresponding to the K1 antenna port groups is used to generate a transmitting beamforming vector of the second wireless signal.

In one embodiment, the transmitting beamforming vector corresponding to the K2 antenna port groups is used to generate a transmitting beamforming vector of the second wireless signal.

In one embodiment, when the transmitting beamforming vector corresponding to the K1 antenna port groups is used to generate a transmitting beamforming vector of the second wireless signal, the first receiving beamforming vector is used to receive the second a wireless signal; when the transmitting beamforming vector corresponding to the K2 antenna port groups is used to generate a transmit beamforming vector of the second wireless signal, the second receiving beamforming vector is used for receive the he second wireless signal.

In one embodiment, the transmitting beamforming vector and the receiving beamforming vector are analog beamforming vectors.

In one embodiment, the second wireless signal is a signal carried by a PDCCH.

In one embodiment, the second wireless signal is a signal carried by a PDSCH.

In one embodiment, the second wireless signal is a reference signal.

The present disclosure provides a method for multi-antenna transmission in a base station, including:

transmitting a first signaling;

transmitting a first wireless signal; and

receiving first information;

wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

In one embodiment, the K1 beamforming vectors and the first proportional sequence respectively corresponding to the K1 antenna port groups are used to generate a service beam for data transmission with the UE.

In one embodiment, the base determines a correspondence between a service beam related to a relative position of the UE and the collection of the K1 antenna ports and the first proportional sequence according to the coverage space, and then determines the service beam according to the K1 antenna ports and the first proportional sequence reported by the UE.

In one embodiment, a correspondence table is stored in the base station. The correspondence table is used to determine a correspondence between a service beam of the UE and the collection of the K1 antenna ports and the first proportional sequence. The base station retrieves the correspondence table according to the first antenna port group, the second antenna port group and the first proportional sequence to obtain an analog beam direction for communication with the UE.

In one embodiment, the K1 beamforming vectors and the first proportional sequence respectively corresponding to the K1 antenna port groups are used to generate a signal for the next beam scanning. The variables of the generation function of the plurality of beamforming vectors used by the signal are the K1 beamforming vectors and the first proportional sequence.

In one embodiment, a center of the coverage space of the plurality of beamforming vectors is determined by the K1 antenna port groups and the first proportional sequence.

In one embodiment, the K channel quality values are wideband channel quality values.

In one embodiment, the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; Or the first proportional sequence includes K1-1 positive real number(s), and the K1-1 positive real numbers is(are) a ratio(ratios) between the channel quality values other than

the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises a quantized value(s) corresponding to K1-1 positive real number(s).

In one embodiment, K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receive beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

In one embodiment, the first information is further used by the base station to determine the first receive beamforming vector and the second receive beamforming vector.

In one embodiment, the first information explicitly indicates the first receive beamforming vector and the second receive beamforming vector.

In one embodiment, the first information implicitly indicates the first receive beamforming vector and the second receive beamforming vector.

In one embodiment, any two antenna port groups in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna port groups in the K1 antenna port groups are on a same carrier, and any two antenna port groups in the K2 antenna port groups are on a same carrier.

In one embodiment, the base station generates a service beam by using a co-located (quasi-co-located) or a co-carrier beamforming vector and its corresponding proportional sequence.

In one embodiment, the first signaling is further used to determine at least the last one of the K1, the K2, or the target threshold. A third channel quality is a best channel quality value among the K2 channel quality values. A fourth channel quality is a worse channel quality value among the K2 channel quality values. A ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

In one embodiment, the base station controls reporting overhead by K1, the K2, and the target threshold.

In one embodiment, the first information is further used to determine at least one of the first channel quality or the third channel quality.

In one embodiment, the base station approximately recovers the K1 channel quality values in combination with the first channel quality, the K1 antenna port groups and the first proportional sequence for multi-user MIMO scheduling.

In one embodiment, the base station approximately recovers the K2 channel quality values in combination with the third channel quality, the K2 antenna port groups and the second proportional sequence for multi-user MIMO scheduling.

In one embodiment, the method for multi-antenna transmission in a base station further includes:

transmitting a second wireless signal;

wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

In one embodiment, the K1 beamforming vectors and corresponding to the K1 antenna port groups are used to generate a target beamforming vector. The target beamforming vector is used for beamforming of the target antenna port group.

In one embodiment, the K2 beamforming vectors and corresponding to the K2 antenna port groups are used to generate a target beamforming vector. The target beamforming vector is used for beamforming of the target antenna port group.

The present disclosure provides a user equipment (UE) for multi-antenna transmission, including:

a first receiver, receiving a first signaling;

a second receiver, receiving a first wireless signal; and

a third transmitter, transmitting first information;

wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

In one embodiment of the above user equipment, the K channel quality values are broadband channel quality values.

In one embodiment of the above user equipment, includes K1 positive real numbers less than or equal to 1, and comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; the first proportional sequence comprises K1-1 positive real numbers, and the K1-1 positive real numbers is(are) a ratio(ratios) between the channel quality values other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises a quantized value(s) corresponding to K1-1 positive real number(s).

In one embodiment, K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

In one embodiment of the above user equipment, any two antenna port groups in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna port groups in

the K1 antenna port groups are on a same carrier, and any two antenna port groups in the K2 antenna port groups are on a same carrier.

In one embodiment of the above user equipment, the first signaling is also used to determine at least the last one of the K1, the K2, or the target threshold. A third channel quality is a best channel quality value of the K2 channel quality values. A fourth channel quality is the worst channel quality value of the K2 channel quality values. The ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

In one embodiment of the above user equipment, the first information is further used to determine at least one of the first channel quality or the third channel quality.

In one embodiment of the above user equipment, the second receiver further receives a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence; or the target antenna port group is associated with the K2 antenna port groups and the first proportional sequence.

The present disclosure provides a base station for multi-antenna transmission, including:

a first transmitter, transmitting a first signaling;

a second transmitter, transmitting a first wireless signal; and

a third receiver, receiving first information;

wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

In one embodiment of the above base station, the K channel quality values are broadband channel quality values.

In one embodiment of the above base station, the first proportional sequence includes K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; the first proportional sequence comprises K1-1 positive real numbers, and the K1-1 positive real numbers is(are) a ratio(ratios) between the channel quality values other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises a quantized value(s) corresponding to K1-1 positive real number(s).

In one embodiment, K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine K2 antenna port groups and the second proportional sequence.

In one embodiment of the above base station, any two antenna port groups in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna port groups in the K1 antenna port groups are on a same carrier, and any two antenna port groups in the K2 antenna port groups are on a same carrier.

In one embodiment of the above base station, the first signaling is also used to determine at least the last one of the K1, the K2, or the target threshold. A third channel quality is a best channel quality value of the K2 channel quality values. A fourth channel quality is the worst channel quality value of the K2 channel quality values. The ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

In one embodiment of the above base station, the first information is further used to determine at least one of the first channel quality or the third channel quality.

In one embodiment of the above base station, the second receiver further receives a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence; or the target antenna port group is associated with the K2 antenna port groups and the first proportional sequence.

Compared with the prior art, the present disclosure has the following advantages:

The service beam may be generated and used more flexibly through reporting channel quality ratios to increase beamforming gain.

The robustness and flexibility of subsequent transmissions are increased by multiple sets of reports for varied receiving beamforming.

The flexibility of multi-user scheduling of the base station is increased by the reporting of the best channel quality, combined with the reporting of the channel quality ratio.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features, objects, and advantages of the present disclosure will become more apparent from the detailed description of the accompanying drawings.

FIG. **1** shows a flow chart of transmission of a first signaling, a first wireless signal, and first information in accordance with one embodiment of the present disclosure.

FIG. **2** shows a schematic diagram of a network architecture in accordance with one embodiment of the present disclosure.

FIG. **3** shows a schematic diagram of a radio protocol architecture of a user plane and a control plane according to an embodiment of the present disclosure.

FIG. **4** shows a schematic diagram of a base station device and a given user equipment according to an embodiment of the present disclosure.

FIG. **5** shows a flow chart of wireless transmission in accordance with one embodiment of the present disclosure.

FIG. **6** shows a schematic diagram of analog beamforming of K reference signal groups in accordance with an embodiment of the present disclosure.

FIG. **7** shows a timing diagram of K reference signal groups in accordance with one embodiment of the present disclosure.

FIG. **8** shows a schematic diagram of K1 antenna port groups and K2 antenna port groups in accordance with one embodiment of the present disclosure.

FIG. **9** shows a schematic diagram of a second wireless signal beamforming in accordance with an embodiment of the present disclosure.

FIG. **10** shows a block diagram showing the structure of a processing device in a UE in accordance with an embodiment of the present disclosure.

FIG. **11** shows a block diagram showing the structure of a processing device in a base station in accordance with an embodiment of the present disclosure.

DESCRIPTION OF THE EMBODIMENTS

Embodiment 1

Embodiment 1 illustrates a flow chart of transmission of a first signaling, a first wireless signal, and first information in accordance with one embodiment of the present disclosure, as shown in FIG. **1**. In FIG. **1**, each box represents a step. In Embodiment 1, the user equipment in this disclosure receives a first signaling, receives a first wireless signal, and transmits a first information in sequence. K antenna port groups are used to transmit the first wireless signal. The first signaling is used to determine the K antenna port groups. The K is a positive integer greater than 1. The K antenna port groups respectively correspond to K channel quality values. The K channel quality values are K non-negative real numbers. K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values the K1 is a positive integer less than or equal to the K. A first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values. The first information is used to determine the K1 antenna port groups and the first proportional sequence.

As a sub-embodiment, the first signaling is a higher layer signaling.

As a sub-embodiment, the first signaling is an RRC signaling.

As a sub-embodiment, the first signaling is used to determine configuration of Channel State Information report (CSI).

As a sub-embodiment, the first signaling is an RRC signaling for configuring CSI-RS.

As a sub-embodiment, the first signaling is an RRC signaling for configuring a beamformed CSI-RS (Beamformed CSI-RS).

As a sub-embodiment, the first signaling is a physical layer signaling.

As a sub-embodiment, the first signaling is carried by a PDCCH.

As a sub-embodiment, the first signaling is used to activate RRC pre-configuration.

As a sub-embodiment, the K antenna port groups respectively correspond to K reference signal groups.

As a sub-embodiment, the antenna port group includes only one antenna port.

As a sub-embodiment, the reference signal group includes only one reference signal.

As a sub-embodiment, the K is one of 2, 4, 8, 12, 16, 24, and 32.

As a sub-embodiment, the reference signal is CSI-RS.

As a sub-embodiment, the reference signal is SS.

As a sub-embodiment, the first wireless signal is composed of the K reference signal groups.

As a sub-embodiment, the first wireless signal is composed of K beam-formed CSI-RSs.

As a sub-embodiment, the channel quality value is one of RSRP, SINR, and SNR.

As a sub-embodiment, the channel quality values are wideband channel quality values.

As a sub-embodiment, a wideband channel measurement is used to determine the wideband channel quality values.

As a sub-embodiment, the wideband channel measurement refers to a channel measurement value for the entire system bandwidth obtained by measuring a channel on the entire system bandwidth.

As a sub-embodiment, the wideband channel measurement refers to a channel measurement value for the entire subcarrier bandwidth obtained by measuring a channel on the entire sub-carrier bandwidth.

As a sub-embodiment, the broadband is composed of a plurality of sub-bands, and the sub-bands are composed of one or more Resource Blocks (RBs).

As a sub-embodiment, one RB includes 12 subcarriers.

As a sub-embodiment, one sub-band includes 5 RBs.

As a sub-embodiment, the wideband includes 10 sub-bands.

As a sub-embodiment, the K1 is smaller than the K.

As a sub-embodiment, the K1 is one of 2, 3, and 4.

As a sub-embodiment, the first signaling is used to determine the K.

As a sub-embodiment, the first signaling is used to determine the K1.

As a sub-embodiment, the K1 channel quality values are a best channel quality values among the K channel quality values.

As a sub-embodiment, the first information is used to determine the K1 antenna port groups and the first proportional sequence.

As a sub-embodiment, the first proportional sequence is composed of K1 non-negative real numbers not greater than one.

As a sub-embodiment, the first proportional sequence is composed of K1 positive real numbers not greater than one.

As a sub-embodiment, the first information is used to determine K1-1 non-negative real number(s), and the K1-1 positive real number(s) is(are) a ratio(s) between the channel quality values other than the best channel quality value among the K1 channel quality values and the best channel quality value.

As a sub-embodiment, the first information is used to determine quantized values corresponding to the K1-1 non-negative real number(s).

As a sub-embodiment, any one of the K1-1 non-negative real number(s) is not less than 0 and not greater than 1.

As a sub-embodiment, the K1-1 non-negative real number(s) is(are) used to determine the first proportional sequence.

As a sub-embodiment, the first information is carried by a PUCCH.

As a sub-embodiment, the first signal is carried by a PUSCH.

As a sub-embodiment, the first information is Uplink Control Information (UCI).

Embodiment 2

Embodiment 2 illustrates a schematic diagram of a network architecture in accordance with the present disclosure,

as shown in FIG. **2**. FIG. **2** illustrates a network structure **200** of NR 5G, long-term evolution (LTE) and long-term evolution advanced (LTE-A) systems. The network architecture **200** of NR 5G or LTE may be referred to as an evolve packet system (EPS) **200** or some other suitable terminology. The EPS **200** may include one or more UEs **201**, an NG-RAN **902**, an Evolved Packet Core (EPC)/5G-Core Network (5G-CN) **210**, a home subscriber server (HSS) **220** and an internet service **230**. The EPS **200** may be interconnected with other access networks, but for the sake of simplicity, these entities/interfaces are not shown. As shown in FIG. **2**, the EPS provides packet switching services. Those skilled in the art would readily appreciate that the various concepts presented throughout this disclosure can be extended to networks or other cellular networks that provide circuit switching services. The NG-RAN comprises an NR Node B (gNB) **203** and other gNBs **204**. The gNB **203** provides user and control plane protocol terminations for the UE **201**. The gNB **203** can be connected to other gNBs **204** via an Xn interface (e.g., a backhaul). The gNB **203** may also be referred to as a base station, a base transceiver station, a radio base station, a radio transceiver, a transceiver function, a basic service set (BSS), an extended service set (ESS), a transmission and reception point (TRP), or some other suitable terminology. The gNB **203** provides the UE**201** with an access point to the EPC/5G-CN **210**. In the embodiment, the UE**201** comprises cellular telephones, smart phones, Session Initiation Protocol (SIP) phones, laptop computers, personal digital assistants (PDAs), satellite radios, non-ground base station communications, satellite mobile communications, global positioning systems, multimedia devices, video devices, digital audio player (e.g. MP3 players), cameras, game consoles, drones, aircrafts, narrowband physical network devices, machine type communication devices, land vehicles, cars, wearable devices, or any other similar to functional devices. A person skilled in the art may also refer to UE **201** as a mobile station, a subscriber station, a mobile unit, a subscriber unit, a radio unit, a remote unit, a mobile device, a radio device, a radio communication device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a radio terminal, remote terminal, handset, user agent, mobile client, client or some other suitable term. The gNB **203** is connected to the EPC/5G-CN **210** through an S1/NG interface. The EPC/5G-CN **210** comprises an MME/AMF/UPF **211**, other MMEs/AMFs/UPFs **214**, a Service Gateway (S-GW) **212** and a Packet Date Network Gateway (P-GW) **213**. The MME/AMF/UPF **211** is a control node that handles a signaling between the UE **201** and the EPC/5G-CN **210**. In general, the MME/AMF/UPF **211** provides carrier and connection management. All User Internet Protocol (IP) packets are transmitted through the S-GW **212**, and the S-GW **212** itself is connected to the P-GW **213**. The P-GW **213** provides UE IP address allocation as well as other functions. The P-GW **213** is connected to the internet service **230**. The internet service **230** includes an operator-compatible internet protocol service, and may specifically include the Internet, an intranet, an IP Multimedia Subsystem (IMS), and a PS streaming service (PSS).

As a sub-embodiment, the UE **201** corresponds to the user equipment in this disclosure.

As a sub-embodiment, the gNB **203** corresponds to the base station in the present disclosure.

As a sub-embodiment, the UE **201** supports multi-antenna transmission.

As a sub-embodiment, the UE **201** supports wideband channel measurement.

As a sub-embodiment, the gNB **203** supports multi-antenna transmission.

As a sub-embodiment, the gNB **203** supports wideband beamforming.

Embodiment 3

Embodiment 3 illustrates a schematic diagram of a radio protocol architecture of a user plane and a control plane according to an embodiment of the present disclosure, as shown in FIG. **3**. FIG. **3** is a schematic diagram illustrating an embodiment of a radio protocol architecture for a user plane and a control plane, and FIG. **3** illustrates a radio protocol architecture for the UE and the base station equipment (gNB or eNB) in three layers: layer 1, layer 2 and layer 3. The Layer 1 (L1 layer) is the lowest layer and implements various signal processing functions of the physical layer (i.e., PHY). The L1 layer will be referred to herein as PHY **301**. The Layer 2 (L2 layer) **305** is above PHY **301** and is responsible for the link between the UE and the gNB through PHY **301**. In the user plane, L2 layer **305** comprises a media access control (MAC) sub-layer **302**, a radio link control (RLC) sub-layer **303** and a packet data convergence protocol (PDCP) sub-layer **304**, and these sub-layers terminate at the gNB of the network side. Although not illustrated in FIG. **3**, the UE may have several upper layers above the L2 layer **305**, including a network layer (i.e., an IP layer) terminated at the P-GW of the network side and an application layer terminated at the other side of the connection (i.e., a peer UE, server, etc.). The PDCP sub-layer **304** provides multiplexing between different radio bearers and logical channels. The PDCP sublayer **304** also provides header compression for an upper layer packet to reduce a radio transmission overhead, provides security by encrypting a packet, and provides support for UE handover between gNBs. The RLC sublayer **303** provides segmentation and reassembling of an upper layer data packet, retransmission of a lost packets and reordering of a packet to compensate for the disordered reception resulted from the hybrid automatic repeat request (HARQ). The MAC sublayer **302** provides multiplexing between a logical channel and a transport channel. The MAC sublayer **302** is also responsible for allocating various radio resources (i.e., resource blocks) in one cell between UEs. The MAC sublayer **302** is also responsible for HARQ operation. In the control plane, the radio protocol architecture for the UE and gNB is substantially the same as the radio protocol architecture in the user plane on the physical layer **301** and the L2 layer **305**, but there is no header compression function for the control plane. The control plane also comprises a Radio Resource Control (RRC) sublayer **306** in Layer 3 (L3 layer). The RRC sublayer **306** is responsible for obtaining radio resources (i.e. radio bearers) and configuring the lower layer using an RRC signaling between the gNB and the UE.

In one embodiment, the radio protocol architecture of FIG. **3** is applicable to the user equipment in this disclosure.

In one embodiment, the radio protocol architecture of FIG. **3** is applicable to the base station in this disclosure.

As a sub-embodiment, the first signaling in the present disclosure is generated in the RRC sublayer **306**.

As a sub-embodiment, the first signaling in the present disclosure is generated by the PHY **301**.

As a sub-embodiment, the first wireless signal in the present disclosure is generated by the PHY **301**.

As a sub-embodiment, the first information in the present disclosure is generated by the PHY **301**.

Embodiment 4

Embodiment 4 shows a schematic diagram of a base station device and a given user equipment according to the present disclosure, as shown in FIG. **4**. FIG. **4** is a block diagram of a gNB **410** in communication with a UE**450** in an access network.

The base station (**410**) may comprise a controller/processor **440**, a scheduler **443**, a memory **430**, a receiving processor **412**, a transmitting processor **415**, a MIMO transmitting processor **441**, a MIMO detector **442**, a transmitter/receiver **416**, and an antenna **420**.

The user equipment (UE**450**) may comprise a controller/processor **490**, a memory **480**, a data source **467**, a transmitting processor **455**, a receiving processor **452**, a MIMO transmitting processor **471**, a MIMO detector **472**, a transmitter/receiver **466**, and an antenna **460**.

In Downlink (DL) transmission, the processing associated with the base station (**410**) may include the following operations:

The upper layer packet is provided to the controller/processor **440**. The controller/processor **440** provides header compression, encryption, packet segmentation and reordering, and multiplexing between a logical channel and a transport channel so as to implement L2 layer protocols for the user plane and the control plane. The upper layer packet may include data or control information, such as a Downlink Shared Channel (DL-SCH).

The controller/processor **440** can be associated with the memory **430** that stores program codes and data. The memory **430** can be a computer readable medium.

The controller/processor **440** notifies the scheduler **443** to transmit the demand. The scheduler **443** is configured to schedule the air interface resource corresponding to the transmission requirement, and notify the controller/processor **440** of the scheduling result.

The transmitting processor **415** receives the output bitstream of controller/processor **440**, and implements various signal transmission processing functions for the L1 layer (i.e., the physical layer), including encoding, interleaving, scrambling, modulation, power control/allocation and generation of physical layer control signaling (including PBCH, PDCCH, PHICH, PCFICH, a reference signal), etc.

The MIMO transmitting processor **441** performs spatial processing for data symbols, control symbols or reference signal symbols (such as precoding, beam shaping), and outputs baseband signals to the transmitter **416**.

The transmitter **416** is configured to convert the baseband signal provided by the MIMO transmitting processor **441** into a radio frequency signal and to transmit the radio frequency signal via the antenna **420**. Each transmitter **416** samples the respective input symbol streams to obtain a respective sampled signal stream. Each transmitter **416** performs further processing (e.g., digital to analog conversion, amplification, filtering, upconversion, etc.) on a respective sampled stream to obtain a downlink signal.

In Downlink (DL) transmission, the processing associated with the user equipment (UE**450**) may include the following operations:

The receiver **456** is configured to convert the radio frequency signal received through the antenna **460** into a baseband signal and provide the baseband signal to the MIMO detector **472**.

The MIMO detector **472** is configured to perform MIMO detection on the signal received from the receiver **456**, and provide the MIMO-detected baseband signal to the receiving processor **452**.

The receiving processor **452** implements various signal receiving processing functions for the L1 layer (i.e., the physical layer) including decoding, deinterleaving, descrambling, demodulation, and physical layer control signaling extraction, etc.

The controller/processor **490** receives the bitstream output by the receive processor **452**. The controller/processor **490** provides header compression, encryption, packet segmentation and reordering, and multiplexing between a logical channel and a transport channel to implement L2 layer protocols for the user plane and the control plane.

The controller/processor **490** can be associated with the memory **480** that stores program codes and data. The memory **480** can be a computer readable medium.

The first signaling in the present disclosure may be generated by the transmitting processor **415** or transmitted to the controller/processor **440** by higher layer signaling. The scheduler **443** schedules the air interface resources occupied by the first signaling. The MIMO transmission processor **441** performs multi-antenna precoding processing on the symbols output by the transmission processor. The transmitter **416** converts the baseband signal provided by the MIMO transmitting processor **441** into a radio frequency signal and transmits the radio frequency signal via the antenna **420**. The receiver **456** converts the radio frequency signal received by the antenna **460** and the first signaling into a baseband signal and provides the baseband signal to the MIMO detector **472**. The MIMO detector **472** performs MIMO detection on the signal received from the receiver **456**. The receiving processor **452** processes the baseband signal output by the MIMO detector **472** to obtain the first signaling or transmits the baseband signal to the controller/processor **440** for further processing related to a higher layer to obtain the first signaling.

The first wireless signal in the present disclosure is K reference signal groups generated by the transmitting processor **415**. The MIMO transmitting processor **441** performs beamforming processing on the K reference signal groups output by the transmitting processor, and transmits the K reference signal groups to the K antenna port groups for transmission. The transmitter **416** converts the baseband signal provided by the MIMO transmitting processor **441** into a radio frequency signal and transmits the radio frequency signal via the antenna **420**. The receiver **456** converts the radio frequency signal received by the antenna **460** and the first radio signal into a baseband signal and provides the first radio signal to the MIMO detector **472**. The MIMO detector **472** performs MIMO detection on the signal received from the receiver **456**. The receiving processor **452** performs channel measurement based on the baseband signal output by the MIMO detector **472** and the K reference signal groups to obtain the K channel quality values.

In Uplink (UL) transmission, the processing associated with the user equipment (UE**450**) may include the following operations:

The data source **467** provides an upper layer packet to the controller/processor **490**. The controller/processor **490** provides header compression, encryption, packet segmentation and reordering, and multiplexing between logical and transport channels to implement L2 layer protocols for the user plane and the control plane. The upper layer packet may include data or control information, such as an Uplink Shared Channel (UL-SCH).

The controller/processor **490** can be associated with the memory **480** that stores program codes and data. The memory **480** can be a computer readable medium.

The transmitting processor **455** receives the bitstream output by the controller/processor **490**, and implements various signal transmission processing functions for the L1 layer (i.e., the physical layer), including encoding, interleaving, scrambling, modulation, power control/allocation and generation of physical layer control signaling (including PUCCH, Sounding Reference Signal (SRS)), etc.

The MIMO transmitting processor **471** performs spatial processing for data symbols, control symbols or reference signal symbols (such as precoding, beam shaping), and outputs baseband signals to the transmitter **456**.

The transmitter **456** is configured to convert the baseband signal provided by the MIMO transmitting processor **471** into a radio frequency signal and to transmit the radio frequency signal via the antenna **460**. Each transmitter **456** samples the respective input symbol streams to obtain a respective sampled signal stream. Each transmitter **456** performs further processing (e.g., digital to analog conversion, amplification, filtering, upconversion, etc.) on the respective sample stream to obtain an uplink signal.

In Uplink (UL) transmission, the processing associated with the base station (**410**) may include the following operations:

The receiver **416** is configured to convert the radio frequency signal received by the antenna **420** into a baseband signal and provide the baseband signal to the MIMO detector **442**.

The MIMO detector **442** is configured to perform MIMO detection on the signal received from the receiver **416**, and provide the MIMO-detected baseband signal to the receiving processor **442**.

The receiving processor **412** implements various signal receiving processing functions for the L1 layer (i.e., the physical layer) including decoding, deinterleaving, descrambling, demodulation, and physical layer control signaling extraction, etc.

The controller/processor **440** receives the bitstream output by the receiving processor **412**. The controller/processor **490** provides header compression, encryption, packet segmentation and reordering, and multiplexing between a logical channel and a transport channel to implement L2 layer protocols for the user plane and the control plane.

The controller/processor **440** can be associated with the memory **430** that stores program codes and data. The memory **430** can be a computer readable medium.

The first information in the present disclosure may be generated by the transmitting processor **455** to the controller/processor **490**. The MIMO transmitting processor **471** performs multi-antenna precoding processing on the symbols output by the transmitting processor. The transmitter **456** converts the baseband signal provided by the MIMO transmitting processor **471** into a radio frequency signal and transmits the radio frequency signal via the antenna **460**. The receiver **416** converts the radio frequency signal related to the first information received by the antenna **420** into a baseband signal and provides the baseband signal to the MIMO detector **442**. The MIMO detector **442** performs MIMO detection on the signal received from the receiver **416**. The receiving processor **412** processes the baseband signal output by the MIMO detector **442** to obtain the first information.

As a sub-embodiment, the UE **450** includes: at least one processor and at least one memory. The at least one memory includes computer program code. The at least one memory and the computer program code are configured to use with the at least one processor together. The UE**450** at least: receives a first signaling; receives a first wireless signal; and transmits first information; wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence.

As a sub-embodiment, the UE **450** includes: a memory storing a computer readable instruction program that, when executed by at least one processor, performs operations. The operations include: receiving a first signaling; receiving a first wireless signal; and transmitting first information; wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence.

As a sub-embodiment, the gNB**410** includes: at least one processor and at least one memory. The at least one memory includes computer program code. The at least one memory and the computer program code are configured to use with the at least one processor together. The UE**450** at least: transmits a first signaling; transmits a first wireless signal; and receives first information; wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence.

As a sub-embodiment, the UE **450** includes: a memory storing a computer readable instruction program that, when executed by at least one processor, performs operations. The operations include: transmitting a first signaling; transmitting a first wireless signal; and receiving first information; wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality

values; the first information is used to determine the K1 antenna port groups and the first proportional sequence.

As a sub-embodiment, the UE **450** corresponds to the user equipment in this disclosure.

As a sub-embodiment, the gNB **410** corresponds to the base station in the present disclosure.

As a sub-embodiment, at least the first three of the receiver **456**, the MIMO detector **472**, the receiving processor **452**, and the controller/processor **490** are used to receive the first signaling in the present disclosure.

As a sub-embodiment, at least the first three of the transmitter **416**, the MIMO transmitter **441**, the transmitting processor **415**, and the controller/processor **440** are used to transmit the first signaling in this disclosure.

As a sub-embodiment, the receiver **456**, the MIMO detector **472** and the receiving processor **452** are used to receive the first wireless signal in the present disclosure.

As a sub-embodiment, the transmitter **416**, the MIMO transmitter **441** and the transmit processor **415** are used to transmit the first wireless signal in this disclosure.

As a sub-embodiment, at least the first three of the transmitter/receiver **456**, the MIMO transmitter **471**, the transmitting processor **455**, and the controller/processor **490** are used to transmit the first information in this disclosure.

As a sub-embodiment, the receiver **416**, the MIMO detector **442**, and the receiving processor **412** are used to receive the first information in this disclosure.

Embodiment 5

Embodiment 5 illustrates a flow chart of wireless transmission, as shown in FIG. **5**. In FIG. **5**, the base station N1 is a maintaining base station for the serving cell of the UE U2. In FIG. **5**, the steps in block F1 are optional.

For N1, the first signaling is transmitted in step S**11**; the first wireless signal is transmitted in step S**12**; the first information is received in step S**13**; and the second signal is transmitted in step S**14**.

For U2, the first signaling is received in step S**21**; the first wireless signal is received in step S**22**; the first information is transmitted in step S**23**; and the second signal is received in step S**24**.

In Embodiment 5, K antenna port groups are used to transmit the first wireless signal the first signaling is used to determine the K antenna port groups by U2. The K is a positive integer greater than 1. The K antenna port groups respectively correspond to K channel quality values. The K channel quality values are K non-negative real numbers. K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values the K1 is a positive integer less than or equal to the K. A first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values. The first information is used to determine the K1 antenna port groups and the first proportional sequence.

As a sub-embodiment, K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values. The K2 is a positive integer less than or equal to the K a second proportional sequence corresponds to a ratio among the K2 channel quality values. A first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups by U@. A second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups by U2. The first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

As a sub-embodiment, any two antenna port groups in the K1 antenna port groups, and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or, any two antenna port groups in the K1 antenna port groups, and any two antenna port groups in the K2 antenna port groups are on the same carrier.

As a sub-embodiment, the first signaling is further used to determine at least the last one of the K1, the K2, or the target threshold by U2. The target threshold is a non-negative real number. The first channel quality is the best channel quality value of the K1 channel quality values. The second channel quality is the worst channel quality value of the K1 channel quality values. The third channel quality is the best channel quality value of the K2 channel quality values. The fourth channel quality is the worst channel quality value of the K2 channel quality values. At least one of a ratio between the second channel quality and the first channel quality, or a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

As a sub-embodiment, the first information is further used by U2 to determine at least one of the first channel quality or the third channel quality.

As a sub-embodiment, the target antenna port group is used by N1 to transmit the second wireless signal.

As a sub-embodiment, the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence. The K1 antenna port groups correspond to K1 analog beamforming vectors. The K1 analog beam vectors and the first proportional sequence are used by N1 to generate a first target analog beamforming vector. The first target analog beamforming vector is used for analog beamforming of the target antenna port group. The first receive beamforming vector is used by U2 to receive the second wireless signal.

As a sub-embodiment, the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence. The K2 antenna port groups correspond to K2 analog beamforming vectors. The K2 analog beam vectors and the second proportional sequence are used by N1 to generate a second target analog beamforming vector. The second target analog beamforming vector is used for analog beamforming of the target antenna port group. The second receive beamforming vector is used by U2 to receive the second wireless signal.

Embodiment 6

Embodiment 6 illustrates a schematic diagram of analog beamforming of K reference signal groups, as shown in FIG. **6**.

In Embodiment 6, the K reference signal groups and the K antenna port groups are in one-to-one correspondence. The number of the reference signals in the reference signal group is equal to the number of the antenna ports in the corresponding antenna port group.

In Embodiment 6, a physical antenna corresponding to one antenna port is divided into S antenna groups, and each of the antenna groups includes a plurality of antennas. The S is a positive integer. The antenna port is formed by superposing multiple antennas in the S antenna groups through antenna virtualization. The mapping coefficients of the plurality of antennas in the S antenna groups to the antenna port constitute a beamforming vector. One antenna group is connected to the baseband processor via a radio

frequency (RF) link. One beamforming vector is composed of an analog beamforming vector and a digital beamforming vector. The mapping coefficients of the plurality of antennas in the same antenna group to the antenna port constitute an analog beamforming vector of the antenna group. Different antenna groups included in one antenna port corresponding to the same analog beamforming vector. The mapping coefficients of the different RF links included in the antenna port to the antenna port constitute a digital beamforming vector of the antenna port.

As a sub-embodiment, the reference signal group includes only one reference signal, and the reference signal in the reference signal group is transmitted by an antenna port in a corresponding transmitting antenna port group.

As a sub-embodiment, the reference signal group includes only a plurality of the reference signals, and the plurality of reference signals in the reference signal group are respectively sent by multiple antenna ports in the corresponding transmitting antenna port group. Different antenna ports in one antenna port group correspond to one same analog beamforming vector.

As a sub-embodiment, different antenna ports in one antenna port group correspond to the different digital beamforming vectors.

As a sub-embodiment, the K antenna port groups are a subset of M antenna port groups. The UE transmits auxiliary information according to the measurement in the M antenna port groups. The base station determines, according to the auxiliary information, and configures the K antenna port groups for the UE.

Embodiment 7

Embodiment 7 illustrates a timing diagram of K reference signal groups, as shown in FIG. **7**.

In Embodiment 7, the K antenna port groups correspond to K reference signal groups. The time domain resources occupied by any two antenna port groups in the K reference signal groups are orthogonal. The analog beamforming vectors corresponding to any two reference signal groups in the K reference signal groups cannot be considered to be the same. The K reference signal groups occupy K time windows. The K time windows are orthogonal in the time domain.

As a sub-embodiment, FIG. **7** depicts one transmission of the K reference signal groups. The K reference signal groups are transmitted periodically.

As a sub-embodiment, the reference signal adopts a pattern of CSI-RS within a time window.

As a sub-embodiment, the reference signal adopts a pattern of SS within a time window.

As a sub-embodiment, the time window in FIG. **7** includes Q1 OFDM symbols, and the Q1 is one of 2, 4, 7 and 14.

Embodiment 8

Embodiment 8 illustrates a schematic diagram of K1 antenna port groups and K2 antenna port groups, as shown FIG. **8**. In Embodiment 8, the K antenna port groups are used to transmit the first wireless signal. The K analog beamforming vectors are used for transmitting analog beamforming of the K antenna port groups respectively. The K antenna port groups respectively correspond to K channel quality values. The best K1+K2 channel quality values of the K channel quality values respectively correspond to the first receive beamforming vector and the second receive beamforming vector. The first receiving beamforming vector performs receiving analog beamforming on the signals transmitted through the K1 antenna port groups. The second receiving beamforming vector performs receiving analog beamforming on the signals transmitted through the K2 antenna port groups.

Embodiment 9

Embodiment 9 illustrates a schematic diagram of a second wireless signal beamforming, as shown in FIG. **9**. In FIG. **9**, the dotted ellipse represents an analog beam for transmitting a first wireless signal, and the solid ellipse represents an analog beam for transmitting a second wireless signal.

In Embodiment 9, the UE receives the first wireless signal transmitted through the K antenna port groups. The K antenna port groups correspond to the K channel quality values. The UE receives the first signaling to determine that K1 is equal to 2. The first antenna port group and the second antenna port group are two antenna port groups of the K antenna port groups. The first antenna port group corresponds to the first channel quality. The second antenna port group is corresponding to the second channel quality. The first channel quality is a best channel quality value of the K channel quality values. The second channel quality is a second best channel quality value of the K channel quality values. The UE reports {the first antenna port group, the second antenna port group, and the first proportional sequence} to the base station. The first proportional sequence is composed of 1, ratio of the second channel quality and the first channel quality. The first analog beamforming vector is used for analog beamforming of the first antenna port group. The second analog beamforming vector is used for analog beamforming of the second antenna port group. The base station generates a target analog beamforming vector by using a direction corresponding to the first analog beamforming vector, a direction corresponding to the second analog beamforming vector, and the first proportional sequence according to the UE report. The beam direction corresponding to the target analog beamforming vector is between a beam direction corresponding to the first analog beamforming vector and a beam direction corresponding to the second analog beamforming vector. The target analog beamforming vector is used for analog beamforming of the target antenna port group. The target antenna port group is used to transmit the second wireless signal.

Embodiment 10

Embodiment 10 illustrates a block diagram showing the structure of a processing device in a UE. In FIG. **10**, a UE **1000** is composed of a first receiver **1001**, a second receiver **1002**, and a third transmitter **1003**.

In Embodiment 10, the first receiver **1001** is configured to receive the first signaling; the second receiver **1002** is configured to receive the first wireless signal; and the third transmitter **1003** is configured to send the first information.

In Embodiment 10, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups. The K is a positive integer greater than 1. The K antenna port groups respectively correspond to K channel quality values. The K channel quality values are K non-negative real numbers. K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values. The K1 is a positive integer less than or equal to the K. A first proportional sequence corresponds to a ratio(ratios)

among the K1 channel quality values. The first information is used to determine the K1 antenna port groups and the first proportional sequence.

As a sub-embodiment, the K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values. The K2 is a positive integer less than or equal to the K. A second proportional sequence corresponds to a ratio among the K2 channel quality values. A first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups. A second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups. The first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

As a sub-embodiment, any two antenna port groups in the K1 antenna port groups, and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or, any two antenna port groups in the K1 antenna port groups and any two antenna port groups in the K2 antenna port groups are on the same carrier.

As a sub-embodiment, the first signaling is further used to determine at least the last one of the K1, the K2, or the target threshold. The target threshold is a non-negative real number. The first channel quality is a best channel quality value of the K1 channel quality values. The second channel quality is the worst channel quality value of the K1 channel quality values. The third channel quality is a best channel quality value of the K2 channel quality values. The fourth channel quality is the worst channel quality value of the K2 channel quality values. At least one of a ratio between the second channel quality and the first channel quality or a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

As a sub-embodiment, the first information is further used to determine at least one of the first channel quality or the third channel quality.

As a sub-embodiment, the second receiver **1002** is also used to receive a second wireless signal. The target antenna port group is used to transmit the second wireless signal. The target antenna port group is associated with the K1 antenna port groups and the first proportional sequence; or, the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

Embodiment 11

Embodiment 11 illustrates a block diagram showing the structure of a processing device in a base station, as shown in FIG. **11**.

In FIG. **11**, the base station **1100** includes a first transmitter **1101**, a second transmitter **1102**, and a third receiver **1103**.

In Embodiment 11, the first transmitter **1101** is configured to transmit the first signaling; the second transmitter **1102** is configured to transmit the first wireless signal; and the third receiver **1103** is configured to receive the first information.

In Embodiment 11, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups. The K is a positive integer greater than 1. The K antenna port groups respectively correspond to K channel quality values. The K channel quality values are K non-negative real numbers. K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values. The K1 is a positive integer less than or equal to the K. A first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values. The first information is used to determine the K1 antenna port groups and the first proportional sequence.

As a sub-embodiment, the K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values. The K2 is a positive integer less than or equal to the K. A second proportional sequence corresponds to a ratio among the K2 channel quality values. A first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups. A second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups. The first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

As a sub-embodiment, any two antenna port groups in the K1 antenna port groups, and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or, any two antenna port groups in the K1 antenna port groups, and any two antenna port groups in the K2 antenna port groups are on the same carrier.

As a sub-embodiment, the first signaling is further used to determine at least the last one of the K1, the K2, or the target threshold. The target threshold is a non-negative real number. The first channel quality is a best channel quality value of the K1 channel quality values. The second channel quality is the worst channel quality value of the K1 channel quality values. The third channel quality is a best channel quality value of the K2 channel quality values. The fourth channel quality is the worst channel quality value of the K2 channel quality values. At least one of a ratio between the second channel quality and the first channel quality or a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

As a sub-embodiment, the first information is further used to determine at least one of the first channel quality or the third channel quality.

As a sub-embodiment, the second transmitter is further configured to transmit a second wireless signal. The target antenna port group is used to transmit the second wireless signal. The target antenna port group is associated with the K1 antenna port group and the first proportional sequence; or the target antenna port group is associated with the K2 antenna port group and the second proportional sequence.

The ordinary skill in the art may understand that all or part of steps in the above method may be implemented by instructing related hardware through a program. The program may be stored in a computer readable storage medium, for example Read-Only-Memory (ROM), hard disk or compact disc, etc. Optionally, all or part of steps in the above embodiments also may be implemented by one or more integrated circuits. Correspondingly, each module unit in the above embodiment may be implemented in the form of hardware, or in the form of software function modules. The present disclosure is not limited to any combination of hardware and software in specific forms. The UE and terminal in the present disclosure include but are not limited to unmanned aerial vehicles, communication modules on unmanned aerial vehicles, telecontrolled aircrafts, aircrafts, diminutive airplanes, mobile phones, tablet computers, notebooks, vehicle-mounted communication equipment, radio sensor, network cards, terminals for Internet of Things (IOT), RFID terminals, NB-IOT terminals, Machine Type Communication (MTC) terminals, enhanced MTC (eMTC) terminals, data cards, low-cost mobile phones, low-cost

tablet computers, etc. The base station in the present disclosure includes but is not limited to macro-cellular base stations, micro-cellular base stations, home base stations, relay base station, gNB (NR node B), Transmitter Receiver Point (TRP), and other radio communication equipment.

The above are merely the preferred embodiments of the present disclosure and are not intended to limit the scope of protection of the present disclosure. Any modification, equivalent substitute and improvement made within the spirit and principle of the present disclosure are intended to be included within the scope of protection of the present disclosure.

What is claimed is:

1. A method for multi-antenna transmission in a user equipment (UE), comprising:

receiving, by the UE, a first signaling originating from a base station;

receiving, by the UE, a first wireless signal originating from the base station; and

transmitting, by the UE, first information to the base station;

wherein, K antenna port groups of the base station are used to transmit the first wireless signal; the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or a Signal to Interference plus Noise Ratios (SINRs); K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

2. The method according to claim **1**, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

3. The method according to claim **1**, wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receive beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

4. The method according to claim **3**, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.

5. The method according to claim **3**, further comprising:

receiving a second wireless signal;

wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

6. A method for multi-antenna transmission in a base station, comprising:

transmitting, by the base station, a first signaling to a user equipment (UE);

transmitting, by the base station, a first wireless signal to the UE; and

receiving, by the base station, first information from the UE;

wherein, K antenna port groups of the base station are used to transmit the first wireless signal; the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs); K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

7. The method according to claim **6**, wherein the K channel quality values are broadband channel quality values;

or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

8. The method according to claim **6**, wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

9. The method according to claim **8**, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.

10. The method according to claim **8**, further comprising:

transmitting a second wireless signal;

wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

11. A user equipment (UE) for multi-antenna transmission comprising:

a first receiver at the UE, receiving a first signaling originating from a base station;

a second receiver at the UE, receiving a first wireless signal originating from the base station; and

a third transmitter at the UE, transmitting first information to the base station;

wherein, K antenna port groups of the base station are used to transmit the first wireless signal; the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs); K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

12. The user equipment to claim **11**, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

13. The user equipment to claim **11**, wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

14. The user equipment to claim **13**, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.

15. The user equipment to claim **13**, wherein the second receiver further receives a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

16. A base station for multi-antenna transmission comprising:

a first transmitter at the base station, transmitting a first signaling to a user equipment (UE);

a second transmitter at the base station, transmitting a first radio signal to the UE; and

a third receiver at the base station, receiving first information from the UE;

wherein, K antenna port groups of the base station are used to transmit the first wireless signal; the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs); K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

17. The base station to claim 16, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers;

or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

18. The base station to claim 16, wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

19. The base station to claim 18, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.

20. The base station to claim 18, wherein the second transmitter further transmits a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

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